

Bio-medicolegal scientific research in Europe. A country-based analysis

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Abstract The European mosaic of socio-cultural, economic and legal realities is reflected in forensic and legal medicine, in which a great variety of operational modes of forensic medical services, organisational systems, structures, functional competences and scientific research strategies can be observed. The present work analyses the European bio-medicolegal scientific output of the last 5.5 years (exact time window, January 1, 2005–June 1, 2010), categorising papers by nationality of the corresponding author and forensic sub-discipline in question, in order to identify the peculiarities of national sub-specialised competences and to build up international research projects. This country-based bibliometric

analysis, based on the number of articles and the impact factor produced by each European country, also considering its economic profile (gross domestic product and per capita gross domestic product), highlights the prevailing productive role of Western and Southern Europe (Germany, Great Britain, Italy, Switzerland, Spain and France). Categorising scientific output by forensic sub-discipline and branch, significant in terms of impact factor are contributions from Germany (coming first in Pathology, Toxicology, Genetics, Anthropology and Biological Criminalistics), Great Britain (first in Clinical Forensic Medicine, Malpractice and Invalidity-Social Insurance), Switzerland (first in Criminology), Italy (second in Toxicology, Anthropology and Invalidity-Social Insurance), The Netherlands (third in Clinical Forensic Medicine and Medical Law and Ethics), Spain (third in Genetics, Criminalistics and Invalidity-Social Insurance) and France (third in Toxicology and Malpractice). Interestingly, several countries with low gross domestic product, such as Poland, Turkey and other Eastern European nations, show notable scientific production in specific sub-disciplines such as Pathology, Toxicology and Forensic Genetics, suggesting that fruitful international cooperation could be planned and be of interest to funding sources within the European Community, also taking into account funds reserved for depressed areas undergoing development.

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Introduction

The process of ultraspecialisation of bio-medicolegal sciences, which may lead to fragmentation of the discipline, is clearly shown by the current divergence of research lines

in this field [1–3]. In reflecting sometimes radical differences in national cultures and their juridical models [4, 5], European heterogeneity expresses the specificity of sub-specialised medicolegal competences, financial resources and the economic productivity of each country involved [6].

This work analyses European scientific productivity in the various sub-disciplines and branches of bio-medicolegal sciences, in order to identify the peculiarities of national sub-specialised competences, to build up international research projects and to favour the desired harmonisation of European legal medicine in the third millennium [7–9].

Materials and methods

In June 2010, a novel process of searching for and categorising references to bio-medicolegal sciences was developed. The method, already described in a previous article [6], is summarised in the following five sequential steps.

1. Making an extensive search of published literature retrieved through the MEDLINE database according to MeSH terms combined with free-text protocols, covering: medicolegal area of interest, affiliation of the corresponding author, country of affiliation of the corresponding author and journal of publication.
2. Pooling and filtering retrieved records within pre-defined limits, by EndNote (Thomson Reuters EndNote X4®, California, USA) and common software for data organisation and analysis (Microsoft Excel 2007®, Washington, USA; SPSS Statistics 17.0®, Illinois, USA).
3. Constructing an extensive database containing the following entries: title, authors, abstract, keywords provided by authors, affiliation, year of publication, journal and language.
4. Categorising all records according to type of document, sub-discipline/branch and main topic of interest, country and professional area of affiliation and impact factor (IF) of the journal.
5. Revising and verifying the quality of the entire process, with internal double-checking for coherence.

Scientific production, thus selected and catalogued, was subjected to country-based analysis covering a time-span of 5.5 years (January 2005 to June 2010).

In detail, the number of articles and the total IF produced by each European country in each sub-discipline and branch, with comparative evaluation of the economy of that country, were examined. In order to standardise each country-based scientific output according to its specific

economic profile, macro-economic data were collected from the statistical appendix of the World Economic Outlook (WEO) report [10]. The WEO database is provided by the International Monetary Fund and contains selected series of macro-economic data. Retrieved information refer to the National Gross Domestic Product expressed in billions of US dollars (NGDPD), National Gross Domestic Product per capita expressed in current US dollars (NGDPDPC) and Population expressed in millions of inhabitants.

In examining the geo-politico-economic features of neighbouring states with similar histories of civic, social and scientific progress, qualitative and quantitative bibliometric analysis included identification of four main supra-national macro-areas, North, West, South and East.

The *North* macro-area comprises Iceland, Norway, Sweden, Finland and Denmark; the *West* Great Britain, Ireland, Germany, Liechtenstein, Luxembourg, The Netherlands, Belgium, France, Principality of Monte Carlo, Switzerland and Austria; the *South* includes Portugal, Spain, Italy, San Marino, Vatican City, Andorra, Greece, Macedonia, Turkey, Cyprus and Malta and the *East*, Albania, Republic of Kosova, Montenegro, Armenia, Belarus, Bosnia–Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Lithuania, Moldova, Latvia, Poland, Romania, Russia, Serbia, Slovak Republic, Slovenia, Ukraine, Kazakhstan and Azerbaijan.

