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Scientometric Assessment of Alberta's Performance in Three Research Areas



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15 January 2007

David Campbell, M.Sc.
and Grégoire Côté, B.Sc.

Contributors :

François Santerre, Ph.D., MBA,
and Julie Caruso, MLIS

Prepared for the
Alberta Heritage Foundation for Medical Research (AHFMR)

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514.495.6505 ▪ 4572 avenue de Lorimier ▪ Montréal ▪ Québec ▪ Canada ▪ H2H 2B5

info@science-metrix.com ▪ www.science-metrix.com



Executive Summary

The Alberta Heritage Foundation for Medical Research (AHFMR) is preparing a plan for targeted research initiatives in response to the most recent recommendations of its International Board of Review and as a part of a strategic planning process. Three areas of interest to AHFMR include Maternal, Foetal and Child Health (MFCH), Mental Health, Mental Illness and Addictions (MHMIA), and Health System Sustainability (HSS). In order to implement its plan, AHFMR needs strategic information on how Alberta's health research system performs in comparison to those of other provinces in the three areas. AHFMR mandated Science-Metrix to conduct a bibliometric study on each area.

The scientometric analysis is based on publications retrieved from the Medline database using a set of MeSH Terms defining each area. A timeframe of 15 years (1991–2005) was divided into five 3-year periods to outline the evolution of the scientific output at world, Canadian, and provincial levels. The performance of the provinces is presented according to four scientometric indicators (number of papers, papers per capita, specialization index (SI), and relative average of impact factors (RAIF)) and a combined multicriteria ranking. Data were gathered on the most productive cities, institutions, and researchers.

Of the three targeted areas, MFCH is the most important in terms of number of papers published from 1991 to 2005 at both world (about 720,000 papers) and Canadian (about 24,000 papers) levels. In MHMIA and HSS, about 376,000 papers and 180,000 papers respectively were published at world level during the same period, and about 17,000 papers and 6,300 papers at Canadian level.

When considering the multicriteria ranking of provinces in all 3-year periods, three provinces emerge as established leaders in MFCH. These include Ontario, which ranks 1st in all periods, Québec, which ranks 2nd over the 15-year period and in the last two 3-year periods, and British Columbia, which ranks 4th in the 15-year period and 2nd in the last period, on a par with Québec and Nova Scotia. Nova Scotia is an up-and-coming leader, having started in 5th place, on a par with Alberta, and finishing in 2nd place, on a par with Québec and British Columbia. Over the whole 15-year period, Nova Scotia ranks 4th, again on a par with British Columbia. Alberta ranks 6th in the whole period and 5th in the most recent period (2003–2005). Based on observed provincial level trends, if Alberta continues to increase its output and its impact the gap between it and the leaders in MFCH research could be reduced. Its main weakness in MFCH research concerns its low SI, but its absolute output is comparable to that of British Columbia and is twice that of Nova Scotia.

Ontario stands out as the leader in MHMIA research, and ranks 1st in all periods considered in the multicriteria ranking. Québec, British Columbia, and Nova Scotia follow, tied in 2nd place for the entire period considered. In the most recent period, Québec and British Columbia are again on a par in 2nd place, while Nova Scotia ranks 3rd. As in MFCH research, Nova Scotia can be regarded as an upcoming leader, given that it started in 6th place in the early 1990s. However, Nova Scotia output is small, less than half of the output of Alberta which ranks 5th both in the 15-year period and the most recent period analysed. Alberta could improve its position by increasing its specialization and its

impact above the world level. It is already making progress in the RAIF ranking, coming in ahead of Nova Scotia, Manitoba, and Saskatchewan in the last period studied.

Ontario leads in the area of HSS, ranking 1st in all periods except the 1994–1996 period, in which it ranked 2nd. For the period 1991 to 2005, Ontario ranks 1st, followed by Manitoba (2nd), British Columbia (3rd), Nova Scotia (4th), Alberta (5th), Québec (6th), and Saskatchewan (7th). Nova Scotia stands out in HSS, being ranked 2nd in the last two 3-year periods. In the most recent period, Alberta is on a par with Nova Scotia in 2nd place, having improved its ranking by four places from the first period in the early 1990s. To consolidate its leading position in this area, Alberta should continue to increase its output and its expected impact.

It is in HSS that Edmonton and Calgary performed the best relative to other leading Canadian cities, being 8th and 9th, respectively, in a multicriteria ranking. In MFCH, Edmonton ranks 11th and Calgary ranks 15th, while in MHMIA, Edmonton ranks 12th and Calgary ranks 10th. The University of Alberta and the University of Calgary rank among the leading Canadian institutions in all three areas, but performed best in HSS, where they both rank 5th in the multicriteria ranking. In MFCH, the University of Alberta ranks 13th and the University of Calgary ranks 31st, while in MHMIA, the University of Alberta ranks 18th and the University of Calgary ranks 19th. There are no researchers from Alberta among the top authors at world level in any of the three targeted areas. However, the leading Canadian researcher in terms of the number of papers published from 2001 to 2005 in HSS, Dr. Cameron R. Donaldson, is from the University of Calgary in Alberta. In MFCH, there is no author from Alberta among the leading Canadian researchers, but in MHMIA, Dr. Scott B. Patten from the University of Calgary ranks 4th.

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Introduction

The Alberta Heritage Foundation for Medical Research (AHFMR), based on the position of its Board of Trustees regarding the most recent recommendations from its International Board of Review and strategic planning process, is proceeding with a series of targeted research initiatives in Alberta. These initiatives are designed to build on Alberta's strengths in medical research and/or to foster research in areas of importance to the province.

Within the framework of its strategic planning, AHFMR needs information about how Alberta's health research system compares to those of other provinces in the targeted research areas. To this end, AHFMR mandated Science-Metrix to benchmark Alberta through bibliometric analysis of its scientific output in three areas: Maternal, Foetal and Child Health (MFCH) (Section 1), Mental Health, Mental Illness and Addictions (MHMIA) (Section 2), and Health System Sustainability (HSS) (Section 3).

The evolution of the number of scientific publications in each research area is presented for the world, Canada, and Alberta (Sections 1.1, 2.1, and 3.1). Subsequently, Alberta's scientific output is compared to that of other provinces, in terms of number of papers, number of papers per capita, specialization index and relative average of impact factors (Sections 1.2, 2.2, and 3.2). Based on these four indicators, the output of the most active Canadian cities and the most active Canadian institutions is compared (Sections 1.3, 1.4, 2.3, 2.4, 3.3, and 3.4). Finally, a list of the most active researchers in Alberta, Canada, and the world, together with basic information on their output, is presented (Sections 1.5, 2.5 and 3.5).

Methods

This bibliometric study is based on data from the Medline database, which is produced and maintained by the US National Library of Medicine (NLM). The database has been tailored by Science-Metrix with a view towards producing statistics on scientific publications in medical research. The Medline database has one limitation: entries include affiliation only for the first authors of the papers indexed. Consequently, the scientific output of geographic and organizational entities (i.e., countries, provinces, cities, and institutions) is underestimated. However, the goal of the present study was not to produce a census of all papers in the three targeted areas, but rather to provide an unbiased comparison of the production of various geographic and organizational entities. This limitation also makes it difficult to analyse collaborations, although methods could potentially be developed to associate most authors with specific affiliations, thereby providing a way to compute statistics on collaboration. Nevertheless, this limitation is more than compensated for by the advantage deriving from the keywords used in Medline, the Medical Subject Headings, or MeSH, which constitute a controlled vocabulary used for indexing the articles in the database.

The construction of the three datasets, one for each targeted area, for scientometric analysis was essentially based on an advanced search method using MeSH Terms. A MeSH Term is the National Library of Medicine's controlled vocabulary thesaurus, which comprises a "descriptor", and a "qualifier", which pinpoints a specific aspect of the concept represented by the descriptor.

In a first step, analysts at Science-Metrix established operational definitions for the three targeted areas and created three sets of MeSH Terms to retrieve all scientific papers relevant to the defined areas:

- **Maternal, Foetal and Child Health (MFCH):** This area includes all scientific papers written in the fields of pediatrics, obstetrics, and gynecology. Pediatrics is defined as a medical specialty concerned with maintaining health and providing medical care to children from birth to adolescence. Obstetrics is defined as a medical-surgical specialty concerned with the management and care of women during pregnancy, parturition, and the puerperium. Gynecology is defined as a medical-surgical specialty concerned with the physiology and disorders primarily of the female genital tract, as well as female endocrinology and reproductive physiology. Papers related to the female urogenital system were discarded from gynecology.
- **Mental Health, Mental Illness and Addictions (MHMIA):** Mental health is a state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community. Mental health includes mental health promotion, an umbrella term that covers a variety of strategies, all of which are aimed at having a positive effect on mental health. As most health care resources are spent on the specialized treatment and care of the mentally ill, mental disorders are central to the definition.
- **Health System Sustainability (HSS):** This area includes all scientific papers addressing issues regarding the effective utilization and coordination of resources such as capital, materials, and labour to improve or maintain the high quality of health care while reducing or maintaining the cost for end-users.

The operational definitions and sets of MeSH Terms were submitted to AHFMR's experts for review. On the basis of their comments Science-Metrix' analysts made some modifications to them. Please refer to the Appendix for the set of MeSH Terms used for querying Medline in order to build the

datasets. It is important to note that the structure of the queries includes complex exclusions for specific MeSH Terms. Thus, simply searching the MeSH Terms presented in the Appendix will not yield appropriate datasets.

Only ‘journal articles’ were retrieved from Medline, and these documents are referred to as ‘papers’ in this report. In HSS, the retrieval of documents classified as ‘journal articles’ resulted in the inclusion of medical news in the dataset, in addition to scientific papers. Thus, the list of leading authors in this area may include some journalists as well as academics. The period covered by this study extends from 1991 to 2005. In benchmarking provinces, cities, and institutions, the 15-year period was divided into five 3-year periods to enable examination of the evolution of each area.

For the present study, statistics were produced based on the following indicators:

- **Number of papers:** The number of scientific papers with authors associated with geographic areas (based on author addresses; e.g., countries, states, provinces).
- **Number of papers per capita:** Average number of papers per million inhabitants per year.
- **Relative average of impact factors (RAIF):** This indicator is a proxy for the quality of the journals in which an entity publishes. Each journal has an impact factor (IF), which is calculated annually by Thomson Scientific based on the number of citations it receives relative to the number of papers it publishes. The IF of papers is calculated by ascribing to them the IF of the journals in which they are published. The RAIF of a given entity is obtained by taking the ratio of the average of IF of an entity’s papers over the average of IF of world papers in a specific research area. When the RAIF is above one, it means that an entity (i.e., a country, a province, a city, an institution, or a researcher) scores better than the world average; when it is below one, this means that on average, an entity (i.e., a country, a province, a city, an institution, or a researcher) publishes in journals that are not cited as often as the world average.
- **Specialization index (SI):** This is an indicator of the intensity of research of a given geographic or organizational entity (e.g., a country) in a given research area (e.g., domain, field) relative to the intensity of the reference entity (e.g., the world) in the same research area. The SI can be formulated as follows:

$$SI = \frac{(X_s / X_r)}{(N_s / N_r)}$$

- X_s = Papers from entity X in a given research area (e.g., Alberta in MFCH)
- X_r = Papers from entity X in a reference set of papers (e.g., Alberta in Medline)
- N_s = Papers from the reference entity N in a given research area (e.g., the world in MFCH)
- N_r = Papers from the reference entity N in a reference set of papers (e.g., the world in Medline).
- An index value above 1 means that a given entity is specialized relative to the reference entity, while an index value below 1 means the reverse.

1 Maternal, Foetal and Child Health

This section presents data on the scientific production of various entities in the area of Maternal, Foetal and Child Health (MFCH), which includes the fields of pediatrics, obstetrics, and gynecology. Papers related to the female urogenital system are not included in the field of gynecology. The focus is on Alberta.

1.1 Trends in the world, Canada and Alberta

This section presents publication trends in MFCH from 1991 to 2005. At world level, annual scientific production in MFCH was fairly stable from 1991 to 2000 with the number of publications fluctuating between 41,000 and 48,000 (Figure 1). From 2000 onward, the number of papers published per year increased steadily, reaching some 58,000 papers in 2005. Relative to the overall scientific production captured by Medline, the importance of MFCH in medicine remained stable, although there was a slight decrease over the period at world level with the share of MFCH papers in Medline decreasing from about 12% in 1991 to around 11% in 2005.

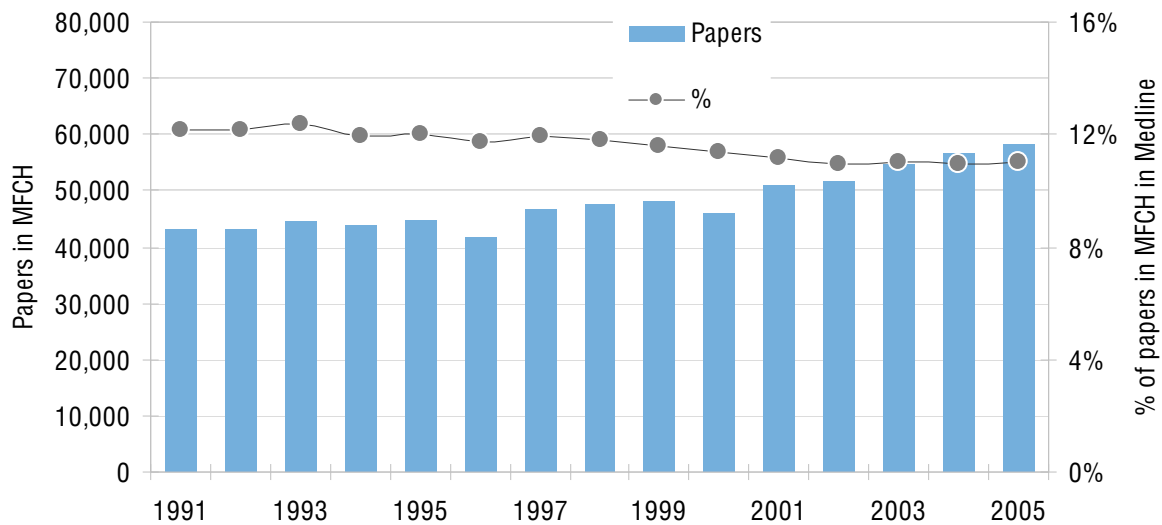


Figure 1 Number and percentage of papers in MFCH in Medline database, 1991–2005

Source: Compiled by Science-Metrix from Medline

The trend in MFCH publications at the Canadian level is similar to the world level trend. From 1991 to 2000, the number of papers published in the area remained stable, having fluctuated between 1,300 and 1,600 (Figure 2). During this period, the Canadian share of world MFCH papers increased from 3% to 3.3%. Subsequently, the number of Canadian papers increased steadily to reach nearly 2,250 papers in 2005. This increase was more rapid than the world level increase, resulting in Canada’s share in world MFCH papers reaching nearly 4% in 2005.

Although more chaotic, the evolution of the scientific output in MFCH in Alberta is similar to that at the world and Canadian levels, with the greatest increase occurring between 2000 (about 130 papers) and 2005 (about 250 papers) (Figure 3).

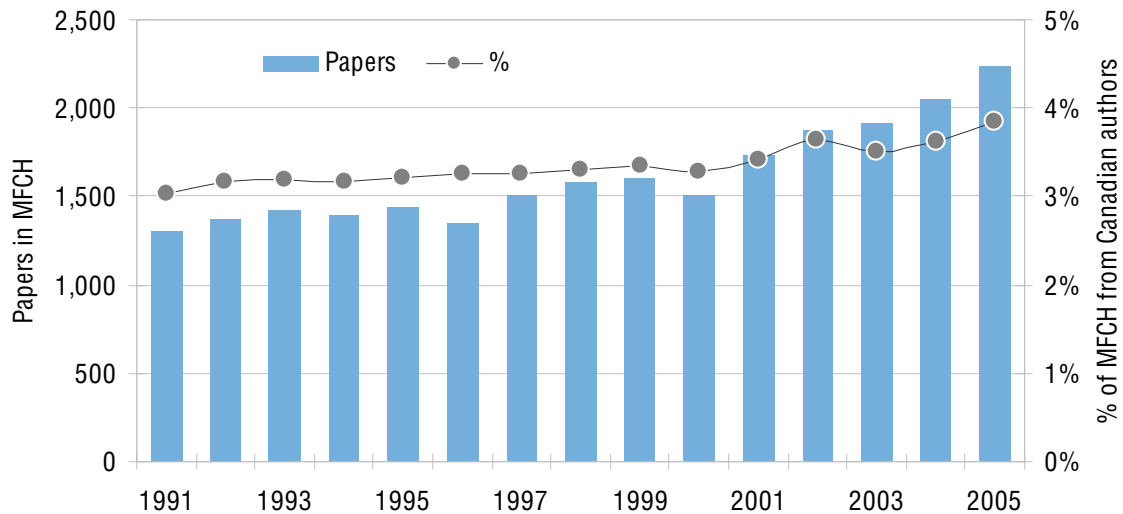


Figure 2 Number of papers in MFCH in Canada and % of world MFCH papers by Canada, 1991–2005

Source: Compiled by Science-Matrix from Medline

Alberta’s share in world MFCH papers increased from 0.25% in 1991 to about 0.45% in 2005, while its share in Canadian MFCH papers increased from about 8% in 1991 to about 11% in 2005 (Figure 3). Thus, Alberta’s contribution to Canada’s production has increased, and particularly in 2004 and 2005.

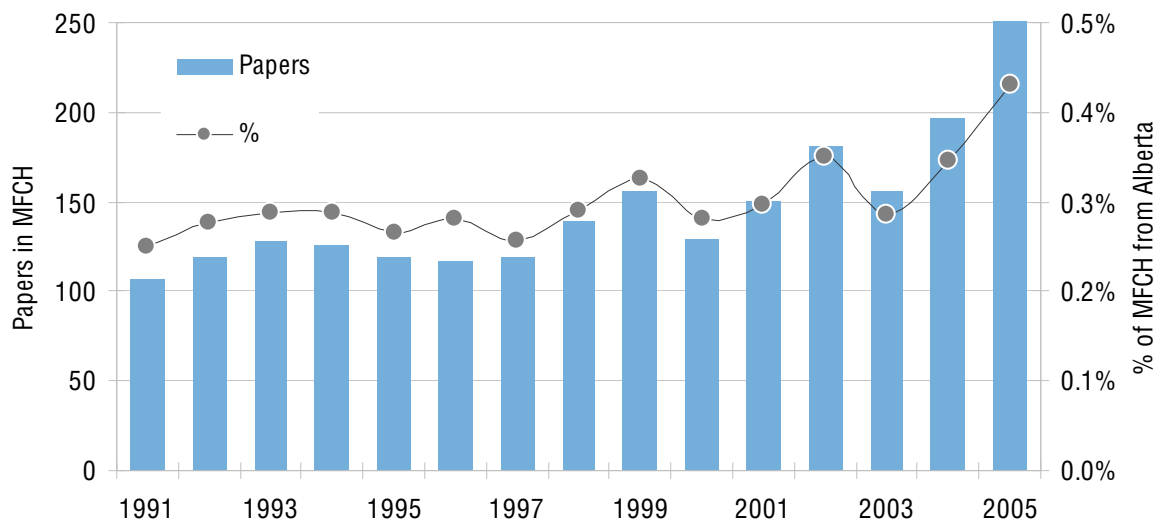


Figure 3 Number of papers in MFCH in Alberta and % of world MFCH papers by Alberta, 1991–2005

Source: Compiled by Science-Matrix from Medline

1.2 Benchmarking provinces

In order to benchmark Alberta's scientific output in MFCH against that of other provinces, four indicators were used:

- Number of papers
- Number of papers per capita
- Specialization index (SI)
- Relative average of impact factors (RAIF).

The indicators were combined in a multicriteria benchmarking of the leading provinces. This benchmarking is based on a 15-year period (1991–2005), which is broken down into five 3-year periods to examine the evolution of this field among the leading provinces.

1.2.1 Number of papers

In absolute scientific output, Ontario dominates in the area of MFCH, accounting for nearly 50% of Canada's scientific production. Québec, British Columbia, and Alberta are in 2nd, 3rd, and 4th places, respectively. These four provinces have increased their scientific production over time, and maintained their respective positions (Table I). Manitoba, Nova Scotia, Saskatchewan, and Newfoundland rank 5th, 6th, 7th, and 8th, respectively. In the 2000–2002 period, Nova Scotia overtook Manitoba in absolute production and has maintained this advance in the most recent period. Data for New Brunswick and Prince Edward Island are not presented given the small size of their scientific output in this area.

