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Article

Tracking the performance of an R&D programme in the biomedical sciences

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Abstract

This article aims at offering an evaluation framework of an R&D programme in the biomedical sciences. It showcases the Spanish Biomedical Research Networking Centres (CIBER) initiative as an example of the effect of research policy management on performance. For this, it focuses on three specific aspects: its role on the national research output in the biomedical sciences, its effect on promoting translational research through internal collaboration between research groups, and the perception of researchers on the programme as defined by their inclusion of their CIBER centres in the address field. Research output derived from this programme represents around 25% of the country's publications in the biomedical fields. After analysing a 7-year period, the programme has enhanced collaborations between its members, but they do not seem to be sufficiently strong. 54.5% of the publications mentioned this programme in their address; however, an increase in the share of papers mention is observed 2 years after it was launched. We suggest that by finding the point at which the share of mentions stabilizes may be a good strategy to identify the complete fulfilment of these types of R&D policies.

Key words: networking centres; biomedical areas; Spain; collaboration; bibliometric indicators; address analysis.

1. Introduction

Efforts on linking basic research with clinical practices in the biomedical sciences have lately become a priority issue in the research agenda of many countries (Rettig, Schechter and Perlman 2004; Barjak, Es-Sadki and Arundel 2015). Since 1979, many have denounced a declining interest on clinical research and on the translation of basic research to societal demands (i.e., Rettig, Schechter and Perlman 2004). As a consequence, in the past decade some countries have introduced research policies to enhance 'translational' research and promote collaboration between clinicians and researchers. Examples of such policies are the European Clinical Research Infrastructures Network (Demotes-Mainard and Ohmann 2005) or the consortium of Clinical and Translational Science Centers promoted by the National Institutes of Health (NIH) in the USA (Butler 2008). The basis of such programmes rests on the idea that by strengthening collaboration between researchers and practitioners the interactions between them will eventually lead to translational outcomes.

While this approach seems reasonable, it will succeed depending on the role collaboration plays as a catalyst between research output and clinical practice. In this sense, many studies have explored publication patterns related with the production of translational research in the biomedical sciences. Luwel and Wijk (2014) analysed biomedical journals indexed in the Web of Science database containing the word 'translational' in their title and compared them with other biomedical journals. Their goal was to study if they published more interdisciplinary work than other journals. They concluded by observing that interdisciplinary work took place more often in papers co-authored by researchers from different institutional categories. Lander and Atkinson-Grosjean (2011) looked into the relationship between scientists and clinicians when researching on a particular disease. Among other findings, they reported that these interactions were more fruitful in the public sector and that the translational research process was 'iterative and untidy' (Lander and

Atkinson-Grosjean 2011). Molas-Gallart et al. (2014) explored the ways in which translational research takes place and what factors may promote collaboration between the different actors.

Scientific collaboration is a widely studied topic in the field of scientometrics (i.e., Beaver and Rosen 1978; Katz and Martin 1997). Generally, it is studied by using co-authorship as an indicative of such collaboration. Although co-authorship is not the only trace collaboration leaves, studies in this regard have shown that it enhances research productivity (Lee and Bozeman 2005) and citation impact (Glänzel 2001). Other studies suggest further benefits when such collaboration is between authors from different institutional categories, such as more innovative and creative research (Bordons, Aparicio and Costas 2013). In this context, many research policies and strategies have been introduced to promote such collaboration links in the biomedical sciences. In our case, we focus specifically on research group collaboration or team collaboration. Most literature analysing research teams focus on how they are developed and the internal structure within their members (i.e., Rey-Rocha, Garzón-García and Martín-Sempere 2006; Cabezas-Clavijo, Jiménez-Contreras and Delgado López-Cózar 2013). The analysis of team collaboration has been paid little attention and only some recent studies can be found in this regard (Benito Amat and Perruchas 2015).

This article focuses on a specific research programme that aims to establish such collaborative networks between clinicians and researchers at the national level. Specifically, we analyse the case of the Spanish Biomedical Research Networking Centres (known as CIBER for their Spanish acronym). Researchers and policy makers in Spain have shown great interest in the past decade to promote collaboration in the biomedical field introducing many initiatives and strategies in its national research agenda (de Pablo and Arenas 2008). Here we mention the introduction of the FIS/Miguel Servet Research Contract Programme which intends to incorporate basic researchers in hospitals (Rey-Rocha and Martín-Sempere 2012). The CIBER initiative is the most important programme in Spain with an annual budget of around €42,000,000. This programme was launched in 2006 pursuing the following goals:

1. Promote excellent research in the biomedical sciences in the National Health System and the National Science and Technology System by launching and promoting stable networking structures.
2. Enhance collaboration links between different research groups through these networking structures in order to strengthen research conducted on the priority areas stated by the different Spanish National Research & Development Plans.
3. Promote translational research by integrating research groups and research members from different institutional categories and connecting clinical practice with basic research.