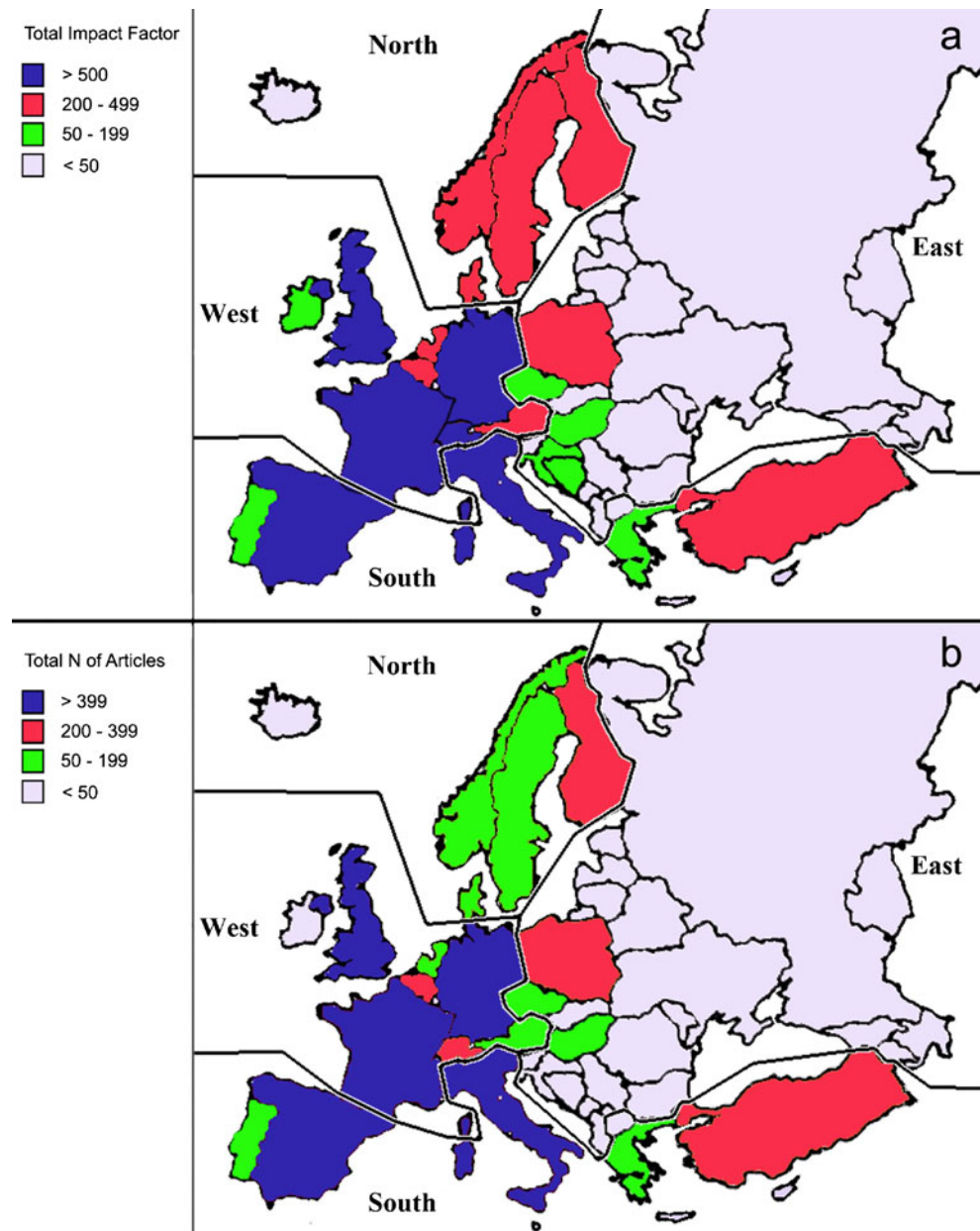
Results

A total of 5,826 articles, of 21,176 records retrieved, fulfilled the above inclusion criteria and were judged pertinent to bio-medicolegal sciences.

In terms of *total impact factor*, Germany (1,738.1), Great Britain (1,080.4), Italy (941.6), Switzerland (863.1), Spain (624.5) and France (592.0) exceeded 500 IF points over the period of time considered (January 2005 to June 2010; Fig. 1a); Finland (488.9), The Netherlands (420.6), Belgium (406.9), Sweden (372.6), Austria (275.1), Norway (276.7), Turkey (243.6), Denmark (222.1) and Poland (210.8) accumulated 200–499 points; Portugal (157.9), Greece (132.1), Czech Republic (107.2), Hungary (80.4), Ireland (79.6), Croatia (65.3) and Bosnia–Herzegovina (51.7) 50–199 points and the other countries less than 50 points each.