Table I Number of papers in MFCH by province and by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk
Ontario	1,945	(1)	2,018	(1)	2,320	(1)	2,487	(1)	3,032	(1)	11,802	(1)
Quebec	867	(2)	892	(2)	1,010	(2)	1,063	(2)	1,267	(2)	5,099	(2)
British Columbia	460	(3)	457	(3)	485	(3)	578	(3)	723	(3)	2,703	(3)
Alberta	354	(4)	362	(4)	414	(4)	461	(4)	603	(4)	2,194	(4)
Manitoba	214	(5)	200	(5)	175	(5)	184	(6)	186	(6)	959	(5)
Nova Scotia	128	(6)	128	(6)	161	(6)	205	(5)	255	(5)	877	(6)
Saskatchewan	56	(7)	60	(7)	70	(7)	78	(7)	79	(7)	343	(7)
Newfoundland	40	(8)	49	(8)	57	(8)	47	(8)	46	(8)	239	(8)
Canada	4,089		4,177		4,698		5,114		6,209		24,287	
World	130,451		130,281		142,070		148,214		169,465		720,481	

Source: Compiled by Science-Metrix from Medline

1.2.2 Papers per capita

Taking the population size of an entity into account when analysing its scientific output can often allow for a better understanding of the relative effort of smaller entities. For example, Nova Scotia,

which is the second smallest province in terms of population size among the eight considered, ranks 2nd in output per capita with an average of about 63 MFCH publications per year per million inhabitants, while it is ranked 6th in absolute output over the 15-year period (Table II). Nova Scotia has improved its position over time, from 3rd place in 1991–1993 to 1st place in 2003–2005. Nova Scotia and Ontario are the only provinces that have performed better than Canada as a whole in the more recent period analysed.

Although Ontario was overtaken by Nova Scotia in the last two 3-year periods, it still remains the leader overall, with an average of nearly 69 MFCH publications per year per million inhabitants for the whole period. Manitoba ranks 3rd over the whole period, but lost 5 positions over time, from 1st place in 1991–1993 to 6th place in 2003–2005. Alberta ranks 4th in both relative and absolute output. However, its position in relative output improved over time to finish 3rd in 2003–2005. Québec ranks 5th over the whole period and in the 2003–2005 period. British Columbia ranks 6th for the 15-year period, but improved over the period examined to finish 4th ahead of Québec in the 2003–2005 period (Table II). Newfoundland and Saskatchewan rank 7th and 8th, respectively.

Table II Average of yearly papers per capita in MFCH by province and by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	yearly papers/ 10 ⁶ inhab	Rk	yearly papers/ 10 ⁶ inhab	Rk	yearly papers/ 10 ⁶ inhab	Rk	yearly papers/ 10 ⁶ inhab	Rk	yearly papers/ 10 ⁶ inhab	Rk	yearly papers/ 10 ⁶ inhab	Rk
Ontario	61.5	(2)	61.5	(1)	68.1	(1)	69.8	(2)	81.6	(2)	68.5	(1)
Nova Scotia	46.4	(3)	45.9	(3)	57.5	(2)	73.2	(1)	90.7	(1)	62.8	(2)
Manitoba	64.2	(1)	59.2	(2)	51.3	(3)	53.3	(3)	53.1	(6)	56.2	(3)
Alberta	44.9	(4)	44.2	(4)	47.7	(4)	50.3	(4)	62.5	(3)	49.9	(4)
Québec	40.7	(6)	41.2	(5)	46.1	(5)	47.9	(5)	56.0	(5)	46.4	(5)
British Columbia	44.3	(5)	40.6	(6)	40.7	(6)	47.3	(6)	57.3	(4)	46.0	(6)
Newfoundland	23.0	(7)	28.8	(7)	34.9	(7)	29.9	(7)	29.7	(7)	29.3	(7)
Saskatchewan	18.6	(8)	19.7	(8)	22.9	(8)	26.0	(8)	26.5	(8)	22.8	(8)
Canada	48.1		47.6		52.0		55.0		64.8		53.5	
World	8.0		7.6		8.0		8.0		8.9		8.1	

Source: Compiled by Science-Metrix from Medline

1.2.3 Specialization index

The specialization index (SI) is an indicator of the intensity of research within a specific research area in an entity (i.e., province or country) relative to the intensity of research within the same research area in the world; a score above one means that an entity specializes in the research area relative to the world.

For the whole 15-year period, Canada's proportion of MFCH papers among its Medline papers is the same as the world proportion, so its SI is equal to that of the world (i.e., SI = 1.00). Five out of the eight provinces considered are specialized for the 1991–2005 period: Newfoundland (1st place, SI of 1.17), Nova Scotia (2nd place, SI of 1.13), Ontario (3rd place, SI of 1.10), Manitoba (4th place, SI of 1.05) and British Columbia (5th place, SI of 1.03) (Table III). However, only three provinces were specialized

in the period 2003-2005: Nova Scotia (1st place, SI of 1.30), Ontario (2nd place, SI of 1.17), and British Columbia (3rd place, SI of 1.09). Québec, Alberta, and Saskatchewan rank, respectively, 6th, 7th, and 8th with a proportion of Medline papers in the area of MFCH that is smaller than that of the world and Canada. However, Québec's position improved in the last period, to 4th place with a SI of 0.99, closely followed by Newfoundland and Manitoba, each with a SI of 0.98 in the 2003–2005 period.

Table III SI of provinces in MFCH by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	SI	Rk	SI	Rk	SI	Rk	SI	Rk	SI	Rk	SI	Rk
Newfoundland	0.89	(5)	1.30	(1)	1.54	(1)	1.25	(1)	0.98	(5)	1.17	(1)
Nova Scotia	0.95	(4)	1.03	(4)	1.06	(3)	1.20	(2)	1.30	(1)	1.13	(2)
Ontario	1.03	(2)	1.06	(3)	1.10	(2)	1.13	(3)	1.17	(2)	1.10	(3)
Manitoba	1.09	(1)	1.10	(2)	0.96	(4)	1.10	(4)	0.98	(6)	1.05	(4)
British Columbia	1.02	(3)	1.01	(5)	0.96	(5)	1.04	(5)	1.09	(3)	1.03	(5)
Québec	0.86	(6)	0.84	(6)	0.88	(6)	0.97	(6)	0.99	(4)	0.91	(6)
Alberta	0.76	(7)	0.75	(7)	0.82	(7)	0.81	(7)	0.87	(7)	0.81	(7)
Saskatchewan	0.49	(8)	0.51	(8)	0.54	(8)	0.60	(8)	0.49	(8)	0.52	(8)
Canada	0.95		0.95		0.98		1.03		1.06		1.00	
World	1.00		1.00		1.00		1.00		1.00		1.00	

Source: Compiled by Science-Metrix from Medline

1.2.4 Relative average of impact factors

The relative average of impact factors (RAIF) is an indicator of the expected impact of papers from an entity relative to the expected impact of papers at the world level; a score above one means that an entity publishes in journals that are more cited than the world average for papers in the same field. It provides a proxy for the quality of the journals in which papers are published.

In the area of MFCH, Canada performs better than the world with a RAIF of 1.10 (Table IV). This means that on average, Canadian papers are published in journals that have 10% more impact than world papers. For the 15-year period, only three provinces had a RAIF above the world level: Québec (1st place, RAIF of 1.17), Ontario (2nd place, RAIF of 1.15), and British Columbia (3rd place, RAIF of 1.01). In the 2003–2005 period, Ontario and Québec maintained their lead with a RAIF of 1.14. British Columbia maintained its 3rd place in the last period with a RAIF of 1.06. Among the provinces with a RAIF below the world level for the whole period, only Alberta managed an increase to above the world level in the 2003–2005 period, finishing in 4th place. In the last period, Manitoba, Nova Scotia, Newfoundland, and Saskatchewan follow in 5th, 6th, 7th, and 8th place, respectively.

Table IV RAI of provinces in MFCH by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	RAIF	Rk	RAIF	Rk	RAIF	Rk	RAIF	Rk	RAIF	Rk	RAIF	Rk
Québec	1.15	(2)	1.14	(1)	1.22	(2)	1.23	(1)	1.14	(2)	1.17	(1)
Ontario	1.17	(1)	1.13	(2)	1.11	(3)	1.20	(2)	1.14	(1)	1.15	(2)
British Columbia	0.95	(4)	1.00	(4)	0.97	(4)	1.05	(4)	1.06	(3)	1.01	(3)
Manitoba	1.06	(3)	0.92	(5)	1.24	(1)	0.85	(8)	0.99	(5)	0.98	(4)
Alberta	0.92	(6)	0.91	(6)	0.95	(5)	0.96	(6)	1.03	(4)	0.97	(5)
Newfoundland	0.94	(5)	1.02	(3)	0.82	(6)	1.09	(3)	0.93	(7)	0.94	(6)
Nova Scotia	0.77	(8)	0.81	(7)	0.79	(7)	0.96	(7)	0.93	(6)	0.88	(7)
Saskatchewan	0.88	(7)	0.71	(8)	0.79	(8)	0.99	(5)	0.74	(8)	0.83	(8)
Canada	1.09		1.07		1.09		1.14		1.10		1.10	
World	1.00		1.00		1.00		1.00		1.00		1.00	

Source: Compiled by Science-Metrix from Medline

1.2.5 Multicriteria ranking

The multicriteria ranking provides an overall assessment of the leading Canadian provinces in MFCH. The indicators considered in the multicriteria ranking are number of papers, number of papers per capita, SI, and RAIIF.

When considering the multicriteria ranking of provinces in all the 3-year periods, three provinces emerge as established leaders in MFCH (Table V). These are Ontario, ranked 1st in all periods, Québec, ranked 2nd over the whole period, and for the last two 3-year periods, and British Columbia, which ranked 4th in the 15-year period and 2nd in the last period on a par with Québec and Nova Scotia. Nova Scotia is an up-and-coming leader, having started in 5th place on a par with Alberta and finishing in 2nd place on a par with Québec and British Columbia. Over the whole period, it ranks 4th, again on a par with British Columbia. Nova Scotia's multicriteria ranking improved primarily as a result of an improvement in output per capita and SI. However, its absolute production is relatively small compared to other provinces such as Ontario, Québec, British Columbia, and Alberta.

Although Manitoba is among the leaders ranking 2nd in the first three 3-year period and 3rd for the entire period covered in this study, its performance in MFCH has been declining in recent years, and in 2003-2005 it was in 6th place. This decline was due to decreased performance in the four indicators considered. For the whole period, Alberta ranks 6th, and 5th in the last period. This position could improve if its output and its RAIIF continue to increase. Its main weakness in MFCH research is its low SI, as can be seen from Figure 4. Newfoundland and Saskatchewan are in 7th and 8th place, respectively.

Table V Multicriteria ranking of provinces in MFCH comprising number of papers, papers per capita, SI, and RAIF, by 3-year period, 1991–2005

Rk	1991-1993	1994-1996	1997-1999	2000-2002	2003-2005	1991-2005
1	Ontario	Ontario	Ontario	Ontario	Ontario	Ontario
2	Manitoba	Manitoba (2)	Manitoba	Québec	BC (2)	Québec
3	BC	Québec (2)	Québec	Nova Scotia	Nova Scotia (2)	Manitoba
4	Québec	BC	BC (4)	BC	Québec (2)	BC (4)
5	Alberta (5)	Newfoundland	Nova Scotia (4)	Newfoundland	Alberta	Nova Scotia (4)
6	Nova Scotia (5)	Nova Scotia	Alberta	Alberta (6)	Manitoba	Alberta
7	Newfoundland	Alberta	Newfoundland	Manitoba (6)	Newfoundland	Newfoundland
8	Saskatchewan	Saskatchewan	Saskatchewan	Saskatchewan	Saskatchewan	Saskatchewan

Source: Compiled by Science-Metrix from Medline

Figure 4 shows the positions of provinces in a two-dimensional space, based on the SI and the RAIF. The SI and the RAIF are log transformed such that the origin (0, 0) represents the world level.

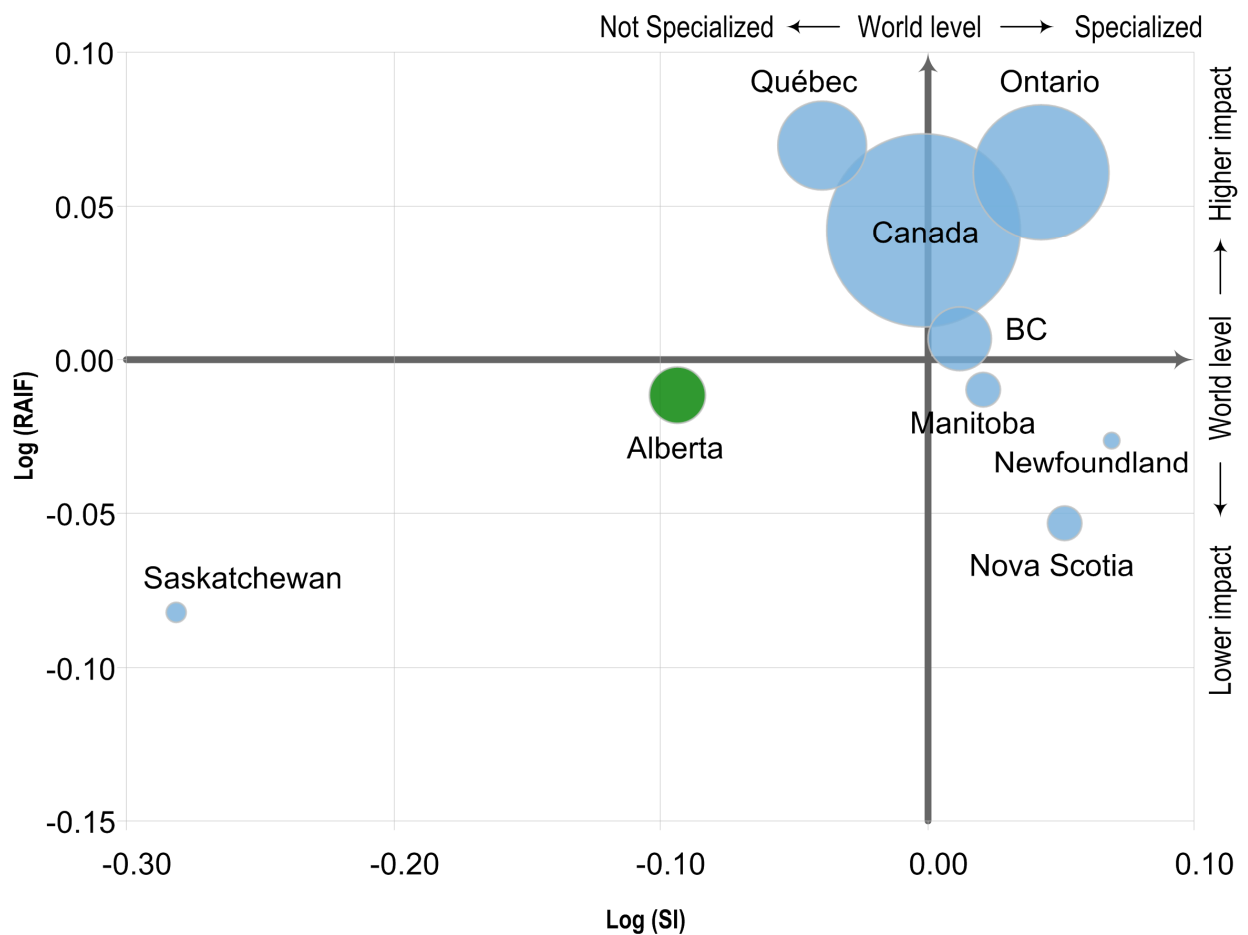


Figure 4 Scientometric positioning of provinces based on specialization and scientific impact in MFCH, 1991–2005

Source: Compiled by Science-Metrix from Medline

For both indicators, a value above zero means that the score is higher than the world level, while a value below zero means that the score is lower than the world level. Thus, leaders are in the top right quadrant (high level of specialization, high level of impact) and the provinces that are lagging are in the lower left quadrant. However, the number of papers published over the period should also be taken account of. For example, a province that makes only a minor scientific contribution to the field may fall in the top right quadrant, while a province that makes a large contribution may fall in the lower left quadrant. The size of bubbles is proportional to the absolute scientific output.

It is important to note that the figure gives a positioning of the provinces based on the entire period examined (1991–2005). As with the multicriteria ranking, Ontario, Québec, and British Columbia are the leaders in an area where Canada as a whole also performs well, being located in the upper part of the figure right on the y-axis. This means that Canada performs better than the world for expected impact of MFCH research, while not being more involved in MFCH research (in proportion of total papers in Medline) than the world average. Ontario and Québec are the only provinces that perform better than Canada as a whole, for expected impact of their scientific research in the area. Québec has a greater impact than British Columbia, but is less specialized although its absolute output is greater than that of British Columbia. Manitoba, Newfoundland, and Nova Scotia are all in the lower right quadrant. If they were able to increase the impact of their research, their ranking would improve. All three provinces have only a small output. Alberta is in the lower left quadrant. However, its RAIF did increase above the world level in the 2003–2005 period. As it ranks 4th in absolute output, it could become one of the leaders if it could improve its SI and increase its impact further. Saskatchewan is clearly lagging behind other provinces with a small output, and an impact and a SI below the world level.

1.3 Cities

This section presents a multicriteria ranking of leading Canadian cities in MFCH based on four indicators: number of papers, number of papers per capita, SI, and RAIF. Leading Canadian cities were selected on the basis of their absolute output in the field. Trends in the number of scientific papers published in MFCH by each city are presented.

The top three cities in absolute output are Toronto (about 7,000 papers), Montreal (about 4,000 papers), and Vancouver (about 2,500 papers). Alberta has two cities in the top 15, namely Edmonton in 6th place (about 1,200 papers) and Calgary in 9th place (about 1,000 papers) (Table VI). When cities' population size is taken into account, the leaders include Kingston (1st), Halifax (2nd), and London (3rd). Edmonton ranks 12th and Calgary ranks 14th. Of the top 15 cities, seven are specialized in MFCH research: Toronto (1st), St-John's (2nd), Halifax (3rd), Vancouver (4th), Hamilton (5th), Ottawa-Hull (6th), and Winnipeg (7th). With a SI of 0.90, Calgary ranks 9th, while Edmonton ranks 12th with a SI of 0.78. There are seven cities whose scientific output has an expected impact above the world level: Quebec (1st), Toronto (2nd), Hamilton (3rd), Montreal (4th), Guelph (5th), Edmonton (6th), and Vancouver (7th). With respect to the expected impact of its research in MFCH, Calgary ranks last among leading cities, with a RAIF of 0.88. When all the indicators are combined in a multicriteria ranking, the top cities for MFCH are Toronto (1st), Hamilton (2nd), and Vancouver (3rd). Edmonton ranks 11th and Calgary ranks 15th.

Table VI Multicriteria ranking of leading Canadian cities in MFCH comprising number of papers, papers per capita, SI, and RAIF, 1991–2005

City	Papers	Rk	Papers/ 10 ⁶ inab.	Rk	SI	Rk	RAIF	Rk	Multicriteria rank
Toronto	6,908	(1)	99.0	(8)	1.36	(1)	1.24	(2)	(1)
Hamilton	1,320	(5)	132.2	(4)	1.10	(5)	1.20	(3)	(2)
Vancouver	2,454	(3)	83.4	(11)	1.13	(4)	1.03	(7)	(3)
Montreal	4,236	(2)	81.8	(13)	0.98	(8)	1.18	(4)	(4)
Ottawa-Hull	1,523	(4)	95.5	(9)	1.05	(6)	1.00	(8)	(4)
Halifax	832	(10)	153.0	(2)	1.14	(3)	0.89	(14)	(6)
Winnipeg	1,026	(7)	100.0	(7)	1.04	(7)	1.00	(9)	(7)
St-John's	273	(14)	102.5	(6)	1.28	(2)	0.96	(10)	(8)
London	999	(8)	152.9	(3)	0.82	(11)	0.94	(11)	(9)
Kingston	505	(12)	222.7	(1)	0.85	(10)	0.91	(12)	(10)
Edmonton	1170	(6)	83.3	(12)	0.78	(12)	1.06	(6)	(11)
Quebec	606	(11)	58.6	(15)	0.70	(13)	1.28	(1)	(12)
Guelph	155	(15)	93.6	(10)	0.29	(15)	1.08	(5)	(13)
Saskatoon	355	(13)	104.0	(5)	0.53	(14)	0.90	(13)	(13)
Calgary	968	(9)	71.4	(14)	0.90	(9)	0.88	(15)	(15)

Source: Compiled by Science-Metrix from Medline

The leading cities in absolute output—Toronto, Montreal, Vancouver, and Ottawa-Hull—have maintained their position over time, as can be seen from Table VII.