As a result, seven CIBER centres were created in 2006 and two more in the subsequent year. Each of the nine centres is thematically oriented and comprises a number of research groups scattered through the country. These centres are not physical—meaning that they do not bring together geographically the research groups which are still located in their original institution—but serve as virtual platforms by which collaboration can be channelled. In order to be included in the CIBER programme, research groups had to apply and pass an evaluation process. Hence, these groups are considered to have a high research profile. In Table 1 we include the fields in which each centre is focused, the year in which they were launched, and the acronym by which they will be referred to in this study. Research groups integrating each centre were selected by a national open call and these could be placed in universities, public research organizations, hospitals, or other research foundations (Molas-Gallart et al. 2014).

The CIBER initiative has gained great interest since its conception, not only nationally, but also at the international level, analysing different aspects of such programme. Three years after its creation, a bibliometric report focused on CIBER 2 indicated that collaboration patterns within the research groups that belonged to this centre were similar to those not belonging to the programme and the overall showed slightly lower collaboration patterns than the national average in biomedicine (Méndez-Vásquez et al. 2009). Contrarily, Delgado Rodríguez (2012) enhanced the importance of the CIBER programme and specifically the role that CIBER 2 played in the promotion and diffusion of excellent research in the Spanish biomedical sciences. Such optimistic view on the importance of such initiative in the field seems to be shared by most researchers and clinicians belonging to the programme (Jimenez-Contreras 2015).

Morillo et al. (2014) offer an interesting perspective with regard to the impact of the CIBER centres on collaboration and citation impact. Instead of focusing on specific centres, they analyse two different disciplines which should fairly represent CIBER 4 and CIBER 9, concluding that collaboration and impact rates are higher among papers produced by researchers belonging to a CIBER centre. However, in order to identify research output belonging to researchers assigned to a CIBER, they use the address information. This is problematic, as they later acknowledge (Morillo, Costas and Bordons 2015), as researchers do not always acknowledge their affiliation to these 'virtual centres'. This aspect was later confirmed in the study led by Jimenez-Contreras (2015) who interviewed the directors of each centre where they acknowledged the difficulties encountered to make researchers feel part of the CIBER centres and include them in their affiliations. In order to solve such issue, Morillo, Costas and Bordons (2015) looked into the funding acknowledgments information provided by Web of Science and compared their capacity to retrieve CIBER outcomes with the list of disambiguated authors developed at the Centre for Science and Technology Studies at Leiden University (Caron and van Eck 2014), finding out that around 80% of the papers were retrieved when combining address and acknowledgments information.

This article aims at analysing the global performance of the CIBER initiative based on its original objectives. So far, no study has done this, always focusing on one or two of the nine centres. It also intends to offer a framework that allows research policy makers to track the effect of their strategies on research outcomes as well as how such efforts are perceived by researchers through their affiliation links. Do they acknowledge the CIBER infrastructure more often in highly cited papers as suggested elsewhere (Costas and van Leeuwen 2012) or do they do it when collaborating with other research groups from their centre? Specifically, our purpose is to answer the following research questions:

- What role has the CIBER initiative played in the Spanish research outcomes in the biomedical fields? Has it improved the productivity and citation impact of publications?
- Have these CIBER centres been able to improve collaboration links between research groups included in the programme? Can a

Table 1. Description of the nine CIBER centres, acronyms, and launch year

CIBER centre	Acronym	Researchers	Groups	Launch year
Bioengineering, biomaterials, and nanomedicine	CIBER 1	647	47	2006
Epidemiology and public health	CIBER 2	474	47	2006
Obesity and nutrition	CIBER 3	484	27	2006
Hepatic and digestive diseases	CIBER 4	555	49	2006
Neurodegenerative diseases	CIBER 5	808	60	2006
Respiratory disorders	CIBER 6	464	32	2006
Rare diseases	CIBER 7	873	59	2006
Diabetes and metabolic disorders	CIBER 8	376	29	2007
Mental health	CIBER 9	354	26	2007

growth in the collaboration between different institutional categories be observed through co-authorship?
- How do researchers perceive the role and influence of funding on their research activity? Do they include the CIBER affiliation only in papers published in high-impact journals?