In terms of *number of published papers*, Germany (989), Great Britain (585), Italy (521), France (514) and Spain (408) published more than 400 papers in the 5.5-year period (Fig. 1b); Poland (374), Switzerland (374), Finland (231), Turkey (224) and Belgium (203) 200–399 articles; The Netherlands (199), Sweden (191), Denmark (150), Norway (150), Austria (124), Portugal (82), Greece (75),

Fig. 1 Classification by total impact factor achieved by each country (a); classification by total number of published articles by each country (b)



Hungary (59) and Czech Republic (56) 50–199 and the other countries less than 50 each.

The contribution of the European countries in terms of *total impact factor* and *published articles* was also evaluated by categorisation into sub-discipline and branch (Table 1).

In Fig. 2 are listed the top 10 countries producing impact factor in *Forensic Pathology*, *Toxicology*, *Genetics*, *Anthropology*, *Psychiatry*, *Criminology*, *Clinical Forensic Medicine* and *Malpractice*.

In *Medical Law and Ethics*, an important contribution was made by Belgium with 153.3 IF points and 62 papers; Great Britain came second with 148.4/90, followed by The

Netherlands with 125.2/24, Switzerland with 59.1/24 and France with 31.2/39 (data not shown).

In *Criminalistics (Biological)*, Germany occupied the highest position with 40.5 IF points and 20 published articles, followed by Switzerland with 38.3/18, Spain with 18.9/10, Italy with 13.0/7 and Great Britain with 8.5/9 (data not shown).

In *Forensic Entomology*, Germany ranked highest with an overall IF of 14.3 points and seven published articles, followed by Italy with 9.3/7, France with 8.5/4, Poland with 6.3/5 and Great Britain with 4.2/2 (data not shown).

Analysis of scientific production, measured in terms of *total impact factor* related to *per capita gross domestic*

Table 1 Country-specific scientific production evaluated by sub-discipline and branch