Table VII Trends in the number of publications of leading Canadian cities in MFCH by 3-year period, 1991–2005

City	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk
Toronto	1,113	(1)	1,154	(1)	1,351	(1)	1,462	(1)	1,828	(1)	6,908	(1)
Montreal	709	(2)	741	(2)	845	(2)	884	(2)	1,057	(2)	4,236	(2)
Vancouver	429	(3)	429	(3)	439	(3)	518	(3)	639	(3)	2,454	(3)
Ottawa-Hull	239	(4)	241	(4)	332	(4)	316	(4)	395	(4)	1,523	(4)
Hamilton	237	(5)	237	(5)	244	(5)	289	(5)	313	(6)	1,320	(5)
Edmonton	157	(9)	194	(8)	225	(6)	259	(6)	335	(5)	1,170	(6)
Winnipeg	228	(6)	219	(6)	194	(7)	194	(7)	191	(10)	1,026	(7)
London	225	(7)	214	(7)	190	(8)	178	(10)	192	(9)	999	(8)
Calgary	191	(8)	164	(9)	178	(9)	193	(8)	242	(8)	968	(9)
Halifax	120	(10)	126	(10)	153	(10)	190	(9)	243	(7)	832	(10)
Quebec	115	(11)	105	(11)	120	(11)	136	(11)	130	(12)	606	(11)
Kingston	66	(12)	86	(12)	105	(12)	111	(12)	137	(11)	505	(12)
Saskatoon	51	(13)	59	(13)	73	(13)	80	(13)	92	(13)	355	(13)
St-John's	40	(14)	46	(14)	64	(14)	55	(14)	68	(14)	273	(14)
Guelph	22	(15)	38	(15)	34	(15)	25	(15)	36	(15)	155	(15)
Canada	4,089		4,177		4,698		5,114		6,209		24,287	

Source: Compiled by Science-Metrix from Medline

Edmonton moved from 9th place in the 1991–1993 period to 5th place in the 2003–2005 period, while Calgary maintained its 8th position. Winnipeg and London are the only two cities in the top 15 whose

scientific output has decreased over time. Winnipeg lost four places to finish 10th in the last period, while London lost two places to finish 9th.

1.4 Institutions

A multicriteria ranking of leading Canadian institutions in MFCH was performed based on three indicators: number of papers, SI, and RAIF. Leading Canadian institutions were selected on the basis of their absolute output in this area. Trends in the number of scientific papers published in MFCH by each of these institutions are presented.

The Hospital for Sick Children (about 3,500 papers), the University of Toronto (about 1,500 papers), the University of British Columbia (about 1,350 papers), and McGill University (about 1,120 papers) are the only Canadian institutions to have published more than 1,000 papers in MFCH in the period 1991 to 2005 (Table VIII).

Table VIII Multicriteria ranking of leading Canadian institutions in MFCH comprising number of papers, SI and RAIF, 1991–2005

Institution	Papers	Rk	SI	Rk	RAIF	Rk	Multicriteria rank
Hospital for Sick Children	3,503	(1)	4.48	(7)	1.16	(11)	(1)
McGill University	1,120	(4)	1.02	(15)	1.24	(8)	(2)
CHU Mère-enfant Hôpital Sainte-Justine	794	(6)	4.67	(6)	1.05	(16)	(3)
McMaster University	794	(6)	1.03	(14)	1.19	(10)	(4)
Mount Sinai Hospital	399	(19)	1.28	(11)	1.74	(1)	(5)
University of Toronto	1,509	(2)	0.85	(23)	1.29	(7)	(6)
Hamilton Health Sciences Corporation	417	(17)	1.51	(9)	1.20	(9)	(7)
University of British Columbia	1,356	(3)	0.94	(18)	1.05	(15)	(8)
Children's & Women's Health Center of BC	714	(8)	6.00	(2)	0.92	(27)	(9)
University of Manitoba	670	(9)	1.04	(13)	1.02	(19)	(10)
Montreal Children's Hospital	580	(12)	4.90	(5)	0.93	(26)	(11)
Sunnybrook & Women's Coll Hlth Sci Ctr	348	(21)	0.93	(20)	1.35	(4)	(12)
Ottawa Hospital	249	(25)	0.98	(16)	1.30	(6)	(13)
University of Alberta	901	(5)	0.69	(29)	1.13	(13)	(13)
CHUQ	307	(22)	0.83	(24)	1.42	(3)	(15)
University Health Network	480	(15)	0.52	(34)	1.49	(2)	(16)
Children's Hospital of Eastern Ontario	427	(16)	5.79	(3)	0.79	(35)	(17)
Royal Victoria Hospital	234	(26)	0.82	(26)	1.33	(5)	(18)
Izaak Walton Killam Hospital for Children	269	(23)	5.36	(4)	0.88	(30)	(18)
University of Ottawa	383	(20)	0.92	(21)	1.03	(17)	(20)
Alberta Children's Hospital	192	(31)	6.15	(1)	0.92	(28)	(21)
University of Western Ontario	618	(10)	0.81	(27)	0.96	(24)	(22)
Université de Montréal	498	(14)	0.65	(31)	0.99	(20)	(23)
Memorial University	187	(32)	1.13	(12)	0.97	(22)	(24)
Health Canada	195	(30)	0.93	(19)	1.03	(18)	(25)
Dalhousie University	499	(13)	0.91	(22)	0.88	(32)	(25)
St. Joseph's Health Care London	142	(35)	1.43	(10)	0.96	(23)	(27)
Winnipeg Health Sciences Centre	212	(28)	3.14	(8)	0.86	(33)	(28)
Université Laval	233	(27)	0.59	(32)	1.14	(12)	(29)
Centre for Addiction and Mental Health	179	(33)	0.97	(17)	0.98	(21)	(29)
University of Calgary	592	(11)	0.68	(30)	0.88	(31)	(31)
Queen's University	413	(18)	0.80	(28)	0.91	(29)	(32)
University of Saskatchewan	267	(24)	0.55	(33)	0.95	(25)	(33)
University of Guelph	153	(34)	0.30	(35)	1.07	(14)	(34)
London Health Sciences Centre	198	(29)	0.83	(25)	0.83	(34)	(35)

Source: Compiled by Science-Metrix from Medline

They are followed by the University of Alberta in 5th place with about 900 papers. Other institutions from Alberta in the top 35 include the University of Calgary (11th with nearly 600 papers) and the Alberta Children’s Hospital (31st with nearly 200 papers). Although it has a small output, the Alberta Children’s Hospital ranks 1st in terms of specialization in MFCH research with a SI of 6.15. Other institutions that are highly specialized in this area include the Children’s & Women’s Health Center of British Columbia (SI of 6.00), the Children’s Hospital of Eastern Ontario (SI of 5.79), the Izaak Walton Killam Hospital for Children (SI of 5.36), the Montreal Children’s Hospital (SI of 4.90), the CHU Mère-Enfant Hôpital Sainte-Justine (SI of 4.67), and the Hospital for Sick Children (SI of 4.48). Of the top 35 institutions, 22 have an expected impact above the world level, and the leaders based on this indicator are not the same as the leaders in output or SI. They include Mount Sinai Hospital in Ontario with a RAIF of 1.74, the University Health Network with a RAIF of 1.49, and the Centre Hospitalier Universitaire de Québec (CHUQ) with a RAIF of 1.42. None of the top 35 institutions is leading with respect to all indicators; the Hospital for Sick Children ranks 1st in the multicriteria ranking, followed by McGill University in 2nd place and the CHU Mère-Enfant Hôpital Sainte-Justine in 3rd place. The University of Alberta ranks 13th, the Alberta Children’s Hospital ranks 21st, and the University of Calgary ranks 31st.

The top four Canadian institutions in terms of output in MFCH research had a stable ranking in the last four 3-year periods. They are the Hospital for Sick Children, the University of Toronto, the University of British Columbia, and McGill University. The University of Alberta increased its productivity over the period studied, from 11th place with 108 papers in 1991–1993 to 5th place, close behind McGill University, with 272 papers in the 2003–2005 period. The Alberta Children’s Hospital improved its ranking from the 32nd place to the 26th place, while the University of Calgary maintained its 9th position.

Table IX Trends in the number of publications of leading Canadian institutions in MFCH by 3-year period, 1991–2005

Institution	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk
Hospital for Sick Children	658	(1)	568	(1)	669	(1)	704	(1)	904	(1)	3,503	(1)
University of Toronto	201	(3)	266	(2)	318	(2)	352	(2)	372	(2)	1,509	(2)
University of British Columbia	276	(2)	262	(3)	226	(3)	266	(3)	326	(3)	1,356	(3)
McGill University	181	(4)	218	(4)	203	(4)	230	(4)	288	(4)	1,120	(4)
University of Alberta	108	(11)	142	(7)	179	(5)	200	(5)	272	(5)	901	(5)
CHU Mère-enfant Hôpital Sainte-Justine	160	(6)	135	(8)	161	(6)	159	(7)	179	(8)	794	(6)
McMaster University	142	(7)	147	(5)	139	(9)	171	(6)	195	(7)	794	(6)
Children's & Women's Health Center of BC	85	(12)	111	(10)	148	(7)	153	(8)	217	(6)	714	(8)
University of Manitoba	165	(5)	144	(6)	113	(11)	122	(9)	126	(15)	670	(9)
University of Western Ontario	133	(8)	117	(9)	119	(10)	119	(10)	130	(14)	618	(10)
University of Calgary	127	(9)	89	(12)	106	(12)	115	(11)	155	(9)	592	(11)
Montreal Children's Hospital	109	(10)	90	(11)	144	(8)	115	(11)	122	(17)	580	(12)
Dalhousie University	77	(13)	79	(14)	89	(16)	105	(15)	149	(10)	499	(13)
Université de Montréal	72	(15)	73	(15)	95	(15)	114	(13)	144	(11)	498	(14)
University Health Network	55	(18)	88	(13)	100	(13)	105	(15)	132	(13)	480	(15)
Children's Hospital of Eastern Ontario	64	(16)	63	(19)	99	(14)	91	(17)	110	(18)	427	(16)
Hamilton Health Sciences Corporation	75	(14)	72	(16)	87	(18)	90	(19)	93	(20)	417	(17)
Queen's University	55	(18)	71	(17)	88	(17)	91	(17)	108	(19)	413	(18)
Mount Sinai Hospital	37	(26)	63	(19)	57	(23)	107	(14)	135	(12)	399	(19)
University of Ottawa	52	(20)	68	(18)	69	(20)	71	(23)	123	(16)	383	(20)
Sunnybrook & Women's Coll Hlth Sci Ctr	51	(22)	50	(22)	86	(19)	80	(20)	81	(21)	348	(21)
CHUQ	43	(23)	43	(25)	66	(21)	76	(21)	79	(22)	307	(22)
Izaak Walton Killam Hospital for Children	32	(31)	37	(29)	56	(24)	67	(24)	77	(23)	269	(23)
University of Saskatchewan	39	(25)	39	(26)	61	(22)	57	(26)	71	(24)	267	(24)
Ottawa Hospital	37	(26)	29	(34)	53	(26)	61	(25)	69	(25)	249	(25)
Royal Victoria Hospital	25	(34)	37	(29)	45	(28)	73	(22)	54	(27)	234	(26)
Université Laval	57	(17)	45	(24)	39	(30)	49	(27)	43	(29)	233	(27)
Winnipeg Health Sciences Centre	41	(24)	48	(23)	42	(29)	43	(28)	38	(31)	212	(28)
London Health Sciences Centre	52	(20)	53	(21)	36	(32)	27	(33)	30	(34)	198	(29)
Health Canada	26	(33)	31	(32)	56	(24)	40	(29)	42	(30)	195	(30)
Alberta Children's Hospital	27	(32)	26	(35)	39	(30)	40	(29)	60	(26)	192	(31)
Memorial University	33	(30)	38	(27)	46	(27)	35	(31)	35	(32)	187	(32)
Centre for Addiction and Mental Health	37	(26)	30	(33)	33	(34)	30	(32)	49	(28)	179	(33)
University of Guelph	22	(35)	38	(27)	34	(33)	25	(34)	34	(33)	153	(34)
St. Joseph's Health Care London	36	(29)	36	(31)	29	(35)	23	(35)	18	(35)	142	(35)
Canada	4,089		4,177		4,698		5,114		6,209		24,287	

Source: Compiled by Science-Matrix from Medline

1.5 Researchers

This section presents data on the most active researchers in the world, in Canada, and in Alberta, based on absolute output in MFCH.

Gideon Koren is the world leader in terms of the number of papers published between 2001 and 2005 (Table X). He is based at the Hospital for Sick Children, which ranked 1st among leading Canadian institutions, and at the University of Toronto, which ranked 6th. Gideon Koren published more than three times as many papers as his closest Canadian competitors (Table XI). Among the other world leaders in this area is a researcher from the UK, two researchers from the US, one from China, one from Denmark, one from Israel, one from France, one from Italy, and one from Belgium.

Table X Number of papers of most active researchers in the world in MFCH, 2001–2005

Author	Affiliation	Papers	Rk
Gideon Koren	Hospital for Sick Children and University of Toronto (Canada)	217	(1)
Kypros H. Nicolaides	School of Medicine, King's College London (UK)	181	(2)
Roberto Romero	Wayne State University and the National Institutes of Health (US)	130	(3)
Joseph Biederman	Massachusetts General Hospital, Harvard Medical School (US)	120	(4)
Tai-Fai Fok	Prince of Wales Hospital, The Chinese University of Hong Kong (China)	113	(5)
Jørn Olsen	University of Aarhus (Denmark)	112	(6)
Moshe Mazor	Ben-Gurion University of the Negev - Soroka University Medical Center (Israel)	109	(7)
Rene Frydman	Hopital Antoine Beclere (France)	109	(7)
Giovanni Scambia	Università Cattolica del Sacro Cuore (Italy)	107	(9)
Paul Devroey	Dutch-Speaking Brussels Free University (Belgium)	107	(9)

Source: Compiled by Science-Metrix from Medline

Among the Canadian leaders in MFCH research, there are eight researchers from the University of Toronto and six researchers from the Hospital for Sick Children. There are no researchers from Alberta among the Canadian leaders (Table XI).

Table XI Number of papers of most active researchers in Canada in MFCH, 2001–2005

Author	Affiliation	Papers	Rk
Gideon Koren	Hospital for Sick Children and University of Toronto	217	(1)
Brian W. McCrindle	Hospital for Sick Children and University of Toronto	67	(2)
Michael S. Kramer	McGill University	61	(3)
Arne Ohlsson	University of Toronto	56	(4)
Steven A. Narod	Sunnybrook & Women's Coll Hlth Sci Ctr and University of Toronto	55	(5)
James T. Rutka	Hospital for Sick Children and University of Toronto	49	(6)
ShiWu Wen	University of Ottawa	48	(7)
Adrienne Einarson	Hospital for Sick Children and University of Toronto	46	(8)
Antoine E. Khoury	Hospital for Sick Children and University of Toronto	45	(9)
Hubert Labelle	CHU Mère-enfant Hôpital Sainte-Justine	45	(9)
Robert W. Platt	McGill University	45	(9)

Source: Compiled by Science-Metrix from Medline

In Alberta, Alexander K.C. Leung, the leading researcher in MFCH, published 43 papers from 2001 to 2005 compared with 45 papers for the Canadian leaders ranking in 9th place (Table XII). Leung is affiliated to the Alberta Children's Hospital and the University of Calgary, both of which rank among the leading Canadian institutions. In total, there are three researchers with this affiliation among Alberta's leading authors. There are also two researchers from the University of Alberta, which is also among the leading Canadian institutions in this area.

Table XII Number of papers of most active researchers in Alberta in MFCH, 2001–2005

Author	Affiliation	Papers	Rk
Alexander K.C. Leung	Alberta Children's Hospital and University of Calgary	43	(1)
Sandra T. Davidge	University of Alberta	30	(2)
Joan L. Robinson	Stollery Children's Hospital, Walter C. MacKenzie Centre	23	(3)
Reginald Sauvé	Alberta Children's Hospital and University of Calgary	23	(3)
Terry P. Klassen	University of Alberta	23	(3)
James C. Cross	University of Calgary	18	(6)
David W. Johnson	Alberta Children's Hospital and University of Calgary	17	(7)
James V. Raso	Capital Health Authority-Glenrose Rehabilitation Hospital	17	(7)
Ban C.H. Tsui	University of Alberta Hospital	16	(9)
Marc J. Moreau	Capital Health Authority-Glenrose Rehabilitation Hospital	16	(9)

Source: Compiled by Science-Metrix from Medline

2 Mental Health, Mental Illness and Addictions

This section presents data on the scientific production of various entities in the fields of mental health, mental illness, and addictions (MHMIA), with a focus on Alberta.

2.1 Trends in the world, Canada and Alberta

This section presents publication trends in MHMIA from 1991 to 2005. At the world level, the annual scientific production in MHMIA has increased steadily from nearly 20,000 papers in 1991 to about 35,000 papers in 2005, an increase of 80% over the period, more than twice that observed in MFCH (Figure 5). In addition, the importance of MHMIA research in medicine appears to have slightly increased over the period, with the share of MHMIA papers in the Medline database increasing from 5.5% in 1991 to 6.7% in 2005.

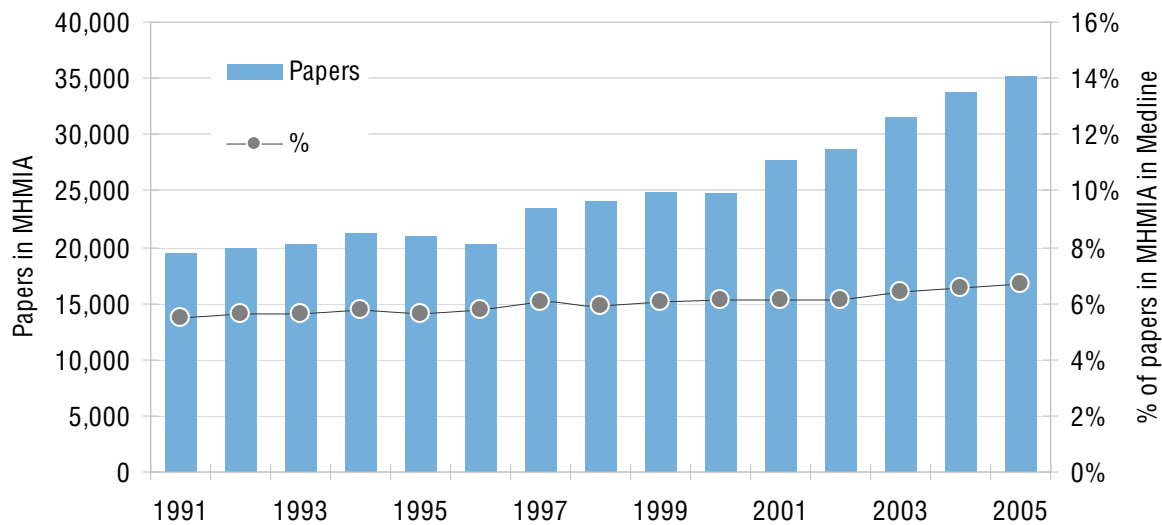


Figure 5 Number and percentage of papers in MHMIA in Medline database, 1991–2005

Source: Compiled by Science-Metrix from Medline

At the Canadian level, the scientific output in MHMIA has increased steadily from nearly 800 papers in 1991 to nearly 1,700 papers in 2005 (Figure 6). This increase in output is about one- and-a-half times higher than that observed at the Canadian level in MFCH. Over the period, the Canadian share of world MHMIA papers increased from 4.1% to 4.8%, a slightly higher increase than was observed in MFCH.

In Alberta, the scientific output in MHMIA research increased from about 70 papers in 1991 to about 150 papers in 2005 (Figure 7). However, the largest scientific production (160 papers) occurred in 2004. The percentage of increase for the whole period (119%) is lower than that in MFCH (135%). Alberta’s share of world MHMIA papers increased from 0.35% in 1991 to 0.42% in 2005, while its share of Canadian MHMIA papers has fluctuated over the years but has only marginally increased from 8.5% in 1991 to 8.7% in 2005.