Although there are other elements rather than research output when implementing translational practices, in this article we will tackle such an issue from a bibliometric perspective, focusing mainly on research publications and leaving aside other outcomes such as clinical guidelines, workshops, etc.

The structure of the article is as follows. The Material and methods section describes the list of research groups and researchers received from the Instituto de Salud Carlos III which coordinates the CIBER programme. It details the data retrieval and processing as well as the identification of publications. It then describes the indicators and techniques employed to pursue the objectives of the study. The results of the various analyses are shown next, structured in three subsections each for each of the specific research questions. In the Discussion and Concluding remarks section we analyse the results obtained relating them with the objectives of the programme and the results obtained by similar studies. We also include some lessons learned on the perception researchers have of initiatives such as the ones discussed above and how research policy makers can introduce policies that can better influence research outcomes alienating them with societal demands.

2. Material and methods

We conducted an analysis on the scientific output of researchers belonging to the nine CIBER centres during the 2005–11 time period. We used two types of data sources: The Instituto de Salud Carlos III, which provided data regarding the researchers and research groups belonging to each of the centres, and the Web of Science database, to obtain the research publications and citation data of each researcher. In this section, we first detail the retrieval and processing of the data set employed for the analysis and we then define the indicators and techniques employed in order to undertake this study.

2.1 Data retrieval and processing

The Instituto de Salud Carlos III provided us with internal data regarding the annual budget of each centre for the 2006–11 time period, research group and centre to which it is affiliated, lead researcher of each team, institutional affiliation of the research group, and Spanish region in which it is located. This data set also included the list of researchers linked to each research group. At the first stage, they also offered information related with the research output of each researcher, but after testing such information we found out that the list of publications was incomplete.

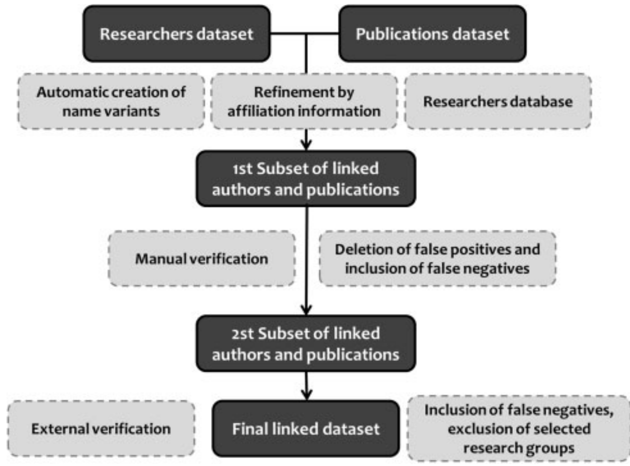

Figure 1. Data processing and matching between the researchers and publications data sets.

For this reason, in January 2012, we proceeded to download the research output of Spain during the 2005–11 time period from the Thomson Reuters Science Citation Index database. We included the year 2005, as this would allow us to see their research performance prior to the establishment of the network infrastructure. We included only the following document types: articles, reviews, letters, and editorial material. The Spanish research output retrieved for the study period is of 277,127 scientific papers. This information was later linked with journal information retrieved from Thomson Reuters Journal Citation Reports (JCR) which includes a set of bibliometric indicators useful to analyse the scientific visibility of the research outputs.

With these two data sets, we proceeded to link publications to individual researchers (Fig. 1). We did this by generating automatic variants of each researcher's name and crossing them with the author field. Such links were limited only for papers where the affiliation information of the two data sets coincided. Finally, we took into account the scientific areas to which these researchers belonged, deleting links to papers from scientific areas which fell apart from their line of work. This set of linked publications and researchers was manually checked by an information specialist eliminating false positives and checking for false negatives by enquiring the database with further name variants that were not considered at first.

This processing work allowed us not only to link research output at the research group level, but at all levels (individual, CIBER centre, and institutional), obtaining a highly grained data set. However, in order to validate it, we required external verification. This is a crucial point in our analysis, as it was done at the micro and meso level, and hence errors in the data set may invalidate the whole study (van Leeuwen 2007). Such validation was undertaken in two stages. In the first stage, a preliminary set of results was presented to a control group of researchers affiliated to the CIBER programme who refined the set of bibliometric indicators used. Then,