	Biological Damage		Clinical Forensic Medicine		Criminalistics (Biological)		Criminology		Forensic Anthropology		Forensic Genetics		Forensic Pathology		Forensic Psychiatry		Forensic Toxicology		Invalidity/Social Insurance		Malpractice		Medical Law, Ethics		Forensic Entomology		Total	
	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i> (%)	IF (%)	<i>n</i>	IF
Albania	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	13.7
Armenia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.0
Austria	0.8	0.2	4.8	1.9	0.8	0.6	0.8	0.0	7.3	5.1	26.6	31.7	9.7	9.7	7.3	7.6	25.8	25.0	0.8	1.1	10.5	14.7	4.0	1.8	0.8	0.6	124	275.1
Belarus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2	1.4
Belgium	0.0	0.0	9.4	6.9	1.0	0.5	0.5	0.0	9.4	7.5	5.9	9.3	11.8	14.5	8.4	4.7	16.7	15.4	2.5	1.1	3.5	2.3	30.4	37.8	0.5	0.0	203	406.9
Bosnia	0.0	0.0	4.0	0.0	0.0	0.0	12.0	58.0	20.0	3.6	44.0	31.7	0.0	0.0	16.0	5.3	4.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25	51.7
Bulgaria	0.0	0.0	0.0	0.0	25.0	6.7	0.0	0.0	5.0	0.0	10.0	41.0	55.0	52.3	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20	16.3
Croatia	0.0	0.0	0.0	0.0	0.0	0.0	1.7	3.2	16.7	26.1	28.3	41.5	23.3	11.0	13.3	3.2	11.7	15.0	0.0	0.0	3.3	0.0	1.7	0.0	0.0	0.0	60	65.3
Cyprus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	2.1
Czech Republic	0.0	0.0	0.0	0.0	1.8	1.0	3.6	2.4	19.6	14.0	8.9	9.7	23.2	9.8	8.9	12.0	26.8	18.7	0.0	0.0	7.2	32.4	0.0	0.0	0.0	0.0	56	107.2
Denmark	0.7	0.0	10.7	5.1	1.3	0.0	4.7	1.5	9.3	7.7	12.7	23.6	20.0	17.3	4.0	2.2	25.3	32.4	0.7	0.0	9.3	5.5	1.3	4.7	0.0	0.0	150	222.1
Estonia	0.0	0.0	23.1	21.5	0.0	0.0	15.4	20.1	0.0	0.0	15.4	15.0	23.0	21.8	23.1	21.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13	29.5
Finland	0.0	0.0	5.2	3.7	0.4	0.0	10.8	8.6	2.6	1.9	4.8	5.5	28.5	40.6	20.8	16.5	16.0	17.2	2.2	2.3	3.5	1.9	4.8	1.4	0.4	0.4	231	488.9
France	0.8	0.2	10.9	4.9	0.6	0.6	3.7	4.0	4.7	5.6	5.6	9.3	19.1	16.8	8.6	5.9	19.7	32.8	3.3	0.4	14.6	12.8	7.6	5.3	0.8	1.4	514	592.0
Georgia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.0
Germany	0.5	0.2	4.8	4.0	2.0	2.3	5.5	4.4	5.8	6.3	11.7	15.0	27.8	27.5	8.6	7.0	20.6	27.7	1.0	0.1	7.3	3.3	3.7	1.4	0.7	0.8	989	1,738.1
Great Britain	0.0	0.0	12.8	11.3	1.5	0.8	12.7	8.3	1.9	1.1	5.0	11.9	11.1	14.9	14.7	17.3	8.2	6.7	0.3	1.3	16.1	12.4	15.4	13.6	0.3	0.4	585	1,080.4
Greece	0.0	0.0	6.7	6.0	0.0	0.0	2.7	0.0	13.3	10.8	5.3	7.7	28.0	18.0	6.7	15.8	34.6	41.7	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	75	132.1
Hungary	0.0	0.0	0.0	0.0	0.0	0.0	11.9	8.0	8.5	5.2	15.3	23.0	18.5	21.9	13.6	9.9	17.0	24.2	1.7	0.0	11.8	7.8	1.7	0.0	0.0	0.0	59	80.4
Iceland	0.0	0.0	22.2	44.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.3	55.2	0.0	0.0	0.0	0.0	9	6.6
Ireland	0.0	0.0	20.5	16.0	2.6	1.1	0.0	0.0	7.7	8.1	7.7	6.3	28.2	49.1	7.7	2.6	15.3	11.4	2.6	3.3	2.6	0.0	5.1	2.1	0.0	0.0	39	79.6
Italy	0.0	0.0	4.4	2.7	1.3	1.4	0.8	0.8	9.6	9.5	10.8	11.9	25.7	20.5	5.2	4.5	29.4	37.2	0.4	0.4	6.5	7.7	4.6	2.4	1.3	1.0	521	941.6
Lithuania	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	0.0	0.0	44.4	86.2	33.4	13.8	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9	7.3
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6	10.2
Macedonia	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	72.4	0.0	0.0	0.0	0.0	20.0	27.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5	6.8
Malta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.7	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0	3	2.4
Netherlands	0.5	0.0	11.1	10.1	0.5	0.0	14.5	5.1	5.0	3.9	13.1	16.8	4.9	4.3	13.1	7.6	9.6	10.1	1.5	0.5	14.1	11.7	12.1	29.9	0.0	0.0	199	420.6
Norway	0.0	0.0	7.3	5.0	0.0	0.0	2.0	2.8	3.3	3.8	5.3	7.3	13.3	16.1	18.7	15.6	37.3	44.0	2.7	2.9	6.8	1.3	3.3	1.2	0.0	0.0	150	276.7
Poland	0.8	0.0	1.6	1.6	1.3	2.9	0.0	0.0	3.2	3.0	20.6	36.7	23.0	13.7	13.5	6.5	14.7	28.5	7.8	0.0	8.8	1.5	2.9	2.6	1.3	3.0	374	210.8
Portugal	0.0	0.0	2.4	0.0	0.0	0.0	1.2	0.0	13.4	11.3	42.7	46.6	6.1	2.7	1.2	0.3	26.9	35.1	0.0	0.0	3.7	1.9	1.2	0.8	1.2	1.3	83	160.0
Romania	0.0	0.0	0.0	0.0	6.2	0.0	6.2	0.0	0.0	0.0	18.8	14.8	31.3	0.0	6.2	2.3	6.2	6.2	0.0	0.0	18.9	75.0	6.2	1.7	0.0	0.0	16	41.0
Russia	0.0	0.0	37.0	0.0	11.1	0.0	0.0	0.0	11.1	1.8	11.1	6.0	18.6	1.5	7.4	3.5	3.7	87.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27	35.3
Serbia	0.0	0.0	16.3	8.3	0.0	0.0	2.3	6.7	14.0	12.6	14.0	20.5	34.8	42.7	7.0	0.0	9.3	9.2	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	43	45.6
Slovak Republic	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	18.8	34.0	12.4	45.4	31.3	0.0	0.0	0.0	6.3	0.0	0.0	0.0	12.4	15.7	6.3	4.9	0.0	0.0	16	10.7
Slovenia	0.0	0.0	10.5	13.0	21.1	14.3	0.0	0.0	10.5	15.0	31.5	29.6	5.3	6.5	0.0	0.0	15.8	18.8	0.0	0.0	5.3	2.8	0.0	0.0	0.0	0.0	19	32.3
Spain	0.3	0.5	7.4	5.3	2.5	3.0	4.4	0.7	7.4	10.0	16.4	18.4	18.6	21.0	14.7	9.0	17.3	26.1	1.0	1.3	4.2	1.9	5.6	2.5	0.2	0.3	408	624.5
Sweden	0.0	0.0	3.7	2.6	0.5	0.4	14.1	11.5	2.6	13.4	17.3	23.5	7.3	7.1	15.7	9.2	29.9	27.9	0.0	0.0	7.3	4.1	1.6	0.3	0.0	0.0	191	372.6
Switzerland	0.0	0.0	1.1	1.3	4.8	4.4	7.0	14.1	2.7	2.5	9.1	11.4	36.0	25.2	6.7	3.4	12.2	17.1	1.9	0.7	11.8	12.7	6.4	6.9	0.3	0.3	374	863.1
Turkey	0.9	0.6	9.8	7.0	0.9	1.3	1.3	0.6	8.9	11.6	1.8	5.1	52.2	42.5	1.8	3.8	12.6	20.2	0.9	0.6	5.8	3.5	2.7	2.3	0.4	0.9	224	243.6
Ukraine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1	0.0

Percentages by country

n number of published articles, *IF* impact factor

product (NGDPDPC), supplied the results shown in Fig. 3a. Grouping the countries belonging to each macro-area, as described in “Materials and methods” gave the results shown in Fig. 3b. East and North macro-areas plot in the lower tercile, near the same line, between 12° and 15° (considering the centre angle). Macro-areas South and West plot in the medium tercile, near the same line, between 32° and 35°.