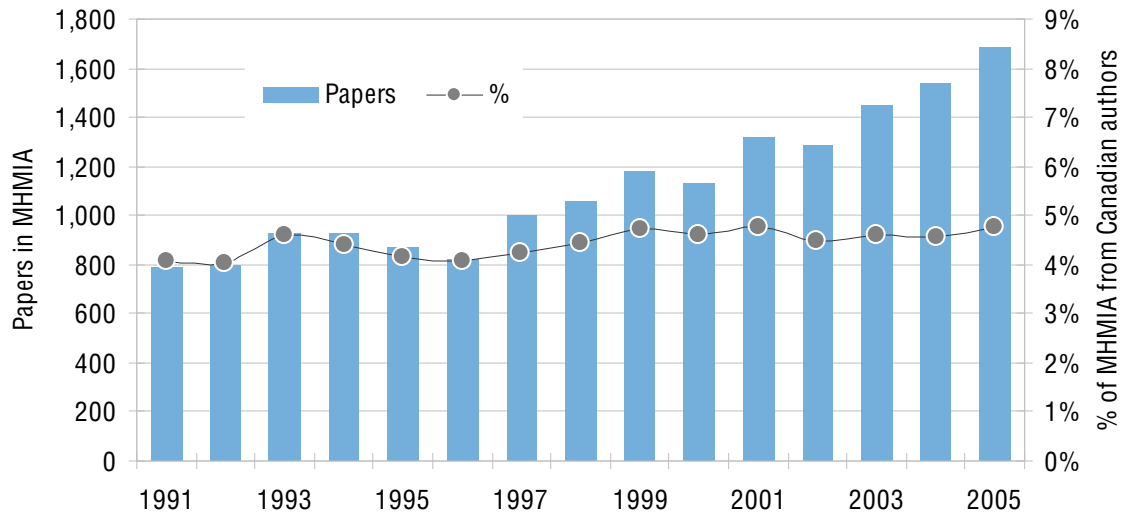


Figure 6 Number of papers in MHMIA in Canada and % of world MHMIA papers by Canada, 1991–2005

Source: Compiled by Science-Metrix from Medline

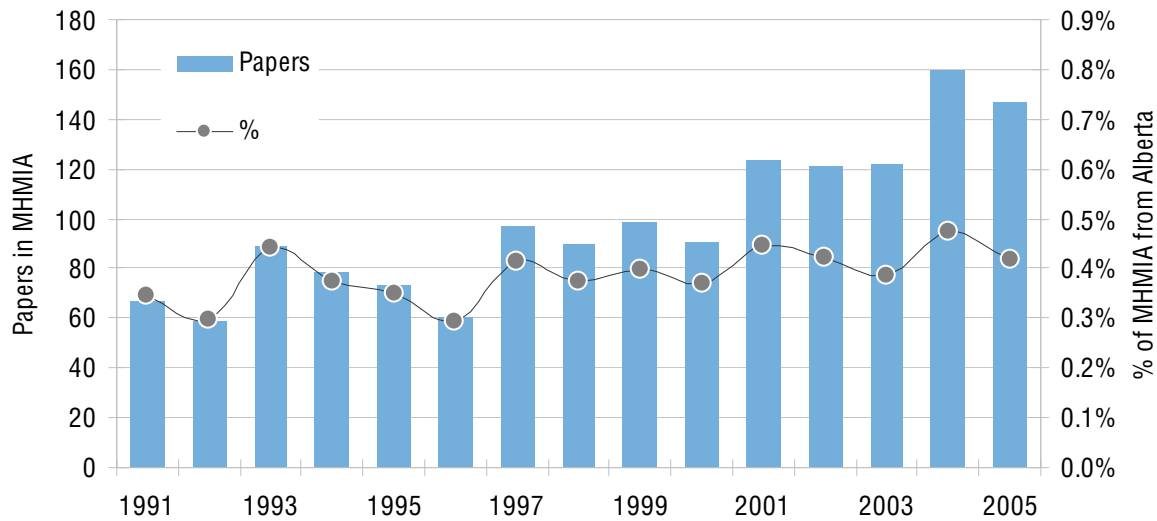


Figure 7 Number of papers in MHMIA in Alberta and % of world MHMIA papers by Alberta, 1991–2005

Source: Compiled by Science-Metrix from Medline

2.2 Benchmarking provinces

In order to benchmark Alberta’s scientific output in MHMIA against that of other provinces, four indicators were used:

- Number of papers
- Number of papers per capita
- Specialization index (SI)

- Relative average of impact factors (RAIF).

The indicators were combined in a multicriteria benchmarking of the leading provinces. This benchmarking is based on a 15-year period (1991–2005), which is broken down into five 3-year periods to examine the evolution of the field among leading provinces.

2.2.1 Number of papers

As was observed in MFCH, the four leading provinces in absolute output in MHMIA are (listed in order from 1st to 4th place): Ontario, Québec, British Columbia, and Alberta. Ontario, with about 8,000 papers published over the 15-year period, leads the area of MHMIA, contributing nearly 50% of Canada’s scientific production. Québec produced about half that number of papers but about twice the number of papers published by British Columbia or Alberta. The four leading provinces have increased their scientific production over time, and maintained their respective positions (Table XIII). In the first two 3-year periods, Manitoba ranked 5th and subsequently slid into 6th place, being overtaken by Nova Scotia, which moved from 6th to 5th place. Over the whole period, those two provinces produced similar numbers of papers, with Nova Scotia ranked 5th and Manitoba 6th. Saskatchewan is in 7th place. Data for New Brunswick, Prince Edward Island, and Newfoundland are not presented, given the small size of their scientific output in this area.

Table XIII Number of papers in MHMIA by province and by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk
Ontario	1,279	(1)	1,226	(1)	1,549	(1)	1,780	(1)	2,104	(1)	7,938	(1)
Québec	506	(2)	610	(2)	695	(2)	796	(2)	1,075	(2)	3,682	(2)
British Columbia	267	(3)	276	(3)	350	(3)	456	(3)	636	(3)	1,985	(3)
Alberta	215	(4)	212	(4)	286	(4)	336	(4)	429	(4)	1,478	(4)
Nova Scotia	57	(6)	87	(6)	144	(5)	162	(5)	187	(5)	637	(5)
Manitoba	103	(5)	104	(5)	115	(6)	103	(6)	127	(6)	552	(6)
Saskatchewan	52	(7)	63	(7)	59	(7)	69	(7)	85	(7)	328	(7)
Canada	2,522		2,626		3,242		3,744		4,677		16,811	
World	59,521		62,499		72,421		81,141		100,450		376,032	

Source: Compiled by Science-Metrix from Medline

2.2.2 Papers per capita

Taking account of the population size of an entity in analysing its scientific output often provides a better understanding of the relative effort of smaller entities. As it did for MFCH, Nova Scotia, which is the smallest province in terms of population size among the seven provinces considered, ranks 2nd in output per capita with an average of about 46 MHMIA publications per year per million inhabitants, while it ranked 5th in absolute output over the 15-year period (Table XIV). Over time, Nova Scotia’s ranking has improved from 6th place in 1991–1993 to 1st place in 2003–2005, making headway over Ontario, its nearest competitor and the leader over the 15-year period. Nova Scotia,

Ontario and British Columbia are the only provinces that performed better than the Canadian average in the last period analysed.

In 1991–2005, Alberta was ranked 3rd followed by British Columbia, Québec, Manitoba, and Saskatchewan. Although Alberta was in 3rd place in 1991–1993, it ranked 5th behind British Columbia (3rd) and Québec (4th) in 2003–2005. In the early 1990s, Manitoba was among the leaders for output per capita, ranking 2nd behind Ontario. However, it lost for places to finish in 6th place in 2003–2005. Again, Saskatchewan comes in last, in 7th place.

Table XIV Average of yearly papers per capita in MHMIA by province and by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	yearly papers/ 10 ⁶ inhab.	Rk	yearly papers/ 10 ⁶ inhab.	Rk	yearly papers/ 10 ⁶ inhab.	Rk	yearly papers/ 10 ⁶ inhab.	Rk	yearly papers/ 10 ⁶ inhab.	Rk	yearly papers/ 10 ⁶ inhab.	Rk
Ontario	40.4	(1)	37.4	(1)	45.5	(2)	50.0	(2)	56.6	(2)	46.0	(1)
Nova Scotia	20.7	(6)	31.2	(2)	51.5	(1)	57.8	(1)	66.5	(1)	45.5	(2)
Alberta	27.3	(3)	25.9	(5)	33.0	(4)	36.6	(4)	44.5	(5)	33.5	(3)
British Columbia	25.7	(4)	24.5	(6)	29.3	(6)	37.3	(3)	50.5	(3)	33.4	(4)
Québec	23.7	(5)	28.2	(4)	31.7	(5)	35.9	(5)	47.5	(4)	33.4	(5)
Manitoba	30.9	(2)	30.8	(3)	33.7	(3)	29.8	(6)	36.2	(6)	32.3	(6)
Saskatchewan	17.3	(7)	20.7	(7)	19.3	(7)	22.9	(7)	28.5	(7)	21.8	(7)
Canada	29.7		29.9		35.9		40.3		48.8		36.9	
World	3.6		3.7		4.1		4.4		5.3		4.2	

Source: Compiled by Science-Metrix from Medline

2.2.3 Specialization index

The specialization index (SI) is an indicator of the intensity of research within a specific research area in an entity (i.e., province or country) relative to the intensity of research within the same research area in the world; a score above one means that an entity specializes in the area relative to the world.

For the 1991–2005 period, Canada is highly specialized in MHMIA with a proportion of MHMIA papers among all its Medline papers that is 32% higher than that observed at the world level (i.e., SI = 1.32). Only one of the provinces analysed, Saskatchewan, was not specialized in this area for the whole 15-year period and the most recent 3-year period (Table XV). Nova Scotia, which was ranked lowest in the first 3-year period, was ranked 2nd in the last period and was in 1st place for the overall period analysed. In the last period, it is almost on a par with British Columbia, which ranks 1st (2nd for the whole period). Over the whole 15-year period, Ontario ranks 3rd, Québec 4th, Manitoba 5th, and Alberta 6th. Ontario lost three places from the first to the last 3-year period in which it ranks 4th, behind Québec in 3rd place. Manitoba lost 2 places over time to finish 5th, and Alberta lost one place to finish 6th. Of all the provinces, only Nova Scotia, British Columbia, Ontario, and Québec performed better than Canada as a whole in the most recent period. From 1991 to 2005, only Nova Scotia, British Columbia, and Ontario had higher specialization than Canada as a whole in MHMIA.

Table XV SI of provinces in MHMIA by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	SI	Rk	SI	Rk	SI	Rk	SI	Rk	SI	Rk	SI	Rk
Nova Scotia	0.93	(7)	1.47	(1)	1.87	(1)	1.73	(1)	1.61	(2)	1.57	(1)
British Columbia	1.29	(2)	1.28	(3)	1.36	(3)	1.50	(2)	1.62	(1)	1.45	(2)
Ontario	1.49	(1)	1.34	(2)	1.45	(2)	1.48	(3)	1.37	(4)	1.42	(3)
Québec	1.11	(4)	1.19	(5)	1.19	(5)	1.33	(4)	1.42	(3)	1.26	(4)
Manitoba	1.15	(3)	1.20	(4)	1.24	(4)	1.12	(5)	1.13	(5)	1.16	(5)
Alberta	1.01	(5)	0.92	(7)	1.11	(6)	1.08	(6)	1.05	(6)	1.04	(6)
Saskatchewan	1.00	(6)	1.11	(6)	0.90	(7)	0.96	(7)	0.89	(7)	0.96	(7)
Canada	1.28		1.24		1.33		1.38		1.34		1.32	
World	1.00		1.00		1.00		1.00		1.00		1.00	

Source: Compiled by Science-Metrix from Medline

2.2.4 Relative average of impact factors

The relative average of impact factors (RAIF) is an indicator of the expected impact of an entity's papers relative to the expected impact of papers at world level; a score above one means that an entity publishes in journals that are more cited than the world average for papers in the same field. It is a proxy for the quality of the journals in which papers are published.

In terms of the expected impact of its papers in the area of MHMIA, Canada is performing slightly better than the world average, with its papers being published in journals that have 5% more impact than world papers on average (Table XVI). Canada's RAIF has been decreasing over time, from 1.11 in 1991–1993 to 1.03 in 2003–2005. Québec is the only province that is performing better than the Canadian average in terms of expected impact, over the whole period and in the most recent 3-year period. However, over the whole series of 3-year periods, the Québec's RAIF has only increased very slightly. This is also the case for Ontario, which ranks 2nd in both the entire period and the last 3-year period, and for Manitoba, which ranks 5th for the 1991–2005 period and 6th in the last period, close behind Nova Scotia in 5th place. The remaining provinces have seen a decrease in their RAIF over time with the exception of Alberta, whose RAIF increased by several percentage points giving it 4th ranking in the last period behind Québec, Ontario, and British Columbia. Saskatchewan again ranked last in all periods considered.

Table XVI RAI of provinces in MHMIA by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	RAIF	Rk	RAIF	Rk	RAIF	Rk	RAIF	Rk	RAIF	Rk	RAIF	Rk
Québec	1.02	(3)	1.16	(1)	1.13	(1)	1.07	(1)	1.05	(1)	1.09	(1)
Ontario	1.02	(2)	1.00	(3)	1.02	(2)	1.03	(2)	1.03	(2)	1.02	(2)
British Columbia	1.26	(1)	0.98	(4)	0.95	(3)	0.98	(4)	1.00	(3)	1.02	(3)
Nova Scotia	0.86	(4)	0.79	(6)	0.91	(4)	1.00	(3)	0.84	(5)	0.91	(4)
Manitoba	0.81	(5)	1.12	(2)	0.89	(5)	0.87	(5)	0.83	(6)	0.87	(5)
Alberta	0.75	(6)	0.69	(7)	0.85	(6)	0.83	(6)	0.90	(4)	0.85	(6)
Saskatchewan	0.72	(7)	0.82	(5)	0.66	(7)	0.62	(7)	0.63	(7)	0.66	(7)
Canada	1.11		1.11		1.04		1.03		1.03		1.05	
World	1.00		1.00		1.00		1.00		1.00		1.00	

Source: Compiled by Science-Matrix from Medline

2.2.5 Multicriteria ranking

The multicriteria ranking provides an overall assessment of the leading Canadian provinces in MHMIA. The indicators considered in the multicriteria ranking are number of papers, number of papers per capita, SI, and RAIIF.

When considering the multicriteria ranking of provinces for all the 3-year periods, Ontario is the clear leader, ranking 1st overall and in every 3-year period (Table XVII). Québec, British Columbia, and Nova Scotia follow, tied in 2nd place for the entire period considered. In the most recent period Québec and British Columbia are again on a par in 2nd place, while Nova Scotia is 3rd. As in MFCH, Nova Scotia is becoming one of the leaders, moving from 6th place in the early 1990s. Nova Scotia's multicriteria ranking has improved over time due to an important increase in output per capita and SI, similar to what was observed in MFCH. Since Alberta has twice the absolute output of Nova Scotia in the field, and because it is next to Nova Scotia in the multicriteria ranking, it can be considered a potential leader in this area.

Table XVII Multicriteria ranking of provinces in MHMIA comprising number of papers, papers per capita, SI, and RAIIF, by 3-year period, 1991–2005

Rk	1991-1993	1994-1996	1997-1999	2000-2002	2003-2005	1991-2005
1	Ontario	Ontario	Ontario	Ontario	Ontario	Ontario
2	British Columbia	Québec	Nova Scotia	Nova Scotia	British Columbia (2)	British Columbia (2)
3	Québec	Manitoba	Québec	British Columbia (3)	Québec (2)	Nova Scotia (2)
4	Manitoba	Nova Scotia	British Columbia	Québec (3)	Nova Scotia	Québec (2)
5	Alberta	British Columbia	Manitoba	Alberta	Alberta	Alberta
6	Nova Scotia	Alberta	Alberta	Manitoba	Manitoba	Manitoba
7	Saskatchewan	Saskatchewan	Saskatchewan	Saskatchewan	Saskatchewan	Saskatchewan

Source: Compiled by Science-Matrix from Medline

It could improve its position by increasing its specialization and its RAIIF above the world level. The latter has already increased, positioning it ahead of Nova Scotia, Manitoba, and Saskatchewan in the last period. Alberta ranks 5th in the most recent period examined for both MFCH and MHMIA. In

addition, it has a similar absolute average of impact factors in both areas, although this is higher for MFCH (2.17) than MHMIA (2.00). Alberta also has a greater absolute output in MFCH. On the other hand, Canada’s share of world output is higher in MHMIA than in MFCH, and Alberta is more specialized in MHMIA than in MFCH. Manitoba and Saskatchewan are ranked 6th and 7th, respectively.

Figure 8 shows the positions of provinces in a two-dimensional space based on SI and RAIF. The SI and the RAIF are log transformed such that the origin (0.0) represents the world level. For both indicators, a value above zero means that the score is higher than the world level, while a value below zero means that the score is lower than the world level.

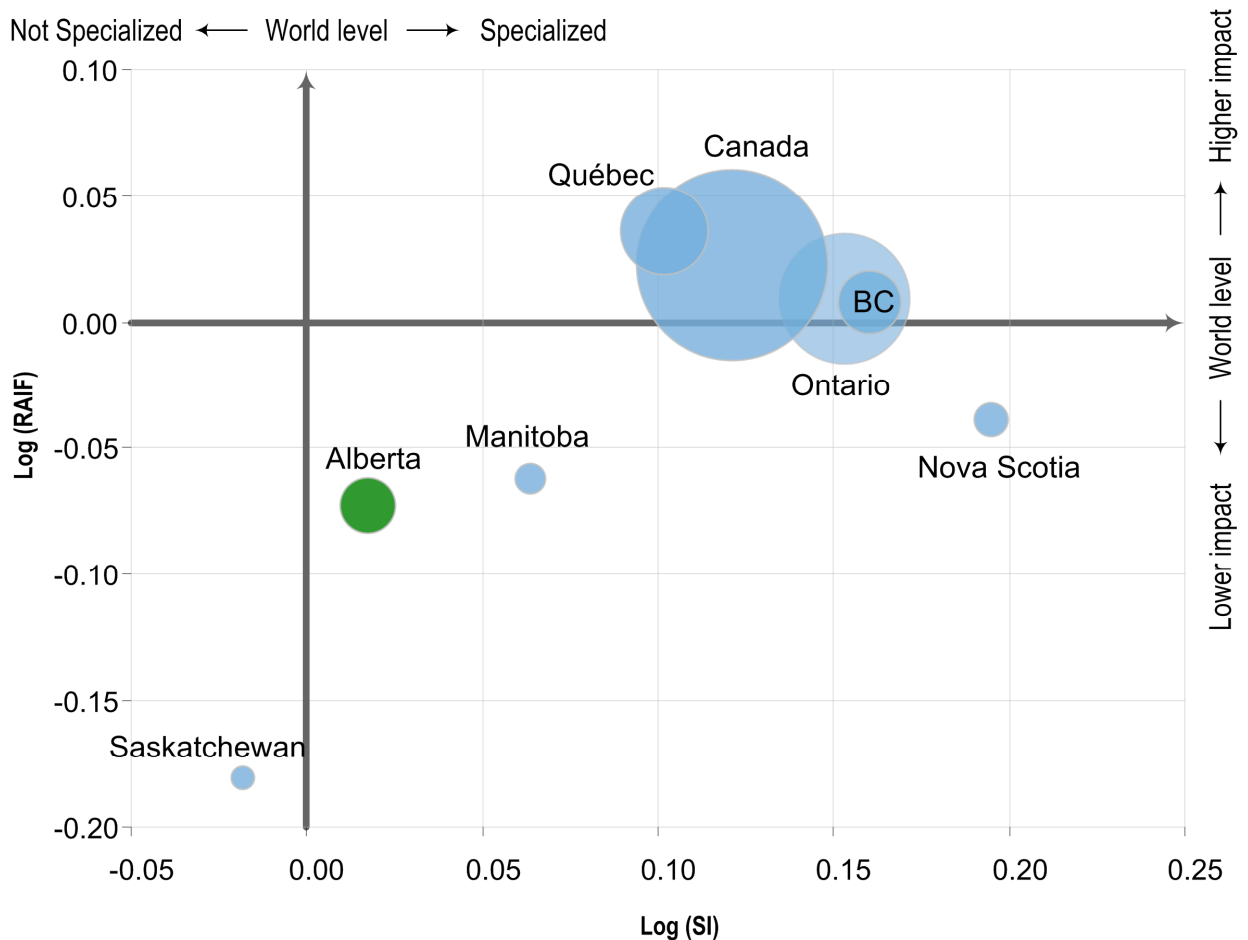


Figure 8 Scientometric positioning of provinces based on their specialization and scientific impact in MHMIA, 1991–2005

Source: Compiled by Science-Metrix from Medline

The leaders are in the top right quadrant (high level of specialization, high level of impact) while the provinces that are lagging are in the lower left quadrant. The number of papers published over the period examined should be taken into account when interpreting the positions of provinces. For instance, a province that makes only a minor scientific contribution to the field may fall in the top

right quadrant, while a province that makes a large contribution may fall in the lower left quadrant. The size of the bubbles is proportional to the absolute scientific output.

It is important to note that the figure provides a positioning of provinces based on the entire period examined (1991–2005). As was observed in the area of MFCH, the leaders in MHMIA are Ontario, Québec, and British Columbia. They are the only provinces to perform better than the world level in MHMIA with respect to both SI and RAIF. Québec is less specialized than British Columbia and Ontario, but its scientific production has a greater expected impact. It is the only province with an expected impact above the Canadian average. Nova Scotia is the most specialized province and is ranked 4th for RAIF. However, it is below the world level with respect to the impact of its research, and it has a small absolute output. Alberta is less specialized than Nova Scotia but has a bigger output and, for the most recent period (2003–2005), also had a higher impact. Manitoba ranks next, followed by Saskatchewan which is the only province in the lower left quadrant.