Table 2. Set of indicators used in the study

Output		
Indicator	*Acronym*	*Definition*
Number of publications	P	Publications indexed in the Science Citation Index. The considered types were articles, reviews, letters, and editorial material.
Citation impact		
Number of citations	C	Total number of citation received by unit of analysis
Citation per paper	C/P	Ratio of citations received per paper published.
Visibility		
Share of 1st quartile papers	%Q1	Share of papers published in journals positioned in the top 25% of their Web of Science subject category according to their Journal Impact Factor. If the journal is classified in more than one category the highest position remains.
Share of 1st decile papers	%D1	Share of papers published in journals positioned in the top 10% of their Web of Science subject category according to their Journal Impact Factor. If the journal is classified in more than one category the highest position remains.
Collaboration		
Density	D	This indicator shows the level of cohesion between the nodes in a network. It is defined as the number of links established between nodes in relation with the highest value they could have if all nodes were connected with each other. It is a normalized indicator ranging from 0 to 1.
Main component	Co	Share of nodes connected with each other at least once in the network (meaning that they have co-authored at least one paper) in the largest cluster of the network.
Share of institutional class collaboration	IC	Share of publications co-authored by CIBER research groups belonging to different institutional categories (i.e., hospitals and universities).

we reported our results to the director of each CIBER. This allowed us to exclude several research groups which were originally selected to be part of the programme but which finally were not integrated. In order to exclude their output in a systematic way, we disregarded research groups which had never collaborated with another CIBER group and had never signed their papers as CIBER during the study time period.

2.2 Indicators and methods

Three sets of indicators are used in this article: production, scientific impact and visibility, and network analysis indicators. Table 2 includes a list of the indicators as well as a definition for each of them. We calculated these indicators at different aggregation levels: Spain, all CIBER output, by CIBER centre, by institutional category, and by research group. We use scientific visibility indicators constructed on the Web of Science subject categories classification and its Journal Impact Factor due to the relevance this indicator has for Spanish research evaluation policies. We must also note that scientific impact is measured looking at raw citation numbers and without any normalization. This should be taken into account, as it may bias the results in favour of certain fields.

3. Results

3.1 General view of the CIBER outcome in the biomedical fields in Spain

A total of 5,010 researchers' output grouped into 376 research teams was analysed (Table 1). They produced a total of 28,251 publications between 2005 and 2011. In Table 3 we show their publications, citation, and journal impact indicators. CIBER 2 was the most productive centre (4,508 papers) followed by CIBER 1 (4,411) and CIBER 4 (4,356). The least productive centre was CIBER 8 (1,710). Regarding their citation impact, CIBER 3 and 5 were the ones with

Table 3. Output and impact indicators for each CIBER, the whole CIBER programme, Spain and Spanish Biomedical research excluding CIBER output for the 2005–11 time period

	P	C	C/P	%Q1	%D1
CIBER 1	4,411	43,666	9.90	61.64	31.38
CIBER 2	4,508	56,035	12.43	57.54	30.30
CIBER 3	2,880	31,907	11.08	54.93	22.99
CIBER 4	4,356	58,176	13.36	57.67	32.21
CIBER 5	3,630	45,261	12.47	57.16	25.62
CIBER 6	3,104	36,822	11.86	54.06	28.67
CIBER 7	4,171	49,436	11.85	55.31	25.25
CIBER 8	1,710	19,044	11.14	60.41	29.47
CIBER 9	2,284	21,753	9.52	57.57	27.89
Spain	111,583	998,548	8.95	40.76	17.05
CIBER	28,251	330,131	11.69	47.32	22.41
non-CIBER	86,452	707,764	8.19	37.15	14.69

Note: There are CIBER publications which are not categorized in biomedical fields.

the highest citation average (13.36 and 12.47), while CIBER 9 and 1 had the lowest citation rate per paper (9.52 and 9.90). In all cases they surpassed the national average (8.95). Similarly, the share of CIBER output published in journals well positioned according to their Journal Impact Factor was much higher than for the rest of the Spanish output. Almost half of the CIBER output was published in Q1 journals (47.32), while roughly above 20% of their output was published in D1 journals (22.41). CIBER 1 and 8 had the highest shares of Q1 papers (61.44 and 60.41), while CIBER 4 and again CIBER 1 showed the best performances regarding the D1 indicator (32.21 and 31.38).