Analysis according to purely economic bases (Figure-Supplement 1) shows that Germany, Great Britain, Italy, Switzerland, Spain, France, Belgium, The Netherlands, Sweden, Austria and Norway maintain a position of high productivity in terms of total IF. This is also confirmed when the above geo-politico-economic macro-areas are examined, with North, West and South occupying prestigious positions in the medium tercile, compared with East, which falls in the lower tercile (Figure-Supplement 1).

Analysis according to purely demographic bases (Figure-Supplement 2) shows that countries such as Germany, Great Britain, Italy, Switzerland, Spain, France, Finland, Belgium, The Netherlands, Sweden, Austria and Norway overlap, confirming their high productivity level, whereas states like Turkey and Russia come very low on the list. Viewing aggregation by geo-politico-economic macro-area, North and West plot in the medium tercile, compared with South and East in the lower tercile, although at opposite sides (Figure-Supplement 2).

Figure 4 shows the percentages of the *total impact factor* of each *sub-discipline* and branch, adjusted for the overall production of each of the four *geopolitical macro-areas* (North, West, East and South Europe).

Discussion

The European mosaic of socio-cultural, economic and legal realities is reflected in forensic and legal medicine, in which a great variety of operational modes of forensic medical services, organisational systems, structures, functional competences and scientific research strategies is observed [9, 11].

The essential starting point for future European planning and harmonisation of medicolegal systems is deep understanding of cultural roots and specialist competences in the development of the various sub-disciplines and branches. Extending the specialist peculiarities and ranges of medicolegal research are of primary importance in identifying cultural and scientific synergies which may be of interest to funding sources within the European Community, partly taking into account funds reserved for depressed areas undergoing development (European Social Fund) [12].

According to the *number of articles* published by each country, the nucleus with the greatest scientific productivity

lies in Western–Southern Europe (Germany, Great Britain, France, Italy and Spain), with a total number of articles exceeding 400 in the 5.5-year period examined. The North (Norway, Sweden, Finland and Denmark) occupies an intermediate publishing position, whereas the East has less than 50 articles published, with the exception of Poland, Czech Republic and Hungary, which approach the level of the North (Fig. 1b).

Considering the *total impact factor*, the preeminent overlap of West–South Europe is clear (Germany, Great Britain, France, Italy, Switzerland and Spain), with more than 500 points in the period considered, the North (Norway, Sweden, Finland and Denmark) uniformly placed in an intermediate position, and lastly the East, with less than 50 IF points (Fig. 1b).

Analysis of publishing by *sub-discipline* and *branch* according to the total IF and the number of articles produced highlights the significant contribution of *Germany*, which comes first for *total impact factor* in Pathology, Toxicology, Genetics, Anthropology and Criminalistics (Biological), second in Forensic Psychiatry and Clinical Forensic Medicine and third in Criminology. This scientific leadership may be at least partially due to the organisation of the German medicolegal system, which focuses on synergy between professional and academic-scientific work, since forensic practice is prevalently the domain of the universities [9, 13].

The contribution of *Great Britain* is also important: first for *total impact factor* in Clinical Forensic Medicine, Malpractice, Invalidation-Social Insurance and second in Genetics, Criminology and Medical Law and Ethics.

Other highly productive nations are *Switzerland*, first in Criminology and second in Pathology, Malpractice and Criminalistics (Biological); *Italy*, second in Toxicology, Anthropology and Invalidation-Social Insurance; *The Netherlands*, third in Clinical Forensic Medicine and Medical Law and Ethics; *Spain*, third in Genetics, Criminalistics and Invalidation-Social Insurance and, lastly, *France*, third in Toxicology and Malpractice.

Scientific output mainly depends on the number of researchers and equipment of medicolegal institutions affiliated to universities. However, in the absence of these data (which are extremely difficult to collect), we have analysed scientific production in comparison with gross domestic product and population data.