2.3 Cities

This section presents a multicriteria ranking of leading Canadian cities for MHMIA based on four indicators: number of papers, number of papers per capita, SI, and RAIF. Leading Canadian cities were selected on the basis of their absolute output in the field. Trends in the number of scientific papers published in MHMIA by each city are presented.

As in the area of MFCH, the top three cities in absolute output in MHMIA research are Toronto (about 4,300 papers), Montreal (about 3,000 papers), and Vancouver (about 1,500 papers) (Table XVIII).

Table XVIII Multicriteria ranking of leading Canadian cities in MHMIA comprising number of papers, papers per capita, SI, and RAIF, 1991–2005

City	Papers	Rk	Papers/ 10 ⁶ inab.	Rk	SI	Rk	RAIF	Rk	Multicriteria rank
Toronto	4,281	(1)	61.1	(6)	1.61	(2)	1.07	(1)	(1)
London	917	(5)	139.4	(2)	1.44	(4)	0.91	(6)	(2)
Montreal	3,068	(2)	59.0	(7)	1.36	(7)	1.05	(2)	(3)
Vancouver	1,562	(3)	52.2	(10)	1.37	(6)	1.04	(3)	(4)
Halifax	587	(9)	107.3	(3)	1.55	(3)	0.88	(7)	(4)
Hamilton	788	(6)	78.9	(4)	1.26	(8)	0.96	(5)	(6)
Ottawa-Hull	919	(4)	57.8	(8)	1.21	(9)	0.82	(9)	(7)
Kingston	365	(12)	160.6	(1)	1.17	(11)	0.74	(13)	(8)
Winnipeg	540	(10)	52.5	(9)	1.05	(12)	0.86	(8)	(9)
Quebec	436	(11)	41.8	(13)	0.96	(13)	0.99	(4)	(10)
Calgary	669	(8)	48.3	(12)	1.19	(10)	0.79	(11)	(10)
Edmonton	726	(7)	51.9	(11)	0.92	(14)	0.81	(10)	(12)
Victoria	159	(15)	33.0	(14)	1.74	(1)	0.60	(15)	(13)
Kitchener	200	(14)	31.9	(15)	1.38	(5)	0.76	(12)	(14)
Saskatoon	265	(13)	78.0	(5)	0.76	(15)	0.63	(14)	(15)

Source: Compiled by Science-Metrix from Medline

Edmonton and Calgary are again in the top 15 of the leading Canadian cities with, respectively, 726 and 669 papers published between 1991 and 2005. Their positions in absolute output, with Edmonton ranking 7th and Alberta ranking 8th, are similar to those for MFCH research (Table XVIII). As in MFCH research, the leaders for output per capita include some of the smaller cities: Kingston (1st), London (2nd), and Halifax (3rd). Edmonton ranks 11th and Calgary ranks 12th. There are twelve cities that specialize in MHMIA research (compared to seven in MFCH research), including Calgary in 10th place with a SI of 1.19. Edmonton is not specialized and ranks 14th. The top three in terms of specialization are Victoria (1st place, SI of 1.74), Toronto (2nd place, SI of 1.61), and Halifax (3rd place, SI of 1.55). In the top 15, there are only three cities whose scientific production has a greater expected impact than world papers on average. They are respectively Toronto (RAIF of 1.07), Montreal (RAIF of 1.05), and Vancouver (RAIF of 1.04). Edmonton ranks 10th with a RAIF of 0.81, followed by Calgary in 11th place with a RAIF of 0.79. In the multicriteria ranking, Toronto ranks 1st followed by London (2nd) and Montreal (3rd). Vancouver and Halifax tie in 4th place. Calgary ranks 10th in MHMIA compared to 15th in MFCH, while Edmonton ranks 12th in MHMIA compared to 11th in MFCH.

Toronto, Montreal, Vancouver, Ottawa-Hull, and London, the top five cities in absolute output, have maintained their respective positions over the entire period covered in this study (Table XIX).

Table XIX Trends in the number of publications of leading Canadian cities in MHMIA by 3-year period, 1991–2005

City	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk
Toronto	661	(1)	646	(1)	816	(1)	977	(1)	1,181	(1)	4,281	(1)
Montreal	430	(2)	522	(2)	580	(2)	670	(2)	866	(2)	3,068	(2)
Vancouver	214	(3)	214	(3)	283	(3)	342	(3)	509	(3)	1,562	(3)
Ottawa-Hull	158	(4)	140	(5)	196	(4)	194	(4)	231	(4)	919	(4)
London	155	(5)	166	(4)	190	(5)	191	(5)	215	(5)	917	(5)
Hamilton	142	(6)	120	(6)	170	(6)	188	(6)	168	(9)	788	(6)
Edmonton	112	(7)	111	(7)	149	(7)	160	(8)	194	(7)	726	(7)
Calgary	94	(9)	91	(9)	120	(9)	161	(7)	203	(6)	669	(8)
Halifax	47	(13)	79	(10)	127	(8)	153	(9)	181	(8)	587	(9)
Winnipeg	102	(8)	98	(8)	115	(10)	101	(10)	124	(11)	540	(10)
Quebec	53	(10)	57	(12)	78	(11)	90	(12)	158	(10)	436	(11)
Kingston	48	(12)	58	(11)	55	(12)	91	(11)	113	(12)	365	(12)
Saskatoon	51	(11)	55	(13)	43	(13)	45	(15)	71	(13)	265	(13)
Kitchener	25	(14)	28	(14)	37	(14)	48	(13)	62	(14)	200	(14)
Victoria	17	(15)	21	(15)	24	(15)	48	(13)	49	(15)	159	(15)
Canada	2,522		2,626		3,242		3,744		4,677		16,811	

Source: Compiled by Science-Metrix from Medline

The rankings of only Ottawa-Hull (4th) and London (5th) varied in the 1994–1996 period. Calgary gained three places for absolute output, overtaking Hamilton, Edmonton, and Winnipeg going from 9th place in the 1991–1993 period to 6th place in the 2003–2005 period. Edmonton maintained its 7th

place. Halifax improved its ranking over the period, from 13th to 8th place, behind Edmonton. None of the top 15 cities show a decrease in scientific output from 1991 to 2005.

2.4 Institutions

A multicriteria ranking of leading Canadian institutions in MHMIA was made based on three indicators: number of papers, SI, and RAIF. Leading Canadian institutions were selected on the basis of their absolute output in this area. Trends in the number of scientific papers published in MHMIA by each of these institutions are presented.

The top three Canadian institutions for output in MHMIA are the University of Toronto (1st), the University of British Columbia (2nd), and the Centre for Addiction and Mental Health (3rd), all of which published over 1,000 papers during the 1991–2005 period (Table XX).

Table XX Multicriteria ranking of leading Canadian institutions in MHMIA comprising number of papers, SI, and RAIF, 1991–2005

Institution	Papers	Rk	SI	Rk	RAIF	Rk	Multicriteria rank
Centre for Addiction and Mental Health	1,048	(3)	10.86	(1)	1.08	(7)	(1)
University of British Columbia	1,163	(2)	1.55	(6)	1.02	(8)	(2)
Douglas Hospital	361	(14)	7.77	(2)	1.31	(1)	(3)
University of Toronto	1,324	(1)	1.42	(10)	1.09	(6)	(3)
McGill University	772	(4)	1.34	(14)	1.09	(5)	(5)
University of Western Ontario	600	(5)	1.51	(7)	0.93	(13)	(6)
Concordia University	160	(22)	3.04	(3)	1.26	(2)	(7)
Sunnybrook & Women's College Health Sciences	271	(18)	1.39	(11)	1.21	(4)	(8)
University Health Network	461	(10)	0.96	(22)	1.22	(3)	(9)
McMaster University	506	(7)	1.26	(16)	0.95	(12)	(9)
Dalhousie University	413	(11)	1.45	(9)	0.89	(15)	(9)
Université de Montréal	479	(8)	1.20	(18)	0.86	(17)	(12)
Hospital for Sick Children	371	(13)	0.91	(23)	1.01	(9)	(13)
University of Ottawa	323	(15)	1.48	(8)	0.72	(22)	(13)
Université Laval	285	(17)	1.38	(13)	0.87	(16)	(15)
Sir Mortimer B. Davis Jewish General Hospital	144	(25)	1.38	(12)	0.97	(10)	(16)
York University	207	(19)	2.35	(5)	0.70	(23)	(16)
University of Alberta	570	(6)	0.84	(24)	0.85	(18)	(18)
Hamilton Health Sciences Corporation	173	(21)	1.20	(17)	0.97	(11)	(19)
University of Calgary	479	(8)	1.06	(21)	0.79	(20)	(19)
University of Manitoba	401	(12)	1.19	(19)	0.85	(19)	(21)
London Health Sciences Centre	159	(23)	1.27	(15)	0.92	(14)	(22)
UQAM	148	(24)	2.57	(4)	0.67	(24)	(22)
Queen's University	294	(16)	1.09	(20)	0.75	(21)	(24)
University of Saskatchewan	197	(20)	0.78	(25)	0.64	(25)	(25)

Source: Compiled by Science-Matrix from Medline

Alberta has two institutions in the top 25, namely the University of Alberta ranked 6th with 570 papers and the University of Calgary ranked 8th with nearly 480 papers. The Centre for Addiction and Mental Health and the Douglas Hospital are both highly specialized in MHMIA and rank 1st and 2nd, respectively. Concordia University is in 3rd place with a SI of 3.04, which though high is less than half of scores of the two leading institutions. For expected impact, the Douglas Hospital leads with a RAIF of 1.31, followed by Concordia University with a RAIF of 1.26. Three institutions stand out with respect to two of the three indicators. The Centre for Addiction and Mental Health ranks 3rd in

output and 1st in specialization, in 1st place in the multicriteria ranking; the Douglas Hospital ranks 2nd in specialization and 1st in impact, in 3rd place in the multicriteria ranking; and Concordia University ranks 3rd in specialization and 2nd in impact, in 7th place in the multicriteria ranking. Other institutions that perform well in the multicriteria ranking include the University of British Columbia in 2nd place and the University of Toronto in 3rd place on a par with the Douglas Hospital. The University of Alberta ranks 18th, and the University of Calgary ranks 19th.

Over the 15-year period studied, the University of Toronto moved from the 2nd place in the 1991–1993 period to 1st in 2003–2005 for output in MHMIA. The University of British Columbia's ranking improved from 3rd to 2nd, while the Centre for Addiction and Mental Health went from 1st to 3rd position in the ranking. The University of Alberta moved from the 7th place with 82 papers in 1991–1993 to 5th place with 166 papers in 2003–2005. The University of Calgary's ranking improved from 9th to 7th.

Table XXI Trends in the number of publications of leading Canadian institutions in MHMIA, by 3-year period, 1991–2005

Institution	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk
University of Toronto	199	(2)	210	(1)	236	(1)	306	(1)	373	(1)	1,324	(1)
University of British Columbia	165	(3)	173	(3)	223	(2)	250	(2)	352	(2)	1,163	(2)
Centre for Addiction and Mental Health	203	(1)	180	(2)	218	(3)	194	(3)	253	(3)	1,048	(3)
McGill University	109	(4)	145	(4)	148	(4)	154	(4)	216	(4)	772	(4)
University of Western Ontario	96	(6)	98	(5)	124	(5)	133	(5)	149	(6)	600	(5)
University of Alberta	82	(7)	78	(7)	119	(6)	125	(6)	166	(5)	570	(6)
McMaster University	98	(5)	79	(6)	105	(7)	114	(7)	110	(13)	506	(7)
Université de Montréal	63	(10)	76	(8)	90	(8)	102	(11)	148	(7)	479	(8)
University of Calgary	65	(9)	68	(11)	88	(9)	110	(10)	148	(7)	479	(8)
University Health Network	60	(11)	73	(9)	85	(11)	111	(9)	132	(10)	461	(10)
Dalhousie University	26	(21)	53	(14)	87	(10)	114	(7)	133	(9)	413	(11)
University of Manitoba	79	(8)	73	(9)	76	(12)	78	(13)	95	(15)	401	(12)
Hospital for Sick Children	48	(13)	56	(13)	59	(15)	97	(12)	111	(12)	371	(13)
Douglas Hospital	47	(14)	59	(12)	54	(17)	78	(13)	123	(11)	361	(14)
University of Ottawa	59	(12)	46	(17)	72	(13)	69	(17)	77	(17)	323	(15)
Queen's University	37	(16)	47	(15)	44	(19)	78	(13)	88	(16)	294	(16)
Université Laval	29	(18)	37	(18)	58	(16)	55	(18)	106	(14)	285	(17)
Sunnybrook & Women's College Health Scien	27	(20)	30	(21)	65	(14)	74	(16)	75	(18)	271	(18)
York University	32	(17)	20	(25)	43	(20)	50	(19)	62	(19)	207	(19)
University of Saskatchewan	44	(15)	47	(15)	34	(22)	26	(25)	46	(21)	197	(20)
Hamilton Health Sciences Corporation	28	(19)	22	(24)	45	(18)	43	(20)	35	(24)	173	(21)
Concordia University	22	(22)	33	(20)	32	(23)	32	(24)	41	(22)	160	(22)
London Health Sciences Centre	19	(23)	36	(19)	41	(21)	36	(22)	27	(25)	159	(23)
UQAM	15	(25)	26	(22)	23	(24)	36	(22)	48	(20)	148	(24)
Sir Mortimer B. Davis Jewish General Hospita	19	(23)	25	(23)	22	(25)	41	(21)	37	(23)	144	(25)
Canada	2,522		2,626		3,242		3,744		4,677		16,811	

Source: Compiled by Science-Metrix from Medline

2.5 Researchers

This section presents data on the most active researchers in the world, in Canada, and in Alberta. They were identified on the basis of their absolute output in MHMIA.

There are no Canadian researchers among the world leaders in MHMIA research. The top ten at the world level published between 130 and 187 papers over the 2001–2005 period. They include five researchers from the US, two from Germany, one from Israel, one from South Africa, and one from the UK (Table XXII).

Table XXII Number of papers of most active researchers in the world in MHMIA, 2001–2005

Author	Affiliation	Papers	Rk
Hans Jurgen Moller	Psychiatric Hospital of the Ludwig Maximilians University (Germany)	187	(1)
Stephen V. Faraone	SUNY Upstate Medical University (US)	186	(2)
Joseph Biederman	Massachusetts General Hospital, Harvard Medical School (US)	176	(3)
Robert A. Rosenheck	Yale University (US)	166	(4)
David Vlahov	New York Academy of Medicine (US)	144	(5)
Abraham Weizman	Tel Aviv University (Israel)	141	(6)
Matthias C. Angermeyer	University of Leipzig (Germany)	140	(7)
Mark A. Smith	Case Western Reserve University (US)	133	(8)
Daniel J. Stein	University of Stellenbosch (South Africa)	132	(9)
Robin M. Murray	Institute of Psychiatry, King's College London (UK)	130	(10)

Source: Compiled by Science-Metrix from Medline

Within Canada, the top author in MHMIA research, James L. Kennedy, published almost twice as many papers as his closest competitors (Table XXIII). He is affiliated to the Centre for Addiction and Mental Health, which ranked 1st among leading Canadian institutions in the area. The other Canadian leaders published similar numbers of papers from 2001 to 2005 (in the range of 43 to 56). They include one author from Alberta, Scott B. Patten, based at the University of Calgary, and ranked 4th among the Canadian leaders with 50 published papers over the period. Interestingly, Gideon Koren, the world leader in MFCH research, also ranks among the Canadian leaders in MHMIA research. This is explained by the fact that he has published on the toxicological effects of drugs used in the treatment of mental disorders and/or addictions, on the development of human foetuses.

Table XXIII Number of papers of most active researchers in Canada in MHMIA, 2001–2005

Author	Affiliation	Papers	Rk
James L. Kennedy	Centre for Addiction and Mental Health and University of Toronto	108	(1)
Kenneth J. Rockwood	Queen Elizabeth II Health Sciences Centre and Dalhousie University	56	(2)
Sandra E. Black	Sunnybrook & Women's Coll Hlth Sci Ctr and University of Toronto	53	(3)
Scott B. Patten	University of Calgary	50	(4)
Jurgen Rehm	Centre for Addiction and Mental Health and University of Toronto	49	(5)
Gideon Koren	Hospital for Sick Children and University of Toronto	48	(6)
Jacques Montplaisir	Hôpital du Sacré-Coeur de Montréal and Université de Montréal	48	(6)
Mark W. Tyndall	St. Paul's Hospital and University of British Columbia	46	(8)
Serge Gauthier	Douglas Hospital	46	(8)
Brian J. Cox	University of Manitoba	43	(10)

Source: Compiled by Science-Metrix from Medline

In Alberta, the leading authors in MHMIA are mostly from two institutions: the University of Calgary, with 8 leading authors, and the University of Alberta, with 3 leading authors (Table XXIV). The University of Calgary ranks 19th among leading Canadian institutions, while the University of Alberta ranks 18th.

Table XXIV Number of papers of most active researchers in Alberta in MHMIA, 2001–2005

Author	Affiliation	Papers	Rk
Scott B. Patten	University of Calgary	50	(1)
Nady el-Guebaly	University of Calgary	30	(2)
Donald E.N. Addington	Foothills Hospital and University of Calgary	28	(3)
Christopher Power	University of Calgary	22	(4)
David B. Hogan	University of Calgary	19	(5)
Peter H. Silverstone	University of Alberta	17	(6)
David C. Hodgins	University of Calgary	16	(7)
Linda E. Carlson	Alberta Cancer Board	16	(7)
Shawn R. Currie	University of Calgary	16	(7)
Cameron T. Wild	University of Alberta	14	(10)
JianLi Wang	University of Calgary	14	(10)
Paul Green	Neurobehavioral Associates	14	(10)
Pierre S. Chue	University of Alberta	14	(10)

Source: Compiled by Science-Metrix from Medline

3 Health System Sustainability

This section presents data on the scientific production of various entities in the area of health system sustainability (HSS), which is concerned with the effective utilisation and coordination of resources such as capital, materials, and labour to improve or maintain the high quality of health care while reducing or maintaining the cost for end-users. The focus is on Alberta.

3.1 Trends in the world, Canada and Alberta

This section presents publication trends in HSS from 1991 to 2005. At the world level, the annual production of papers in HSS increased from nearly 8,000 papers in 1991 to about 15,000 papers in 2005, an increase of about 120% over the period, and greater than that observed in MHMIA and MFCH (Figure 9). However, current annual scientific output in this area at world level is less than half of that in MFCH and MHMIA. The proportion of HSS research in medicine increased by one percentage point over the period, the share of HSS papers in the Medline database increasing from 1.9% in 1991 to 2.9% in 2005.

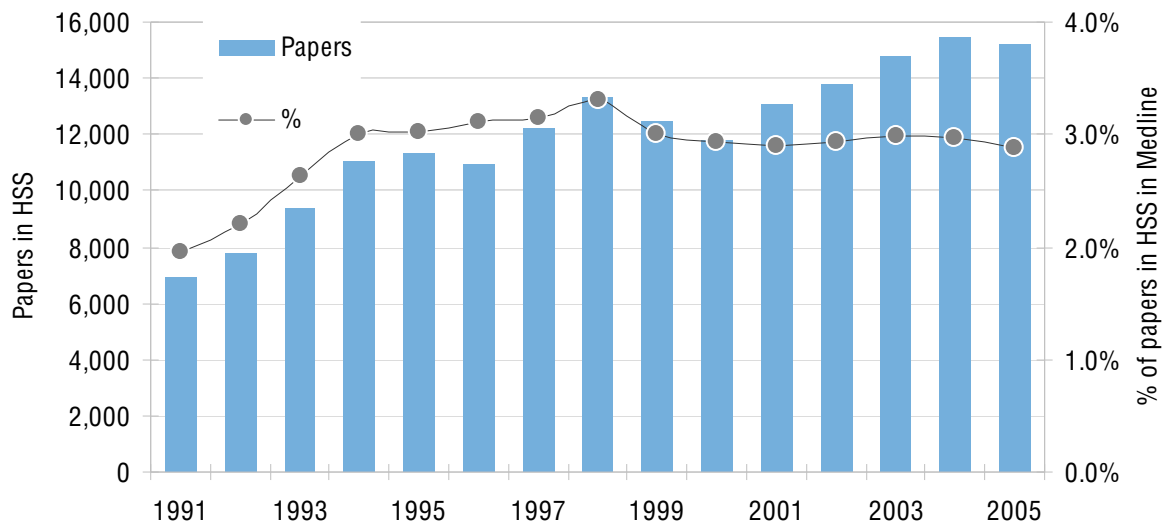


Figure 9 Number and percentage of papers in HSS in Medline database, 1991–2005
 Source: Compiled by Science-Metrix from Medline

Of the three areas targeted by AHFMR, HSS is clearly the one where Canadian scientific production has experienced the strongest growth, with a five-fold increase from 1991 (about 150 papers) to 2005 (about 740 papers) (Figure 10). The growth in the Canadian share of world papers has also been the strongest in HSS, increasing from around 2% in 1991 to some 5% in 2005, a share similar to that in the two other targeted areas. Current annual scientific output in this area at the Canadian level is less than half the output in MFCH and MHMIA.