CIBER output has had a relative publication growth of 6.1% for the whole period. It represents approximately above 25% of the national output in the biomedical fields. While its number of

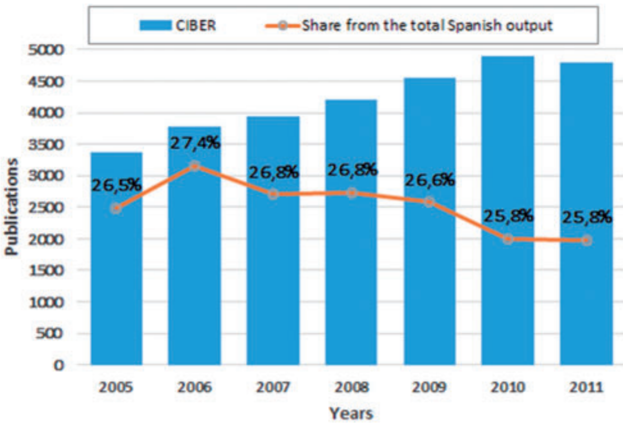

Figure 2. Number of publications produced by members of the CIBER programme and share they represent from the total Spanish biomedical outcome during the 2005–11 time period.

publications has increased annually during the study time period, it has not increased as much as the rest of the Spanish biomedical output. Fig. 2 shows the annual growth of publications from CIBER researchers as well as the share they represent from the whole output. As observed, since 2006 there has been a recession on the number of publications with respect to the rest of the country.

Table 4 shows number of CIBER papers published during the study time period in their most productive subject category. As observed, in regard with the national output, they represent below 50% of the total production. However, the citation impact and visibility of the CIBER output is much higher than the overall. The only exception can be found on the average number of citation received per paper for CIBER 7 (11.87 for CIBER papers and 12.83 for the Spanish output).

3.2 Internal collaboration patterns in the CIBER programme

In this section, we focus on the collaboration trends developed within research groups in the CIBER programme during the study time period. For this, Table 5 and Fig. 4 compare two time periods of 2 years each. The first time period has to do with the year prior to the establishment of the CIBER centre and its first year, while the second period focuses on the 2010–11 period. If we focus on the network analysis indicators (Co and D), we observe an increase for all CIBER centres. The greatest increase considering the share of groups forming part of the main component (Co) is for CIBER 1, where the co-authorship network was loosely tied at the beginning of the time period with just 31.9% of the research groups connected through the main component and has ended in the last 2 years with 68.1% of the nodes included in the main component. Regarding collaboration between researchers affiliated to different institutional classes, the evolution is not as noteworthy and shares are similar or even lesser (as in CIBER 8 which descends from 6.8% to 3.1%).

Despite the increase in collaboration between CIBER research groups during the study time period, the share of papers done in collaboration is substantially low (under 20% of publications for all CIBER centres). Fig. 3 shows the share of paper authored by one or more CIBER research groups. As observed, CIBER 9 is the centre with a higher share of collaborative papers while research groups in CIBER 1 co-authored papers with each other for less than 5% of their total output.

In Fig. 4 we take another perspective and analyse collaboration between CIBER research groups and institutional classes according to the share of papers they produce in Q1 journals by CIBER centre (IC). In general terms, a larger share of collaborative papers are published in top journals, while the share of non-collaborative papers published in Q1 journals is lower. The only exception can be found for CIBER 4 where the share of IC papers was lower in both periods analysed (2005–6: 43.8% IC vs. 47.5% No IC; 2010–11: 49.3% IC vs. 53.3% No IC).

We must note that the share of No IC and No Collaboration Q1 papers was lower than 60% for all CIBER centres in both time periods. On the other hand, more than 60% of IC papers were published in Q1 journals for two centres (CIBER 6 and 9) in the first period, and seven centres (CIBER 1, 2, 3, 5, 7, 8, and 9) in the second period. With regard to papers authored by more than one CIBER group, the share of Q1 papers was again higher for all CIBER centres except for CIBER 4 (2005–6: 42.3% IC vs. 49.3% No IC; 2010–11: 50.0% IC vs. 50.8% No IC). The share of papers authored by research groups which did not collaborate with any other CIBER research group did not reach 60% Q1. In the first period, CIBER 5 reaches 60.2% of Q1 collaborative papers, while in the second period five centres surpass such threshold (CIBER 2, 5, 7, 8, and 9).

3.3 Funding acknowledgment and impact

In this section we show results regarding the share of papers where researchers include their CIBER information in the address field. In all, 54.5% of the CIBER output could be identified as such through the address information; however, there are substantial differences between centres (Table 6). While 75.2% of the papers produced by CIBER 9 were signed as such, 38.5% of the total output of CIBER 8 included such information. Indeed, for most centres (CIBER 1, 3, 4, 5, 6, and 8), less than half of their production were signed as CIBER.