The *total impact factor* correlated with each country's gross domestic product, shows that Germany, Great Britain, Italy, Switzerland, Spain, France, Finland, Belgium, The Netherlands, Sweden, Austria and Norway are the first for *total impact factor* (Figure-Supplement 1) and of impact factor adjusted according to the total population of each country (Figure-Supplement 2). Overall, North and West always fall in the medium tercile, whereas East is always in the lower one. South plots in the medium tercile as regards

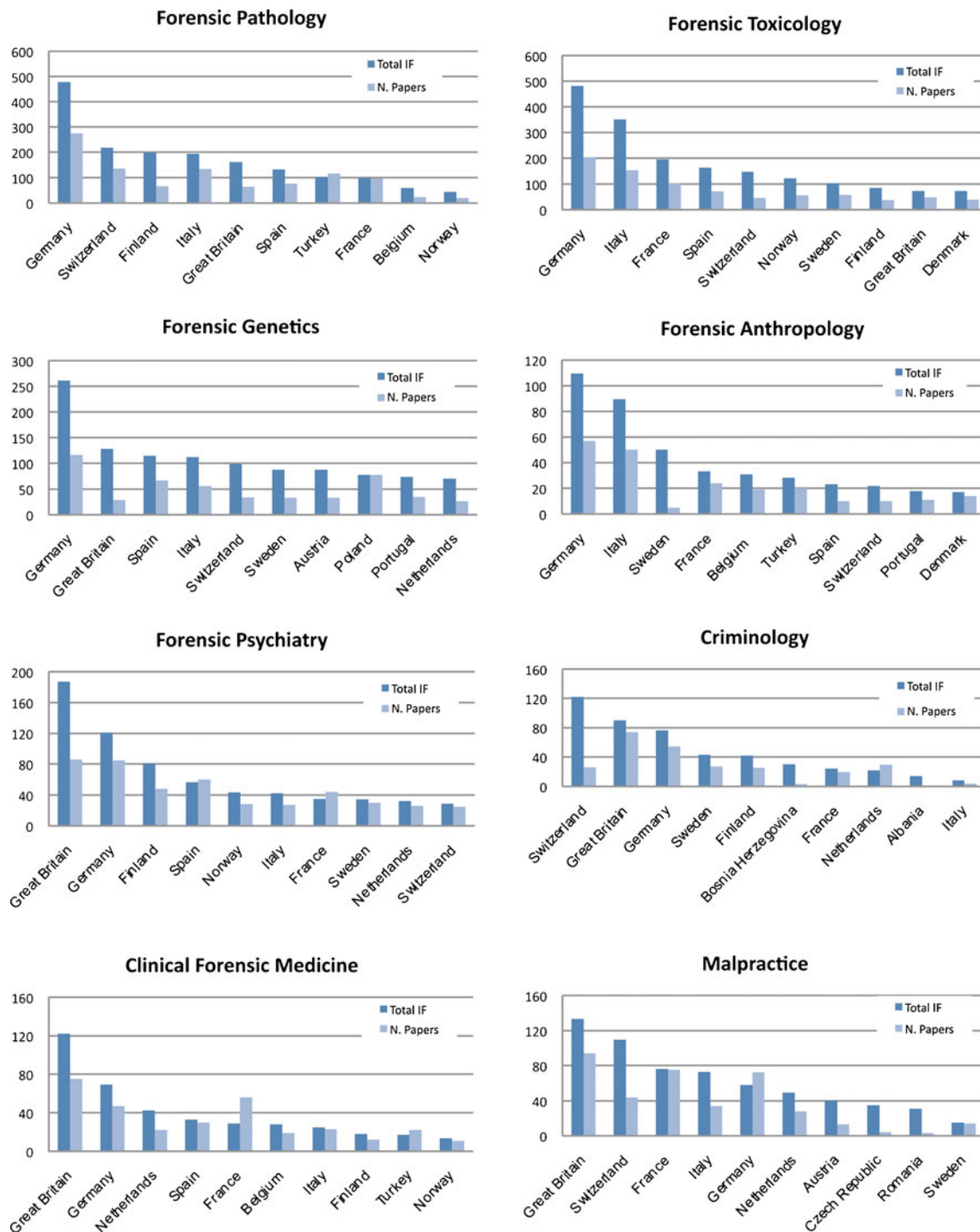


Fig. 2 Numbers of published papers in bio-medicolegal sciences and total impact factor over a 5.5-year time period. Higher-ranking 10 countries are shown by each sub-discipline or branch

productive adjustment according to the NGDPD, and in the lower tercile according to demographic adjustment. However, in this case, the position is clearly better than that of East (Figure-Supplement 2).

The productivity of *total impact factor* in relation to the per capita gross domestic product (considered as an index

obtained by dividing NGDP by population) confirms the picture of the leading European countries, that is, Germany, Great Britain, Italy, Switzerland, Spain and France falling in the higher part of the central portion (IF >500 points; NGDP 30–70,000 USD) of Fig. 3a. Surprisingly, countries with a per capita NGDP equal to or higher than those in