Similarly, growth in scientific production in HSS in Alberta has been greater than in the other two areas analysed. The number of papers published by authors from Alberta increased more than ten-fold from 1991 (8 papers) to 2005 (100 papers) (Figure 11). Alberta’s share of world HSS papers

increased from 0.12% in 1991 to 0.66% in 2005, while its share of Canadian HSS papers increased from 5.4% in 1991 to 13.6% in 2005. Thus, despite the smaller scientific output in HSS, it is in this area that Alberta has the largest share of both world and Canadian papers.

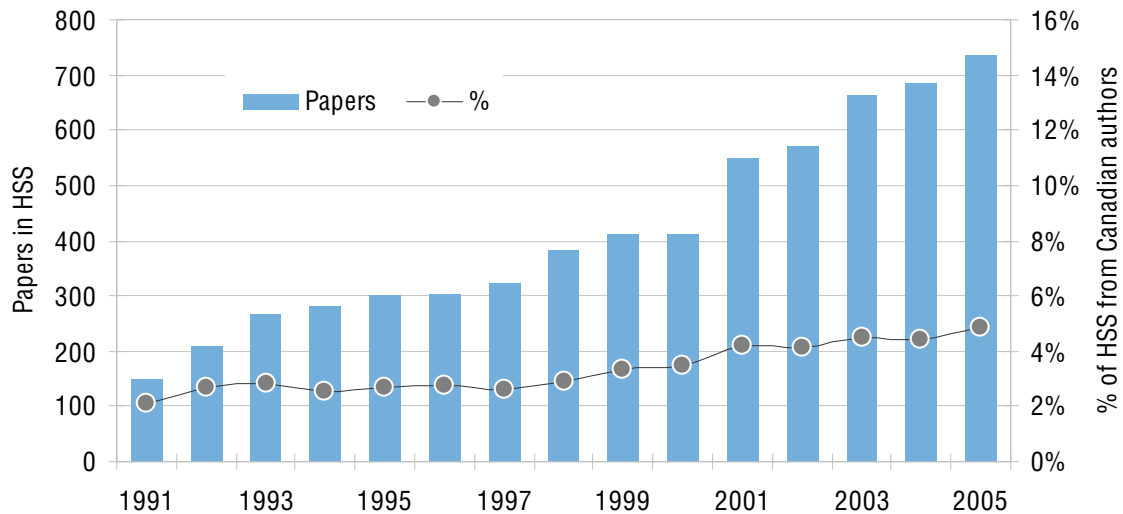


Figure 10 Number of papers in HSS in Canada and % of world HSS papers by Canada, 1991–2005

Source: Compiled by Science-Metrix from Medline

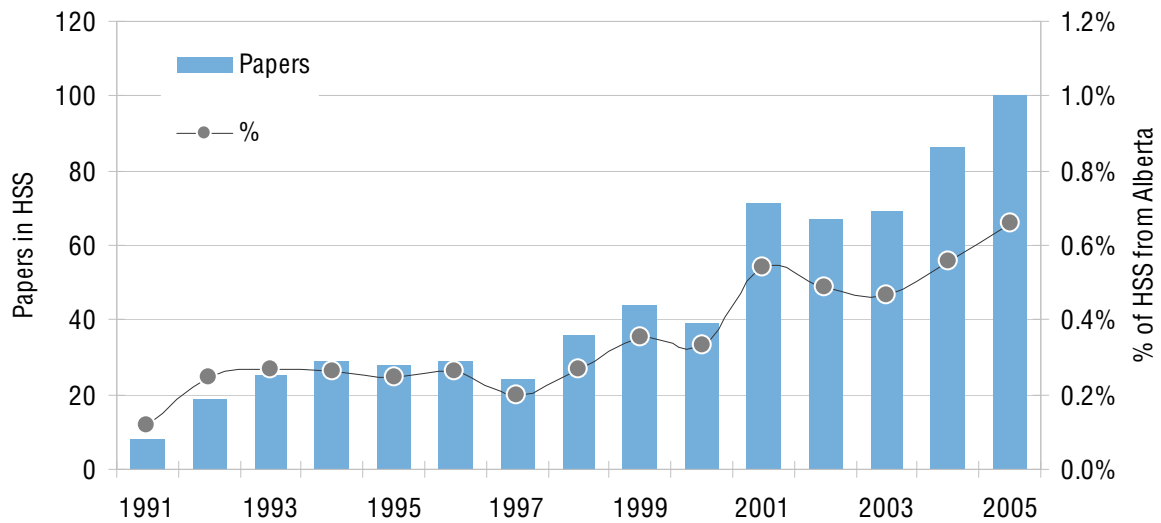


Figure 11 Number of papers in HSS in Alberta and % of world HSS papers by Alberta, 1991–2005

Source: Compiled by Science-Metrix from Medline

3.2 Benchmarking provinces

In order to benchmark Alberta’s scientific output against that of other provinces in HSS, four indicators were used:

- Number of papers
- Number of papers per capita
- Specialization index (SI)
- Relative average of impact factors (RAIF).

The indicators are subsequently combined in a multicriteria benchmarking of the leading provinces. This benchmarking is based on a 15-year period (1991–2005), which is broken down into five 3-year periods to examine the evolution of the field among leading provinces.

3.2.1 Number of papers

Again, the four leading provinces in absolute output in HSS over the 15-year period are Ontario in 1st place, Québec in 2nd place, British Columbia in 3rd place, and Alberta in 4th place (Table XXV). As in the two other targeted areas, Ontario contributed 50% of Canada’s scientific production, with about 3,200 papers between 1991 and 2005. Québec, British Columbia, and Alberta follow with similar numbers of papers published over the 15-year period, and especially in the last 3-year period examined. Alberta improved to overtake British Columbia in the 2000–2002 period, ranking 3rd in the last period. Manitoba, Nova Scotia, and Saskatchewan follow in 5th, 6th, and 7th place, respectively. Data for New Brunswick, Prince Edward Island, and Newfoundland are not presented, given the small size of their scientific output in this area.

Table XXV Number of papers in HSS by province and by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk
Ontario	323	(1)	469	(1)	587	(1)	793	(1)	1,035	(1)	3,207	(1)
Québec	95	(2)	108	(2)	154	(2)	184	(2)	265	(2)	806	(2)
British Columbia	74	(3)	100	(3)	112	(3)	168	(4)	248	(4)	702	(3)
Alberta	52	(4)	86	(4)	104	(4)	177	(3)	255	(3)	674	(4)
Manitoba	25	(5)	55	(5)	59	(5)	81	(5)	72	(6)	292	(5)
Nova Scotia	23	(6)	19	(7)	57	(6)	58	(6)	84	(5)	241	(6)
Saskatchewan	11	(7)	22	(6)	11	(7)	33	(7)	57	(7)	134	(7)
Canada	626		888		1,120		1,537		2,085		6,256	
World	24,098		33,318		37,994		38,725		45,420		179,555	

Source: Compiled by Science-Metrix from Medline

3.2.2 Papers per capita

Taking account of the population size in analysing an entity’s scientific output often provides a better understanding of the relative effort of smaller entities. Again, Nova Scotia, which is the smallest province in terms of population size among the seven considered, performed better in relative terms than in absolute output, ranking 2nd behind Ontario for the 15-year period (Table XXVI), followed by Manitoba in 3rd place. Alberta is ranked 4th followed by British Columbia in 5th place, Saskatchewan in 6th place, and Québec in 7th place. In the 2003–2005 period, Nova Scotia

overtook Ontario to finish 1st and Alberta improved over Manitoba to finish 3rd. Only Nova Scotia, Ontario, and Alberta performed better than Canada as a whole in terms of relative output in HSS.

Table XXVI Average of yearly papers per capita in HSS by province and by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	yearly papers/ 10 ⁶ inhab.	Rk	yearly papers/ 10 ⁶ inhab.	Rk	yearly papers/ 10 ⁶ inhab.	Rk	yearly papers/ 10 ⁶ inhab.	Rk	yearly papers/ 10 ⁶ inhab.	Rk	yearly papers/ 10 ⁶ inhab.	Rk
Ontario	10.2	(1)	14.3	(2)	17.2	(3)	22.3	(2)	27.8	(2)	18.4	(1)
Nova Scotia	8.3	(2)	6.8	(6)	20.4	(1)	20.7	(3)	29.9	(1)	17.2	(2)
Manitoba	7.5	(3)	16.3	(1)	17.3	(2)	23.4	(1)	20.6	(4)	17.0	(3)
Alberta	6.6	(5)	10.5	(3)	12.0	(4)	19.3	(4)	26.4	(3)	15.0	(4)
British Columbia	7.1	(4)	8.8	(4)	9.4	(5)	13.7	(5)	19.7	(5)	11.7	(5)
Saskatchewan	3.7	(7)	7.2	(5)	3.6	(7)	11.0	(6)	19.1	(6)	8.9	(6)
Québec	4.5	(6)	5.0	(7)	7.0	(6)	8.3	(7)	11.7	(7)	7.3	(7)
Canada	7.4		10.1		12.4		16.5		21.7		13.6	
World	1.5		2.0		2.1		2.1		2.4		2.0	

Source: Compiled by Science-Metrix from Medline

3.2.3 Specialization index

The specialization index (SI) is an indicator of an entity’s intensity of research within a specific research area, relative to the intensity of research within the same research area in the world; a score above one means that an entity specializes in the research area relative to the world.

For the 1991–2005 period, Canada is only slightly specialized in HSS with a proportion of HSS papers among all of its Medline papers that is 3% higher than that observed at the world level (i.e., SI = 1.03) (Table XXVII). However, while Canada was not specialized in HSS in the early 1990s, it is now highly specialized in the area with a proportion of HSS papers among all its Medline papers that is 32% higher than that observed at the world level in the most recent period examined. In fact, in the 1991–1993 period, none of the provinces was specialized in this area, while in 2003–2005, all provinces except Québec (SI of 0.77) are specialized with SI ranging from 1.31 to 1.60. For the entire period covered in this study, Manitoba ranks 1st, Nova Scotia 2nd, Ontario 3rd, British Columbia 4th, Alberta 5th, Saskatchewan 6th, and Québec 7th. In the most recent period, Nova Scotia leads with a SI of 1.60, followed by Ontario with a SI of 1.49. Manitoba (SI of 1.41), British Columbia (SI of 1.40) and Alberta (SI of 1.38) which are almost on par rank next.

Table XXVII SI of provinces in HSS by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	SI	Rk	SI	Rk	SI	Rk	SI	Rk	SI	Rk	SI	Rk
Manitoba	0.69	(4)	1.19	(1)	1.22	(2)	1.85	(1)	1.41	(3)	1.28	(1)
Nova Scotia	0.93	(2)	0.60	(6)	1.41	(1)	1.30	(3)	1.60	(1)	1.24	(2)
Ontario	0.93	(1)	0.96	(2)	1.04	(3)	1.38	(2)	1.49	(2)	1.20	(3)
British Columbia	0.89	(3)	0.87	(3)	0.83	(4)	1.16	(5)	1.40	(4)	1.07	(4)
Alberta	0.60	(5)	0.70	(5)	0.77	(5)	1.19	(4)	1.38	(5)	0.99	(5)
Saskatchewan	0.52	(6)	0.73	(4)	0.32	(7)	0.97	(6)	1.31	(6)	0.82	(6)
Québec	0.51	(7)	0.40	(7)	0.50	(6)	0.65	(7)	0.77	(7)	0.58	(7)
Canada	0.78		0.79		0.88		1.19		1.32		1.03	
World	1.00		1.00		1.00		1.00		1.00		1.00	

Source: Compiled by Science-Metrix from Medline

3.2.4 Relative average of impact factors

The relative average of impact factors (RAIF) is an indicator of the expected impact of papers from an entity relative to the expected impact of papers at the world level; a score above one means that an entity publishes in journals that are more cited than the world average for papers in the same field. It provides a proxy for the quality of the journals in which papers are published.

The expected impact of Canada's paper in the area of HSS is lower than the world average for the 15-year period and in each of the 3-year periods. Nevertheless, Canada's RAIF increased from 0.63 in 1991–1993 to 0.93 (near the world level) in 2003–2005 (Table XXVIII). All the provinces analysed have a RAIF below the world level for the overall period, and only Ontario has a RAIF equal to the world level in the most recent period. Ontario is ranked 1st for the 15-year period, followed by Manitoba (2nd), British Columbia (3rd), Québec (4th), Alberta (5th), Nova Scotia (6th), and Saskatchewan (7th).

Table XXVIII RAIF of provinces in HSS by 3-year period, 1991–2005

Province	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	RAIF	Rk	RAIF	Rk	RAIF	Rk	RAIF	Rk	RAIF	Rk	RAIF	Rk
Ontario	0.70	(1)	0.74	(5)	0.93	(2)	0.89	(3)	1.00	(1)	0.92	(1)
Manitoba	0.48	(4)	1.01	(1)	1.15	(1)	0.65	(7)	0.84	(4)	0.85	(2)
British Columbia	0.58	(3)	0.77	(3)	0.66	(5)	0.87	(4)	0.87	(3)	0.82	(3)
Québec	0.67	(2)	0.75	(4)	0.76	(4)	0.92	(1)	0.83	(5)	0.82	(4)
Alberta	0.41	(6)	0.40	(6)	0.80	(3)	0.82	(5)	0.90	(2)	0.81	(5)
Nova Scotia	0.43	(5)	0.94	(2)	0.63	(6)	0.90	(2)	0.75	(6)	0.76	(6)
Saskatchewan	0.23	(7)	0.39	(7)	0.42	(7)	0.77	(6)	0.71	(7)	0.67	(7)
Canada	0.63		0.73		0.85		0.86		0.93		0.86	
World	1.00		1.00		1.00		1.00		1.00		1.00	

Source: Compiled by Science-Metrix from Medline

British Columbia, Québec and Alberta are almost on a par. In the 2003–2005 period, Ontario ranks 1st followed by Alberta and British Columbia. Manitoba and Québec are similar and are ranked 4th and 5th, respectively.

3.2.5 Multicriteria ranking

The multicriteria ranking provides an overall assessment of the leading Canadian provinces in HSS. The indicators considered in the multicriteria ranking are number of papers, number of papers per capita, SI, and RAIF.

Ontario is the leader among the provinces considered in the area of HSS, ranking 1st in all periods except 1994–1996, when it was ranked 2nd (Table XXIX). In the 1991 to 2005 period, Manitoba was ranked 2nd, British Columbia 3rd, Nova Scotia 4th, Alberta 5th, Québec 6th, and Saskatchewan 7th. Nova Scotia also stands out as a leader in HSS, ranking 2nd in the last two 3-year periods. In the most recent period, Alberta is on a par with Nova Scotia in 2nd place, improving by four places since the first period in the early 1990s. British Columbia ranks 4th in the most recent period, followed by Manitoba in 5th place, Québec in 6th place, and Saskatchewan in 7th place.

The improvement in Alberta’s multicriteria ranking can be attributed to the increase in its output per capita and its RAIF. Based on its excellent ranking in the most recent period analysed, and the increase in its absolute output and its share of world and Canadian papers in HSS, Alberta is likely to become a key player among the leading Canadian provinces in the area in the future.

Table XXIX Multicriteria ranking of provinces in HSS comprising number of papers, papers per capita, SI, and RAIF, by 3-year period, 1991–2005

Rk	1991-1993	1994-1996	1997-1999	2000-2002	2003-2005	1991-2005
1	Ontario	Manitoba	Ontario	Ontario	Ontario	Ontario
2	British Columbia	Ontario	Manitoba	Manitoba (2)	Alberta (2)	Manitoba
3	Nova Scotia	British Columbia	Nova Scotia	Nova Scotia (2)	Nova Scotia (2)	British Columbia
4	Manitoba	Alberta	Alberta	Alberta	British Columbia	Nova Scotia
5	Québec	Québec	British Columbia	Québec	Manitoba	Alberta
6	Alberta	Nova Scotia	Québec	British Columbia	Québec	Québec
7	Saskatchewan	Saskatchewan	Saskatchewan	Saskatchewan	Saskatchewan	Saskatchewan

Source: Compiled by Science-Metrix from Medline

Figure 12 shows the positioning of provinces in a two-dimensional space in terms of SI and RAIF. The SI and the RAIF are log transformed such that the origin (0, 0) represents the world level. For both indicators, a value above zero means that the score is higher than the world level, while a value below zero means that the score is lower than the world level.

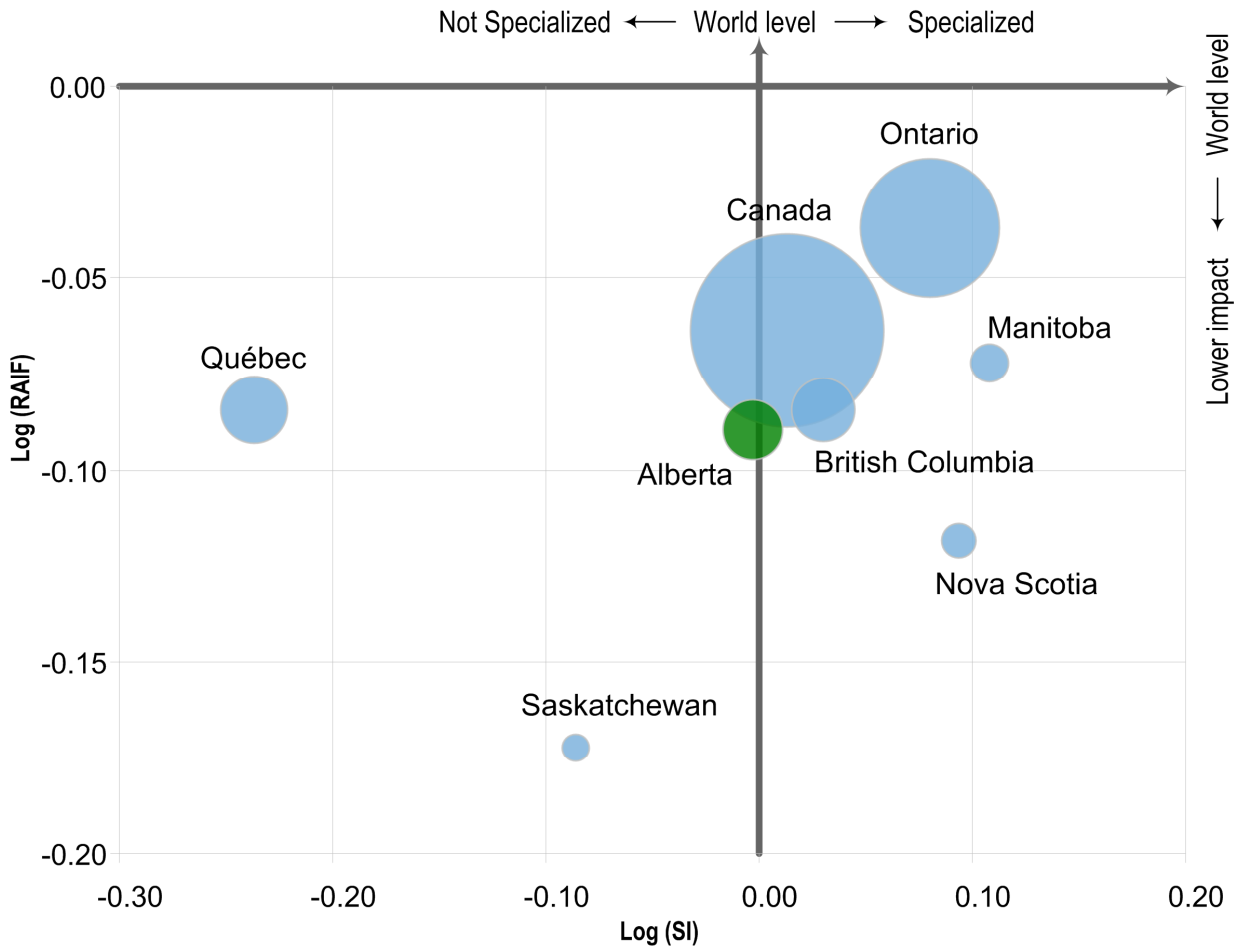


Figure 12 Scientometric positioning of provinces based on their specialization and scientific impact in HSS, 1991–2005

Source: Compiled by Science-Metrix from Medline

The leaders are in the top right quadrant (high level of specialization, high level of impact) while the provinces that are lagging are in the lower left quadrant. The number of papers published over the period examined should be taken into account when interpreting the positions of provinces. A province that makes only a minor scientific contribution to the field may fall in the top right quadrant, while a province that makes a large contribution may fall in the lower left quadrant. The size of the bubbles is proportional to the absolute scientific output.