If we focus only on papers published in Q1 journals, such share increases to values between 56.9% (CIBER 3) and 66.7% of signed papers (CIBER 8). We find CIBER 9 as an exception as 63.3% of Q1 papers were signed, a lower share than for the whole of the papers signed (75.2% of the total output). However, such increase is not perceived for D1 publications, where the share of signed papers drops for all CIBER centres to shares between 20% and 30%. However, we do observe an increasing trend of the number of papers signed as CIBER since the launch of the programme (Fig. 5). In this regard, we observe that there is an increasing awareness on behalf of researchers to acknowledge their membership to this research policy initiative. It is not until 4 years after the launch of the programme that half of the papers produced by CIBER researchers start to be signed as such. Here we see again a relation between the journal's position according to its Impact Factor and the share of papers signed as CIBER. Although the share of papers signed published in D1 journals is relatively low (Table 6), if we look at the opposite, the trend is quite similar to that observed with regard to Q1 publications, that is, an important share (nearly 60% for 2011) of D1 publications indicate in their address that they are affiliated to a CIBER centre.

Table 4. Output and impact indicators for each of the JCR categories with the highest output per CIBER centre compared with the overall Spanish output during the 2005–11 time period

CIBER centre	JCR main output category	P		%Q1		%D1		C/P	
		CIBER	% Spain	CIBER	Spain	CIBER	Spain	CIBER	Spain
#1	Biomedical Engineering	467	34.09	47.97	40.07	24.20	16.57	8.04	6.57
#2	Public, Environmental . . . Health	913	32.44	55.64	36.00	23.88	13.50	8.49	6.13
#3	Endocrinology and Metabolism	690	20.25	47.10	40.82	14.49	12.59	13.52	11.20
#4	Gastroenterology and Hepatology	1,588	43.18	58.19	38.91	38.92	24.36	14.67	9.63
#5	Neurosciences	1,452	19.78	43.53	33.72	16.39	12.91	12.90	9.80
#6	Respiratory System	704	29.72	50.14	38.08	40.20	24.19	13.15	9.34
#7	Genetics and Heredity	846	17.88	46.57	40.37	19.74	16.59	11.87	12.83
#8	Endocrinology and Metabolism	468	13.73	53.63	40.82	30.13	12.59	12.68	11.20
#9	Psychiatry	1,292	40.92	56.27	46.40	26.70	17.68	10.03	8.53

Table 5. Internal collaboration indicators by CIBER centre for two time periods: 2005–6 and 2010–11. For CIBER 8 and 9 the initial period is 2006–7

	Periods	Co	D	IC
CIBER 1	2005–6	31.9	0.05	5.80
	2010–11	68.1	0.1	8.22
CIBER 2	2005–6	76.6	0.16	17.65
	2010–11	91.5	0.24	22.28
CIBER 3	2005–6	66.7	0.25	20.42
	2010–11	88.9	0.49	20.48
CIBER 4	2005–6	76.7	0.12	7.17
	2010–11	88.3	0.19	7.98
CIBER 5	2005–6	78.1	0.23	11.30
	2010–11	93.8	0.27	16.58
CIBER 6	2005–6	78.1	0.23	4.16
	2010–11	93.8	0.27	5.19
CIBER 7	2005–6	59.4	0.11	7.19
	2010–11	84.8	0.17	7.08
CIBER 8	2006–7	65.5	0.16	6.79
	2010–11	79.3	0.19	3.10
CIBER 9	2006–7	88.5	0.36	8.67
	2010–11	100.0	0.61	9.43

4. Discussion and concluding remarks

This article analyses a research programme which intends to enhance translational research in the biomedical sciences in Spain. Among other goals, it aims at promoting collaboration between Spanish research teams. As observed in subsection 3.1, CIBER output represents an important share of Spanish output (25.3%), playing a key role on the visibility of Spanish research. In terms of citation impact and visibility, the findings show that CIBER output is clearly higher than non-CIBER output in the biomedical fields. However, one may question if this is due to a good research groups selection or as a result of the interactions produced between its members.

To analyse this, subsection 3.2 focuses on the collaboration patterns of CIBER groups. We analyse internal collaboration at two levels: between research groups affiliated to the programme and between researchers belonging to different institutional classes, as goal of the programme is to enhance translational research through collaboration. In this regard, we observe that collaboration between research groups is generally low; however, the network is much more connected than it was before the programme launched. In this regard, one may hypothesize that the CIBER initiative has allowed research groups to connect with each other but has not succeeded on strengthening such connections. In this regard, maybe a wider study period may be necessary to confirm such hypothesis.