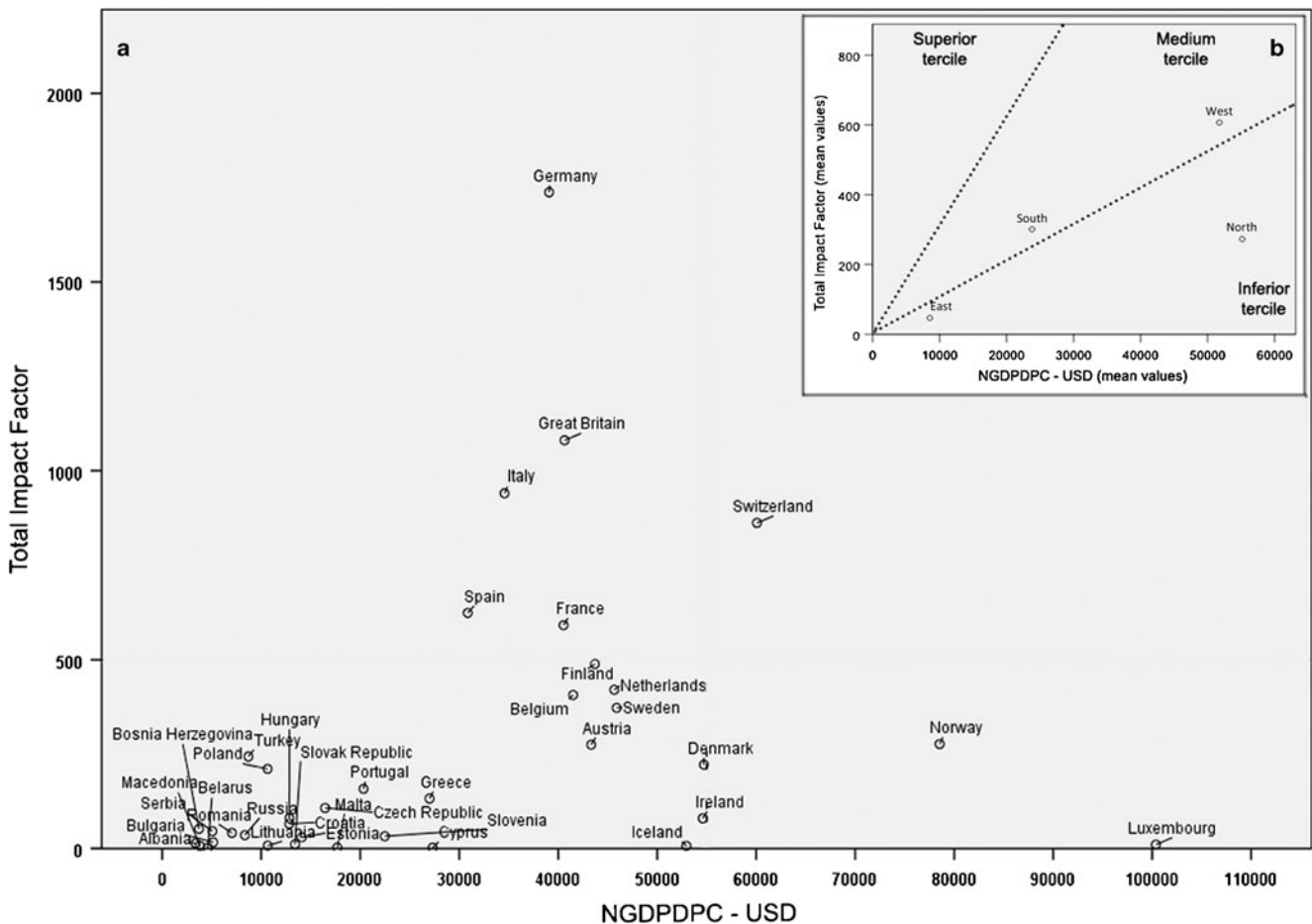


Fig. 3 **a** Country-specific total impact factors adjusted by National Gross Domestic Product Per Capita (*NGDPDPC*), expressed in US dollars. **b** Data aggregation. Mean impact factor of a macro-area is

matched to its mean *NGDPDPC* expressed in US dollars. Dotted lines upper, medium and lower tertiles (defined as third part of a right angle)

Finland, The Netherlands, Belgium, Sweden, Austria, Denmark, Ireland, Iceland, Luxembourg and Norway, plot on clearly lower levels of scientific productivity (Fig. 3a). Emblematic in this sense are Luxembourg (*NGDPDPC* 100,375 USD; IF <50 points in the 5.5-year period) and Norway (*NGDPDPC* 78,528 with IF <300 points). Conversely, of the countries with low *NGDPDPC* (<30,000 USD), in which the *total impact factor* in the 5.5-year period mainly oscillates between 0 and 100 points, emblematic are Turkey (IF 243.6), Poland (IF 210.8) and Portugal (IF 157.9).