It is important to note that the positioning of provinces in this figure is based on the entire period examined (1991–2005). It is also worth mentioning that, like Canada as a whole, none of the provinces fall in the upper part of the figure. This indicates that the expected impact of Canadian research on average is smaller than that of world research on average. As in the multicriteria ranking, Ontario, Manitoba, and British Columbia are clearly leading in HSS research for the entire period studied with Alberta and Nova Scotia following. However, as the multicriteria ranking shows, Alberta and Nova Scotia lead in the most recent period studied (2003–2005) being tied in 2nd place behind Ontario. Québec and Saskatchewan are lagging somewhat.

Québec's low score in HSS may in part be due to a linguistic bias. Indeed, Archambault *et al.* (2004) demonstrated that in the Thomson Scientific database, the linguistic bias, resulting in an underestimation of the scientific production published in French, was greater for the social sciences and the humanities than for the natural and engineering sciences¹. Assuming that a similar bias exists in Medline, Québec's scientific production in HSS, which in part falls within the social sciences and the humanities, could well be underestimated.

3.3 Cities

This section presents a multicriteria ranking of leading Canadian cities for HSS, based on four indicators: number of papers, number of papers per capita, SI, and RAIF. Leading Canadian cities were selected on the basis of their absolute output in the field. Trends in the number of scientific papers published in HSS by each of these cities are presented.

Toronto leads in all three areas targeted by AHFMR in terms of absolute production of papers. In HSS, it published nearly 1,500 papers, more than twice the volume of the output of its nearest competitor, Montreal, which ranks 2nd with nearly 650 papers. Hamilton ranks 3rd with about 550 papers, followed by Vancouver and Ottawa-Hull, tied for 4th place with about 500 papers each (Table XXX).

Table XXX Multicriteria ranking of leading Canadian cities in HSS comprising number of papers, papers per capita, SI, and RAIF, 1991–2005

City	Papers	Rk	Papers/ 10 ⁶ inab.	Rk	SI	Rk	RAIF	Rk	Multicriteria rank
Hamilton	552	(3)	54.8	(1)	1.85	(1)	0.88	(5)	(1)
Ottawa-Hull	501	(4)	31.0	(4)	1.38	(2)	0.97	(2)	(2)
Toronto	1,494	(1)	21.0	(7)	1.18	(4)	1.01	(1)	(3)
Halifax	226	(10)	41.1	(2)	1.25	(3)	0.77	(8)	(4)
Vancouver	501	(4)	16.6	(9)	0.92	(8)	0.92	(3)	(5)
Winnipeg	286	(7)	27.7	(5)	1.17	(5)	0.85	(7)	(5)
Montreal	644	(2)	12.4	(10)	0.60	(10)	0.89	(4)	(7)
Edmonton	390	(6)	27.4	(6)	1.04	(6)	0.76	(9)	(8)
Calgary	257	(8)	17.9	(8)	0.96	(7)	0.88	(6)	(9)
London	234	(9)	35.4	(3)	0.77	(9)	0.67	(10)	(10)

Source: Compiled by Science-Metrix from Medline

As was the case for MFCH and MHMIA, Edmonton and Calgary are the only cities in Alberta that rank at the top in terms of absolute output. Edmonton is 6th with about 400 papers and Calgary is 8th with about 260 papers published between 1991 and 2005. Also, once again the most productive cities in output per capita are the smaller ones, such as Hamilton (1st), Halifax (2nd), and London (3rd). In HSS, Edmonton and Calgary perform equally well in absolute and relative output, ranking 6th and 8th, respectively, for both indicators. Six out of ten leading Canadian cities are specialized in HSS

¹ Archambault E. & Vignola Gagné E. 2004. *Examen de la bibliométrie comme outil d'évaluation des sciences sociales et humaines*. Prepared for the Social Sciences and Humanities Research Council, 60 pages.

research, including Edmonton in 6th place with a SI of 1.04. The leaders are Hamilton (1st place, SI of 1.85), Ottawa-Hull (2nd place, SI of 1.38), and Halifax (3rd place, SI of 1.25). Calgary ranks 7th behind Edmonton with a SI near to the world level (0.96). Toronto is the only city among the Canadian leaders with a scientific production that has, on average, an expected impact above the world level. However, its RAIF is only slightly higher than the world level (RAIF of 1.01). Based on the expected impact of its research in HSS, Calgary ranks 6th (RAIF of 0.88) and Edmonton ranks 9th (RAIF of 0.76). The top three cities for HSS in the multicriteria ranking are all in Ontario: Hamilton (1st), Ottawa-Hull (2nd), and Toronto (3rd). Edmonton ranks 8th for HSS compared to 11th for MFCH and 12th for MHMIA, while Calgary ranks 9th for HSS compared to 15th for MFCH and 10th for MHMIA.

Toronto and Montreal maintained their leading positions in absolute output, ranking 1st and 2nd, respectively, in all the 3-year periods considered (Table XXXI). Edmonton gained one place, moving from the 7th place in the 1991–1993 period to the 6th place in the 2003–2005 period, while Calgary improved from 9th to 7th place.

Table XXXI Trends in the number of publications of leading Canadian cities in HSS by 3-year period, 1991–2005

City	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk
Toronto	142	(1)	219	(1)	269	(1)	356	(1)	508	(1)	1,494	(1)
Montreal	77	(2)	84	(2)	130	(2)	152	(2)	201	(2)	644	(2)
Hamilton	71	(3)	78	(3)	112	(3)	133	(3)	158	(5)	552	(3)
Ottawa-Hull	56	(4)	72	(4)	77	(4)	126	(4)	170	(4)	501	(4)
Vancouver	55	(5)	70	(5)	74	(5)	121	(5)	181	(3)	501	(4)
Edmonton	27	(7)	51	(7)	74	(5)	98	(6)	140	(6)	390	(6)
Winnipeg	23	(8)	53	(6)	64	(7)	76	(7)	70	(9)	286	(7)
Calgary	21	(9)	26	(9)	28	(10)	75	(8)	107	(7)	257	(8)
London	30	(6)	40	(8)	50	(9)	56	(9)	58	(10)	234	(9)
Halifax	20	(10)	19	(10)	53	(8)	52	(10)	82	(8)	226	(10)
Canada	626		888		1,120		1,537		2,085		6,256	

Source: Compiled by Science-Metrix from Medline

3.4 Institutions

The multicriteria ranking of leading Canadian institutions in HSS was based on three indicators: number of papers, SI, and RAIF. Leading Canadian institutions were selected on the basis of their absolute output in this area. Trends in the number of scientific papers published in HSS by each of these institutions are presented.

For number of papers published in HSS between 1991 and 2005, the University of Toronto leads with about 700 papers (Table XXXII) and is followed by McMaster University (2nd with 385 papers), the University of British Columbia (3rd with about 320 papers), the University of Alberta (4th with nearly 300 papers), the University of Manitoba (5th with about 200 papers), and the University of Calgary (6th with about 190 papers).

The University of Toronto leads in specialization and impact, ranking 2nd for both indicators (SI = 1.59; ARIF = 1.09). It ranks 1st in the multicriteria ranking, well ahead of its competitors. McMaster University ranks 1st for SI (2.01), but only 6th for its expected impact which is below the world level (RAIF of 0.89). Still, it comes in 2nd place in the multicriteria ranking. The University of Calgary and the University of Alberta are, when all indicators are combined, tied in 5th place.

Table XXXII Multicriteria ranking of leading Canadian institutions in HSS comprising number of papers, SI, and RAIF, 1991–2005

Institution	Papers	Rk	SI	Rk	RAIF	Rk	Multicriteria rank
University of Toronto	708	(1)	1.59	(2)	1.09	(2)	(1)
McMaster University	385	(2)	2.01	(1)	0.89	(6)	(2)
University of British Columbia	321	(3)	0.90	(6)	0.93	(5)	(3)
University of Manitoba	204	(5)	1.27	(3)	0.84	(7)	(4)
University of Calgary	187	(6)	0.86	(7)	0.94	(4)	(5)
University of Alberta	296	(4)	0.91	(5)	0.76	(8)	(5)
University Health Network	157	(10)	0.68	(9)	1.23	(1)	(7)
McGill University	173	(7)	0.63	(10)	0.99	(3)	(7)
Dalhousie University	163	(9)	1.20	(4)	0.73	(9)	(9)
Université de Montréal	164	(8)	0.86	(8)	0.59	(10)	(10)

Source: Compiled by Science-Metrix from Medline

Over the whole period studied, the University of Toronto kept its leading position in volume of output, ranking 1st in each of the 3-year periods (Table XXXIII). McMaster University moved down in the ranking in the last period, finishing on a par with the University of Alberta in 3rd place. The University of British Columbia moved from 3rd place in 1991–1993 to 2nd place in 2003–2005. It should be noted that McMaster University and the University of Alberta are almost on a par with the University of British Columbia in the most recent period. Finally, the output of the University of Calgary increased more than eight-fold, improving its ranking from the 10th place in the first period to the 5th place in the last period.

Table XXXIII Trends in the number of publications of leading Canadian institutions in HSS by 3-year period, 1991–2005

Institution	1991-1993		1994-1996		1997-1999		2000-2002		2003-2005		1991-2005	
	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk	Papers	Rk
University of Toronto	62	(1)	105	(1)	121	(1)	177	(1)	243	(1)	708	(1)
McMaster University	47	(2)	53	(2)	80	(2)	92	(2)	113	(3)	385	(2)
University of British Columbia	34	(3)	41	(4)	50	(4)	80	(3)	116	(2)	321	(3)
University of Alberta	15	(7)	30	(5)	58	(3)	80	(3)	113	(3)	296	(4)
University of Manitoba	16	(6)	43	(3)	43	(5)	54	(6)	48	(9)	204	(5)
University of Calgary	9	(10)	16	(9)	18	(10)	60	(5)	84	(5)	187	(6)
McGill University	20	(4)	23	(7)	20	(9)	42	(7)	68	(6)	173	(7)
Université de Montréal	20	(4)	18	(8)	37	(6)	41	(8)	48	(9)	164	(8)
Dalhousie University	14	(8)	14	(10)	36	(7)	37	(10)	62	(7)	163	(9)
University Health Network	11	(9)	24	(6)	24	(8)	39	(9)	59	(8)	157	(10)
Canada	626		888		1,120		1,537		2,085		6,256	

Source: Compiled by Science-Metrix from Medline

3.5 Researchers

This section presents data on the most active researchers in the world, in Canada, and in Alberta, based on their absolute output in HSS.

In HSS, the retrieval of documents classified as ‘journal articles’ in Medline resulted in the inclusion in the dataset of medical news as well as scientific papers. This has resulted in freelance journalists being identified among the leading authors at world level. Two are from the UK (Adrian O’Dowd and Alison Moore) and one is from the US (John Carroll). Among the world’s leading academics are five researchers from the US, one from the UK, and one from the Netherlands (Table XXXIV). Robert A. Rosenheck from Yale University is also among the world leaders in MHMIA research.

Table XXXIV Number of papers of most active researchers in the world in HSS, 2001–2005

Author	Affiliation	Papers	Rk
Wayne J. Katon	University of Washington (US)	68	(1)
Adrian O'Dowd	Freelance journalist, UK	66	(2)
Alison Moore	Freelance journalist, UK	57	(3)
Harlan M. Krumholz	Yale University (US)	55	(4)
Robert A. Rosenheck	Yale University (US)	55	(4)
John Appleby	King's Fund (UK)	53	(6)
John Carroll	Freelance journalist, USA	53	(6)
Barbara H. Starfield	John's Hopkins University (US)	49	(8)
Kenneth B. Wells	University of California at Los Angeles (US)	48	(9)
Richard P.T.M. Grol	Radboud University Nijmegen Medical Centre (Netherlands)	48	(9)

Source: Compiled by Science-Metrix from Medline

Cameron R. Donaldson from the University of Calgary published twice as many papers from 2001 to 2005 as his closest competitor in Alberta. He is also the leading Canadian author in HSS (Table XXXV).

Table XXXV Number of papers of most active researchers in Canada in HSS, 2001–2005

Author	Affiliation	Papers	Rk
Cameron R. Donaldson	University of Calgary	44	(1)
Bernie J. O'Brien	McMaster University	31	(2)
Amiram Gafni	McMaster University	29	(3)
Peter A. Singer	University of Toronto	29	(3)
Stephen Birch	McMaster University	27	(5)
Jack V. Tu	University of Toronto	26	(6)
Craig R. Mitton	University of British Columbia	25	(7)
Jeremy M. Grimshaw	Ottawa Health Research Institute	25	(7)
Douglas K. Martin	University of Toronto	23	(9)
Sanjay Sharma	Queen's University	22	(10)

Source: Compiled by Science-Metrix from Medline

Among the leading Canadian authors, there are three researchers from the University of Toronto, which ranks 1st among leading Canadian institutions, and three from McMaster University, which is ranked 2nd.

As in MHMIA, Scott B. Patten from the University of Calgary ranks among Alberta's leading authors in HSS. Alberta's leading researchers in this area are from the University of Calgary (8 authors) and the University of Alberta (6 authors); these universities are ranked 5th among leading Canadian institutions in the field.

Table XXXVI Number of papers of most active researchers in Alberta in HSS, 2001–2005

Author	Affiliation	Papers	Rk
Cameron R. Donaldson	University of Calgary	44	(1)
David H. Feeny	University of Alberta	20	(2)
Philip Jacobs	University of Alberta	20	(2)
William A. Ghali	University of Calgary	19	(4)
Steven J. Lewis	University of Calgary	16	(5)
Ross T. Tsuyuki	University of Alberta	12	(6)
Tom W. Noseworthy	University of Calgary	11	(7)
Scott B. Patten	University of Calgary	9	(8)
Braden J. Manns	University of Calgary	9	(8)
Kent V. Rondeau	University of Alberta	9	(8)
Lawrence W. Svenson	University of Alberta	9	(8)
Marja J. Verhoef	University of Calgary	9	(8)
Penelope Hawe	University of Calgary	9	(8)
Sumit R. Majumdar	University of Alberta	9	(8)

Source: Compiled by Science-Metrix from Medline

Conclusion

The AHFMR is in the process of developing a plan for targeted research initiatives. In this report, the three areas of interest are Maternal, Foetal and Child Health (MFCH), Mental Health, Mental Illness and Addictions (MHMIA), and Health System Sustainability (HSS). In order to put forth its plan, AHFMR needs strategic information on how Alberta's health research system performs in comparison to those of other provinces in the three areas. To fulfill this need, Science-Metrix conducted a bibliometric study on each area to compare the scientific output of Alberta with that of other provinces in terms of volume, volume per capita, specialization and expected impact, and also provided data on the most productive Canadian cities, institutions, and researchers.

In Canada, MFCH comes 1st among the three targeted fields in terms of absolute output with nearly 25,000 papers published between 1991 and 2005. MHMIA is next in importance with about 17,000 papers and HSS is in 3rd place with about 6,300 papers. However, it is in MHMIA research that Canada was the most specialized in the 1991–2005 period, having 32% more of its Medline papers published in this area than the world. HSS and MFCH follow almost on a par with a share similar to that of the world considering the whole period. However, Canada specialization in HSS has increased substantially over the period, such that in the most recent period analysed (2003–2005), the SI for HSS was almost to that in MHMIA. In the most recent period analysed Canada was specialized in all three areas. The expected impact of Canadian research is above the world level in both MFCH (1.10) and MHMIA (RAIF of 1.05), but slightly below the world level in HSS (RAIF of 0.86). The absolute expected impact of Canadian research is highest in MHMIA (average of impact factors [AIF] of 2.49); MFCH has an AIF of 2.45 and HSS has an AIF of 2.09. Thus, Canada as a whole appears to be performing better in MFCH and MHMIA although its performance in HSS has been improving over time. In particular, the Canadian scientific output in HSS increased five-fold from 1991 to 2005 but only two-fold in the other two areas.

Relative to other provinces, Alberta performed equally well in each of the three targeted areas across the whole period covered in this study. In a multicriteria ranking based on number of papers, output per capita, SI, and RAIF, Alberta ranks 6th for MFCH, 5th for MHMIA, and 5th for HSS. However, Alberta made the most progress in HSS, ranking 2nd in the most recent period (2003–2005) analysed, while it improved its overall performance by only one place in MFCH and remained in 5th place in MHMIA. In fact, only in HSS did Alberta perform better than the Canadian average with respect to two indicators: the output per capita in the 1991–2005 and the 2003–2005 periods and the SI in the 2003–2005 period. In addition, Edmonton and Calgary performed the best relative to other Canadian cities in HSS, ranking 8th and 9th respectively, in the multicriteria ranking. In MFCH, Edmonton ranks 11th and Calgary ranks 15th, while in MHMIA, Edmonton ranks 12th and Calgary ranks 10th. The Universities of Alberta and Calgary are among leading Canadian institutions in all three areas, but they performed best in HSS where they both rank 5th in the multicriteria ranking. In MFCH, the University of Alberta ranks 13th and the University of Calgary ranks 31st, while in MHMIA, the University of Alberta ranks 18th and the University of Calgary ranks 19th. There are no researchers from Alberta among the top authors at the world level in any of the three targeted areas. However, the leading Canadian researcher for number of papers published in HSS from 2001 to

2005, Dr. Cameron R. Donaldson, is from the University of Calgary in Alberta. In MFCH, there is no author from Alberta among the leading Canadian researchers, while in MHMIA, Dr. Scott B. Patten from the University of Calgary ranks 4th.

Within Canada, Alberta is better positioned to compete with other provinces in HSS than in MFCH or MHMIA. Still, Alberta's absolute output is smallest in HSS, and its expected impact in this area is not any higher than in MFCH or MHMIA.

Based on observed trends at the provincial level, the gap between Alberta and the leaders in MFCH research (Ontario, Québec, and British Columbia) may be lessened if the province continues to increase both its output and impact. In MHMIA research, Alberta could improve its position by increasing its specialization and its impact above the world level. It has already made progress with the RAIF ranking, coming in ahead of Nova Scotia, Manitoba, and Saskatchewan in the last period. In HSS, Alberta was among the leaders in the most recent period (2003–2005), ranking 2nd on a par with Nova Scotia. To maintain this leading position, Alberta should continue to increase its output and expected impact.