When comparing the effect of collaboration on impact we observe that, as confirmed in other studies (Bordons, Aparicio and Costas, 2013), collaboration is an important variable associated with higher visibility (Fig. 4). However, this should not be a capital issue for this programme as it is acknowledged elsewhere that clinical research may have a lower citation impact than basic research (van Eck et al. 2013). Although out of the scope of this study, here we must emphasize the need to analyse if any other types of collaboration have emerged in hospitals such as organizing workshops, the publications of clinical guidelines, etc. In this regard, an interesting issue to explore in the future would be to compare these collaboration networks with the networks established by Spanish biomedical teams not included within the CIBER programme. This could provide new insight on the role played by the CIBER to promote collaboration.

From a bibliometric perspective, an interesting aspect analysed is whether researchers acknowledge their affiliation to a CIBER centre. This aspect has already been discussed elsewhere (Morillo, Costas and Bordons 2015), however never for the whole programme and using a *bottom up* approach with external validation. This allows us to have an accurate picture of the behaviour researchers have with regard to their funding bodies. In this regard, we observe a similar share of papers that include the CIBER information in authors' affiliation to that reported by Morillo, Costas and Bordons (2015) for CIBER centres 4 and 9 (Hepatic and Digestive Diseases and Mental Health). In their study, they analyse the 2008–11 time period with a greater increase on the share of signed papers (Fig. 5).

The 'virtual' nature of CIBER centres as well as the role they play as funding agencies introduces novelties on the way they are perceived by researchers. While one would expect them to acknowledge the CIBER as a second affiliation, there is evidence suggesting that this does not always occur that way. As suggested by the heads of the centres (Jimenez-Contreras 2015), many researchers choose to sign a paper as CIBER members depending on how they value the programme and the role its funding may have played. As including the CIBER information has not been mandatory, maybe by analysing the share of publications signed as CIBER could be a good strategy to determine the time period needed for the programme to start to give results. This could infer that researchers feel part of the programme as it becomes part of their daily work. In this regard, a follow-up study would be

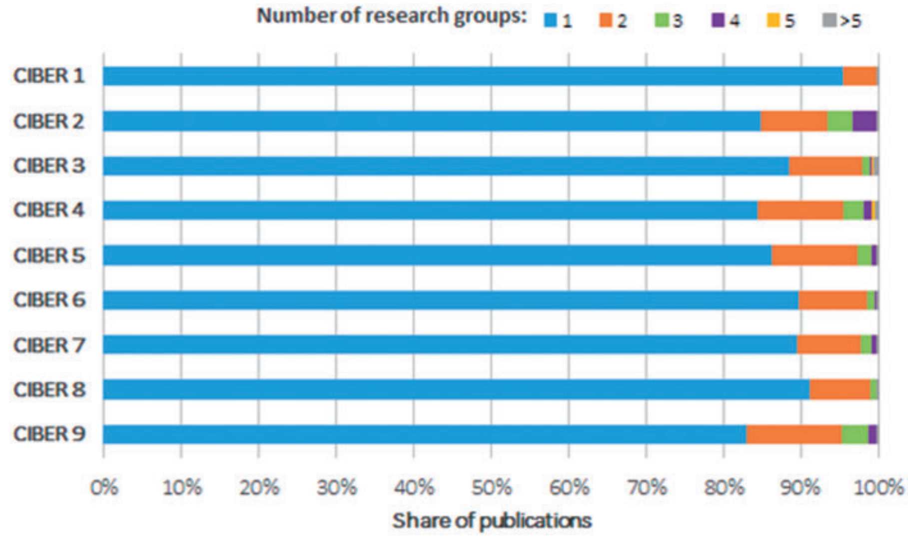

Figure 3. Share of research output by CIBER centre according to the number of research groups collaborating.