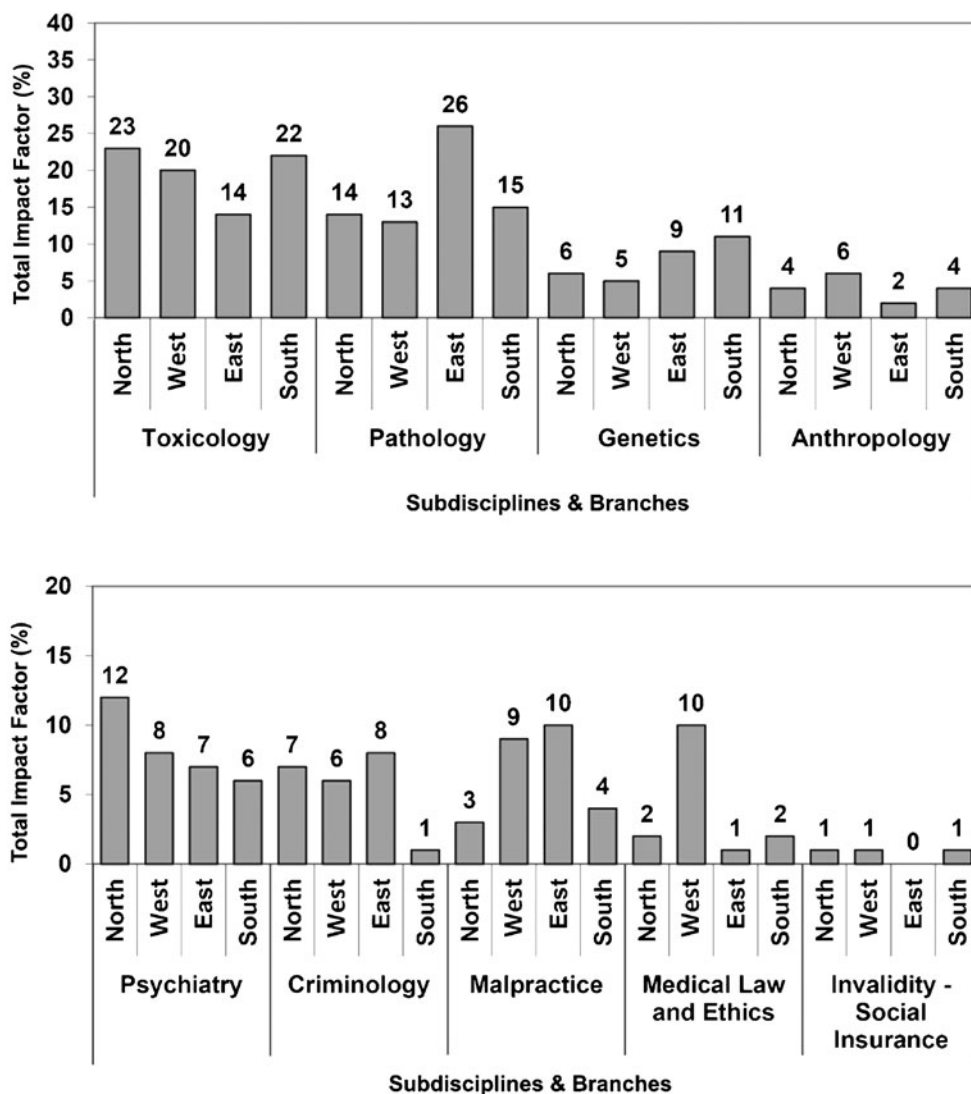
Analysis of geographic macro-areas shows that West and South each accumulate a *total impact factor* (calculated as the mean for the macro-area), which is higher than that of North and East. Figure 3b also shows that West and South have a similar relation between *total impact factor* and per capita GDP (again calculated as mean value per macro-area) and plot on the same line passing through the origin, within the medium tertile (Fig. 3b).

North and East also have the same mutual relationship between *impact factor* and per capita GDP, and lie on the same line within the lower tertile. West and North, although having comparable *NGDPDPC* (43,702–78,528 USD), have levels of scientific production 2:1 in favour of West.

North, West and South produce more than 20% of their *impact factor* in Toxicology and 13–15% in Pathology (Fig. 4). Most of the *impact factor* (26%) in East is produced in the field of Pathology, and 14% in Toxicology. One interpretation of the predominant role played by Pathology over Toxicology in East may be that research in Toxicology is based on the development and validation of analytical methods which require considerable technological and financial resources, unlike Forensic Pathology, which is partly supported by analysis of case series.

A large percentage of the productivity in South and East is expressed by Forensic Genetics (respectively 11% and 9%). In North, the main role is that of Forensic Psychiatry,

Fig. 4 Total impact factor by sub-discipline and branch, expressed as percentages of overall impact factor of each macro-area



yielding 12% of total impact factor, perhaps partly due to the particular importance given to this discipline in academic settings. In Finland, Sweden and Norway, for example, Forensic Psychiatry is an autonomous sub-discipline with respect to legal medicine practised by psychiatrists who have further specific forensic training [9, 14].

In conclusion, this country-based bibliometric analysis of scientific bio-medicolegal production for the 5.5-year period considered (January 2005–June 2010) highlights the prevailing role of Western and Southern Europe (Germany, Great Britain, Italy, Switzerland, Spain and France), for both number of publications and total impact factor.

Interestingly, several countries with low gross domestic product, such as Poland, Turkey and other Eastern European nations, show notable scientific production in specific sub-disciplines such as Pathology, Toxicology and Forensic Genetics, suggesting that fruitful international cooperation could be planned and be of interest to funding sources within the European Community, also taking into

account funds reserved for depressed areas undergoing development.

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