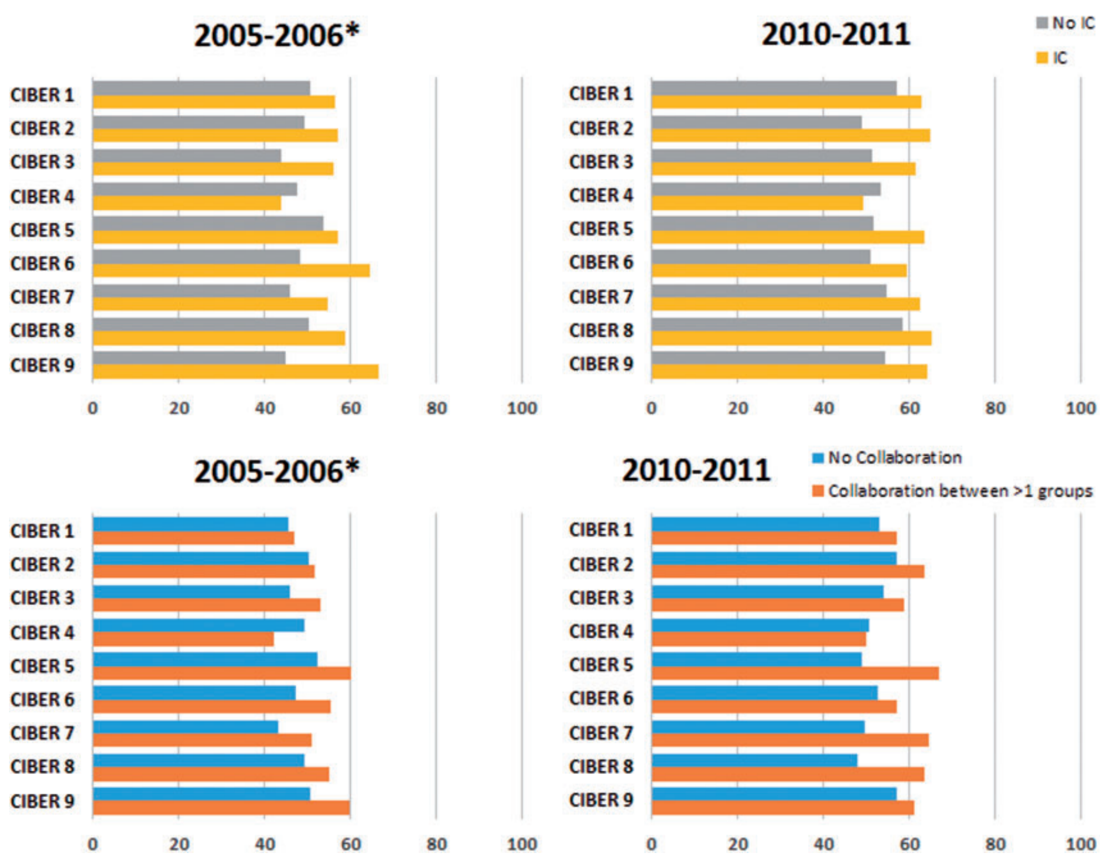

Figure 4. Share of Q1 publications by type of collaboration: different institutional categories vs. single institutional category, collaborative CIBER publications vs. non-collaborative CIBER publications at the beginning and end of the study time period. Beginning time period 2005–6. End time period 2010–11. *Beginning time period for CIBER centres 8 and 9 is 2006–7.

Table 6. Number of papers signed in the address field as CIBER for all publications, 1st quartile publications and 1st decile publications by CIBER centre. Time period 2005–11

	P	P_{signed}	$Q1_{signed}$ (%)	$D1_{signed}$ (%)
CIBER 1	4,411	1,850	1,131 (61.1)	516 (27.9)
CIBER 2	4,508	2,312	1,337 (57.8)	588 (25.4)
CIBER 3	2,880	1,427	806 (56.9)	272 (19.1)
CIBER 4	4,356	2,107	1,370 (65.0)	647 (30.7)
CIBER 5	3,630	1,668	1,008 (60.4)	399 (23.9)
CIBER 6	3,104	1,394	824 (59.1)	396 (28.4)
CIBER 7	4,171	2,248	1,296 (57.7)	523 (23.3)
CIBER 8	1,710	658	439 (66.7)	174 (26.4)
CIBER 9	2,284	1,718	1,087 (63.3)	481 (28.0)
Total	28,251	15,382	9,298 (54.5)	3,996 (26.0)

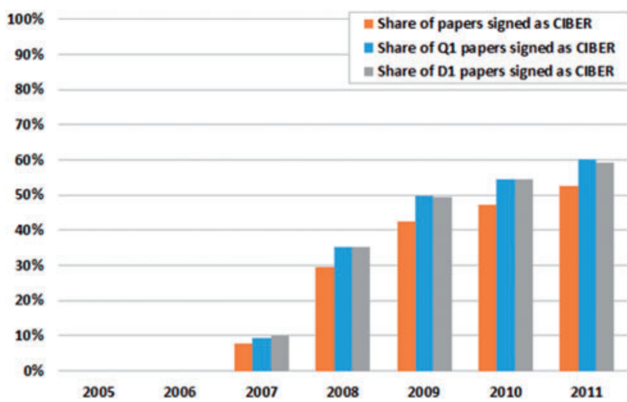

Figure 5. Share of papers signed as CIBER in the address field by year from the total CIBER output, from 1st quartile publications and from 1st decile publications. Time period 2005–11.

desirable to analyse whether the increasing share of signed papers stabilizes over time and how many years since the launch of the programme are needed for this to happen.

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