Appendix A – MeSH Terms used in querying Medline

MeSH Terms for Maternal, Foetal and Child Health (MFCH)

'abortion, eugenic', 'abortion, habitual', 'abortion, incomplete', 'abortion, induced', 'abortion, legal', 'abortion, missed', 'abortion, septic', 'abortion, spontaneous', 'abortion, therapeutic', 'abortion, threatened', 'abruptio placentae', 'adnexal diseases', 'adolescent', 'adolescent behavior', 'adolescent development', 'adolescent health services', 'adolescent medicine', 'adolescent nutrition', 'adolescent psychiatry', 'adolescent psychology', 'adolescent, hospitalized', 'adolescent, institutionalized', 'aid to families with dependent children', 'amniocentesis', 'amniotic band syndrome', 'analgesia, obstetrical', 'anemia, neonatal', 'anesthesia, obstetrical', 'anovulation', 'asphyxia neonatorum', 'battered child syndrome', 'birth injuries', 'blood transfusion, intrauterine', 'breech presentation', 'brenner tumor', 'bronchopulmonary dysplasia', 'candidiasis, vulvovaginal', 'carcinoma, endometrioid', 'cardiotocography', 'cephalopelvic disproportion', 'cerclage, cervical', 'cervical ripening', 'cesarean section', 'cesarean section, repeat', 'chiari-frommel syndrome', 'child', 'child abuse', 'child abuse, sexual', 'child advocacy', 'child behavior', 'child behavior disorders', 'child care', 'child custody', 'child day care centers', 'child development', 'child development disorders, pervasive', 'child guidance', 'child guidance clinics', 'child health services', 'child language', 'child mortality', 'child nutrition', 'child nutrition disorders', 'child of impaired parents', 'child psychiatry', 'child psychology', 'child reactive disorders', 'child rearing', 'child welfare', 'child, abandoned', 'child, exceptional', 'child, gifted', 'child, hospitalized', 'child, institutionalized', 'child, preschool', 'child, unwanted', 'chorea gravidarum', 'chorioamnionitis', 'choriocarcinoma', 'chorionic villi sampling', 'colposcopy', 'colpotomy', 'congenital, Hereditary, and Neonatal Diseases and Abnormalities', 'corpus luteum maintenance', 'culdoscopy', 'cyclofenil', 'cystic fibrosis', 'dandy-walker syndrome', 'delivery, obstetric', 'dental care for children', 'depression, postpartum', 'diabetes, gestational', 'diagnostic techniques, obstetrical and gynecological', 'diapers, infant', 'diarrhea, infantile', 'dilatation and curettage', 'disabled children', 'dyspareunia', 'dystocia', 'early intervention (education)', 'eclampsia', 'embolism, amniotic fluid', 'embryo loss', 'embryo transfer', 'endometrial hyperplasia', 'endometrial neoplasms', 'endometrial stromal tumors', 'endometriosis', 'endometritis', 'epilepsy, benign neonatal', 'episiotomy', 'erythroblastosis, fetal', 'extraction, obstetrical', 'fallopian tube diseases', 'fallopian tube neoplasms', 'fallopian tube patency tests', 'family leave', 'family planning policy', 'family planning services', 'father-child relations', 'feeding and eating disorders of childhood', 'female genital diseases and pregnancy complications', 'fertilization in vitro', 'fetal alcohol syndrome', 'fetal death', 'fetal diseases', 'fetal distress', 'fetal growth retardation', 'fetal hypoxia', 'fetal macrosomia', 'fetal membranes, premature rupture', 'fetal monitoring', 'fetal mortality', 'fetal nutrition disorders', 'fetal resorption', 'fetal therapies', 'fetofetal transfusion', 'fetomaternal transfusion', 'fetoscopy', 'galactorrhea', 'gamete intrafallopian transfer', 'genital diseases, female', 'genital neoplasms, female', 'gestational trophoblastic neoplasms', 'granulosa cell tumor', 'gravidity', 'gynatresia', 'gynecology', 'heart rate, fetal', 'hellp syndrome', 'hematocolpos', 'hematometra', 'hemorrhagic disease of newborn', 'hernia, umbilical', 'herpes genitalis', 'home childbirth', 'hospitals, maternity', 'hospitals, pediatric', 'hyaline membrane disease', 'hydatidiform mole', 'hydatidiform mole, invasive', 'hydrocephalus', 'hydrocolpos', 'hydrophthalmos', 'hydrops fetalis', 'hyperbilirubinemia, neonatal', 'hyperemesis gravidarum',

'hyperkeratosis, epidermolytic', 'hyperostosis, cortical, congenital', 'hypertension, pregnancy-induced', 'hysterectomy', 'hysterectomy, vaginal', 'hysterosalpingography', 'hysteroscopy', 'hysterotomy', 'ichthyosiform erythroderma, congenital', 'ichthyosis', 'ichthyosis, lamellar', 'ichthyosis, x-linked', 'immunity, maternally-acquired', 'incubators, infant', 'infant behavior', 'infant care', 'infant equipment', 'infant food', 'infant formula', 'infant mortality', 'infant nutrition', 'infant nutrition disorders', 'infant welfare', 'infant, low birth weight', 'infant, newborn', 'infant, newborn, diseases', 'infant, postmature', 'infant, premature', 'infant, premature, diseases', 'infant, small for gestational age', 'infant, very low birth weight', 'infanticide', 'infertility, female', 'insemination, artificial', 'insemination, artificial, heterologous', 'insemination, artificial, homologous', 'intensive care units, neonatal', 'intensive care units, pediatric', 'intensive care, neonatal', 'jaundice, chronic idiopathic', 'jaundice, neonatal', 'kallmann syndrome', 'kernicterus', 'labor onset', 'labor pain', 'labor presentation', 'labor stage, first', 'labor stage, second', 'labor stage, third', 'labor, induced', 'labor, obstetric', 'lactation', 'lactation', 'lactation disorders', 'lead poisoning, nervous system, childhood', 'leishmania infantum', 'leukomalacia, periventricular', 'leukorrhea', 'live birth', 'luteoma', 'mastitis', 'maternal age', 'maternal behavior', 'maternal deprivation', 'maternal exposure', 'maternal health services', 'maternal mortality', 'maternal nutrition', 'maternal welfare', 'maternal-child health centers', 'maternal-child nursing', 'maternal-fetal exchange', 'maternal-fetal relations', 'meconium aspiration syndrome', 'meigs syndrome', 'menopause, premature', 'menorrhagia', 'mental disorders diagnosed in childhood', 'metrorrhagia', 'midwifery', 'milk ejection', 'mobius syndrome', 'morning sickness', 'mother-child relations', 'mother-child relations', 'mothers', 'munchausen syndrome by proxy', 'myasthenia gravis, neonatal', 'natural childbirth', 'natural family planning methods', 'neonatal abstinence syndrome', 'neonatal nursing', 'neonatal screening', 'neonatology', 'nuchal translucency measurement', 'nurse midwives', 'nurseries', 'nurseries, hospital', 'nystagmus, congenital', 'obstetric labor complications', 'obstetric labor, premature', 'obstetric surgical procedures', 'obstetrical forceps', 'obstetrical nursing', 'obstetrics', 'obstetrics and gynecology department, hospital', 'oligohydramnios', 'only child', 'oocyte donation', 'oophoritis', 'ophthalmia neonatorum', 'ovarian cysts', 'ovarian diseases', 'ovarian failure, premature', 'ovarian function tests', 'ovarian hyperstimulation syndrome', 'ovarian neoplasms', 'ovariectomy', 'ovulation detection', 'ovulation induction', 'ovulation prediction', 'oxytocics', 'paralysis, obstetric', 'parametritis', 'parental leave', 'parent-child relations', 'parity', 'parturition', 'pediatric assistants', 'pediatric dentistry', 'pediatric nursing', 'pediatrics', 'pelvic inflammatory disease', 'pelvimetry', 'pemphigoid gestationis', 'perinatal care', 'perinatology', 'persistent fetal circulation syndrome', 'persistent hyperinsulinemia hypoglycemia of infancy', 'phenylketonuria, maternal', 'placenta accreta', 'placenta diseases', 'placenta previa', 'placenta, retained', 'placental function tests', 'placental insufficiency', 'polycystic ovary syndrome', 'polyhydramnios', 'posthumous conception', 'postnatal care', 'postpartum hemorrhage', 'postpartum period', 'postpartum thyroiditis', 'preconception care', 'pre-eclampsia', 'pregnancy', 'pregnancy complications', 'pregnancy complications, cardiovascular', 'pregnancy complications, hematologic', 'pregnancy complications, infectious', 'pregnancy complications, neoplastic', 'pregnancy complications, parasitic', 'pregnancy in adolescence', 'pregnancy in diabetics', 'pregnancy maintenance', 'pregnancy outcome', 'pregnancy reduction, multifetal', 'pregnancy tests', 'pregnancy tests, immunologic', 'pregnancy trimester, first', 'pregnancy trimester, second',

'pregnancy trimester, third', 'pregnancy trimesters', 'pregnancy, abdominal', 'pregnancy, ectopic', 'pregnancy, high-risk', 'pregnancy, multiple', 'pregnancy, prolonged', 'pregnancy, tubal', 'pregnancy, unplanned', 'pregnancy, unwanted', 'preimplantation diagnosis', 'premature birth', 'prenatal care', 'prenatal diagnosis', 'prenatal exposure delayed effects', 'prenatal injuries', 'prenatal nutrition', 'pruritus vulvae', 'puerperal disorders', 'puerperal infection', 'reproductive history', 'reproductive medicine', 'reproductive techniques', 'reproductive techniques, assisted', 'respiratory distress syndrome, newborn', 'retinopathy of prematurity', 'rooming-in care', 'rothmund-thomson syndrome', 'salpingitis', 'salpingostomy', 'sarcoma, endometrial stromal', 'schizophrenia, childhood', 'sclerema neonatorum', 'sertoli-leydig cell tumor', 'severe combined immunodeficiency', 'sexual dysfunction, physiological', 'shaken baby syndrome', 'sjogren-larsson syndrome', 'spasms, infantile', 'sperm injections, intracytoplasmic', 'spinal muscular atrophies of childhood', 'sterilization, tubal', 'stillbirth', 'sudden infant death', 'superovulation', 'surrogate mothers', 'syphilis, congenital', 'term birth', 'thanatophoric dysplasia', 'thecoma', 'tocolysis', 'tocolytic agents', 'toxoplasmosis, congenital', 'trial of labor', 'trichomonas vaginitis', 'trophoblastic neoplasms', 'trophoblastic tumor, placental site', 'tuberculosis, female genital', 'ultrasonography, mammary', 'ultrasonography, prenatal', 'uterine cervical diseases', 'uterine cervical dysplasia', 'uterine cervical erosion', 'uterine cervical incompetence', 'uterine cervical neoplasms', 'uterine cervicitis', 'uterine contraction', 'uterine diseases', 'uterine hemorrhage', 'uterine inertia', 'uterine inversion', 'uterine monitoring', 'uterine neoplasms', 'uterine perforation', 'uterine prolapse', 'uterine rupture', 'vacuum curettage', 'vacuum extraction, obstetrical', 'vaginal birth after cesarean', 'vaginal discharge', 'vaginal diseases', 'vaginal fistula', 'vaginal neoplasms', 'vaginal smears', 'vaginismus', 'vaginitis', 'vaginosis, bacterial', 'version, fetal', 'vulvar diseases', 'vulvar lichen sclerosus', 'vulvar neoplasms', 'vulvitis', 'vulvovaginitis', 'wolman disease', 'zygote intrafallopian transfer'

MeSH Terms for Mental Health, Mental Illness and Addictions (MHMIA)

'acting out', 'adaptation, psychological', 'adjustment disorders', 'affective disorders, psychotic', 'aggression', 'agnosia', 'agoraphobia', 'aids dementia complex', 'alcohol amnestic disorder', 'alcohol withdrawal delirium', 'alcoholic intoxication', 'alcoholism', 'alcohol-related disorders', 'alexia, pure', 'alzheimer disease', 'amnesia', 'amnesia, anterograde', 'amnesia, retrograde', 'amnesia, transient global', 'amphetamine-related disorders', 'anorexia', 'anorexia nervosa', 'antisocial personality disorder', 'anxiety disorders', 'anxiety, separation', 'aphasia, primary progressive', 'apraxias', 'asperger syndrome', 'attention deficit and disruptive behavior disorders', 'attention deficit disorder with hyperactivity', 'auditory perceptual disorders', 'autistic disorder', 'biological psychiatry', 'bipolar disorder', 'borderline personality disorder', 'brief psychiatric rating scale', 'bulimia', 'burnout, professional', 'capgras syndrome', 'cataplexy', 'catatonia', 'child behavior disorders', 'child development disorders, pervasive', 'child reactive disorders', 'cocaine-related disorders', 'cognition disorders', 'cognitive science', 'cognitive therapy', 'combat disorders', 'commitment of mentally ill', 'communication disorders', 'community mental health centers', 'community mental health services', 'community psychiatry', 'compulsive personality disorder', 'conduct disorder', 'confusion', 'consciousness disorders', 'conversion disorder', 'convulsive therapy', 'coprophagia', 'couples therapy', 'creutzfeldt-jakob syndrome', 'cyclothymic disorder',

'defense mechanisms', 'deinstitutionalization', 'delirium', 'delirium, dementia, amnestic, cognitive disorders', 'delusions', 'dementia', 'dementia, multi-infarct', 'dementia, vascular', 'denial (psychology)', 'dependent personality disorder', 'depersonalization', 'depression', 'depression, involuntional', 'depression, postpartum', 'depressive disorder', 'desensitization, psychologic', 'developmental disabilities', 'diagnostic and statistical manual of mental disorders', 'disorders of excessive somnolence', 'displacement (psychology)', 'dissociative disorders', 'dyslexia', 'dyslexia, acquired', 'dyspareunia', 'dyssomnias', 'dysthymic disorder', 'eating disorders', 'education of mentally retarded', 'electroconvulsive therapy', 'electroshock', 'elimination disorders', 'emergency services, psychiatric', 'encopresis', 'enuresis', 'exhibitionism', 'factitious disorders', 'fantasy', 'feeding and eating disorders of childhood', 'fetishism (psychiatric)', 'firesetting behavior', 'gambling', 'hallucinations', 'helplessness, learned', 'heroin dependence', 'histrionic personality disorder', 'hospitals, psychiatric', 'hyperphagia', 'hypersomnolence, idiopathic', 'hypochondriasis', 'hysteria', 'identification (psychology)', 'illusions', 'implosive therapy', 'impulse control disorders', 'insanity defense', 'institutionalization', 'insurance, psychiatric', 'interview, psychological', 'jet lag syndrome', 'kleine-levin syndrome', 'kluver-bucy syndrome', 'korsakoff syndrome', 'learning disorders', 'lewy body disease', 'malingering', 'marijuana abuse', 'masochism', 'mental disorders', 'mental fatigue', 'mental healing', 'mental health', 'mental health associations', 'mental health services', 'mental retardation', 'mental retardation, x-linked', 'mental status schedule', 'mentally disabled persons', 'mentally ill persons', 'mood disorders', 'morphine dependence', 'motor skills disorders', 'multiple personality disorder', 'munchausen syndrome', 'mutism', 'narcolepsy', 'narcotherapy', 'national institute of mental health (u.s.)', 'neonatal abstinence syndrome', 'neurasthenia', 'neurocirculatory asthenia', 'neurolinguistic programming', 'neuropsychology', 'neurotic disorders', 'night terrors', 'nocturnal paroxysmal dystonia', 'obsessive behavior', 'obsessive-compulsive disorder', 'opioid-related disorders', 'orthopsychiatry', 'panic disorder', 'paranoid behavior', 'paranoid disorders', 'paranoid personality disorder', 'paraphilias', 'parasomnias', 'passive-aggressive personality disorder', 'pedophilia', 'perceptual defense', 'perceptual disorders', 'personality disorders', 'phantom limb', 'phencyclidine abuse', 'phobic disorders', 'pica', 'pick disease of the brain', 'preventive psychiatry', 'projection', 'psychiatric department, hospital', 'psychiatric nursing', 'psychiatric somatic therapies', 'psychiatric status rating scales', 'psychiatry', 'psychoanalysis', 'psychoanalytic interpretation', 'psychoanalytic therapy', 'psycholinguistics', 'psychological techniques', 'psychoneuroimmunology', 'psychopathology', 'psychopharmacology', 'psychoses, alcoholic', 'psychoses, substance-induced', 'psychosomatic medicine', 'psychosurgery', 'psychotherapy', 'psychotherapy, brief', 'psychotherapy, group', 'psychotherapy, multiple', 'psychotherapy, rational-emotive', 'psychotic disorders', 'rationalization', 'reactive attachment disorder', 'refractory period, psychological', 'regression (psychology)', 'rem sleep behavior disorder', 'rem sleep parasomnias', 'repression', 'repression-sensitization', 'restless legs syndrome', 'sadism', 'schizoid personality disorder', 'schizophrenia', 'schizophrenia, catatonic', 'schizophrenia, childhood', 'schizophrenia, disorganized', 'schizophrenia, paranoid', 'schizophrenic language', 'schizophrenic psychology', 'schizotypal personality disorder', 'seasonal affective disorder', 'self-injurious behavior', 'self mutilation', 'sexual and gender disorders', 'sexual dysfunctions, psychological', 'shared paranoid disorder', 'signal detection (psychology)', 'sleep arousal disorders', 'sleep bruxism', 'sleep deprivation', 'sleep

disorders', 'sleep disorders, circadian rhythm', 'sleep disorders, intrinsic', 'sleep initiation and maintenance disorders', 'sleep paralysis', 'sleep-wake transition disorders', 'socioenvironmental therapy', 'somatoform disorders', 'somnambulism', 'stereotypic movement disorder', 'stress disorders, post-traumatic', 'stress, psychological', 'sublimation', 'substance abuse, intravenous', 'substance withdrawal syndrome', 'substance-related disorders', 'suicide', 'suicide, attempted', 'tic disorders', 'tobacco use disorder', 'tourette syndrome', 'transsexualism', 'transvestism', 'trichotillomania', 'united states substance abuse and mental health services administration', 'voyeurism', 'wernicke encephalopathy'

MeSH Terms for Health System Sustainability (HSS)

'benchmarking', 'community health planning', 'comprehensive health care', 'cost allocation', 'delivery of health care', 'delivery of health care, integrated', 'drug costs', 'economics, medical', 'efficiency, organizational', 'fee-for-service plans', 'health care coalitions', 'health care rationing', 'health care reform', 'health expenditures', 'health facilities, proprietary', 'health manpower', 'health plan implementation', 'health planning', 'health planning support', 'health planning technical assistance', 'health policy', 'health priorities', 'health promotion', 'health resources', 'health services accessibility', 'health services administration', 'health services misuse', 'health services research', 'health status indicators', 'hospitals, proprietary', 'hospitals, public', 'insurance, health', 'long-term care', 'managed care programs', 'medicare', 'models, econometric', 'models, economic', 'multi-institutional systems', 'national health insurance, united states', 'national health programs', 'patient care management', 'primary health care', 'private sector', 'privatization', 'public health', 'public health administration', 'public sector', 'quality assurance, health care', 'quality indicators, health care', 'quality of health care', 'quality-adjusted life years', 'regional health planning', 'resource allocation', 'single-payer system', 'state health plans', 'state medicine', 'technology, high-cost', 'total quality management', 'uncompensated care', 'universal coverage', 'unnecessary procedures'

Appendix B

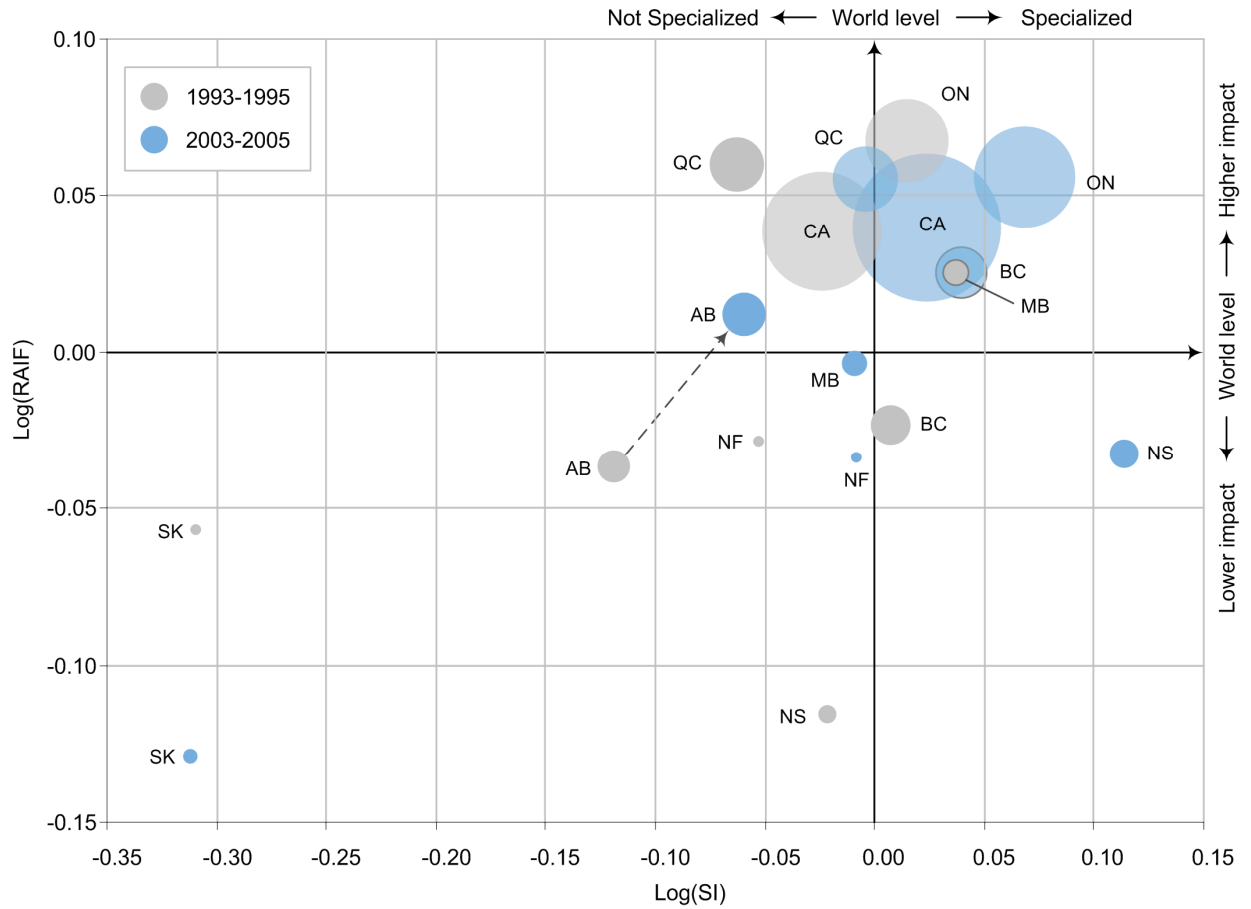


Figure 13 Trends in the scientometric positioning of provinces based on their specialization and scientific impact in MFCH, 1993–1995 to 2003–2005

Source: Compiled by Science-Metrix from Medline

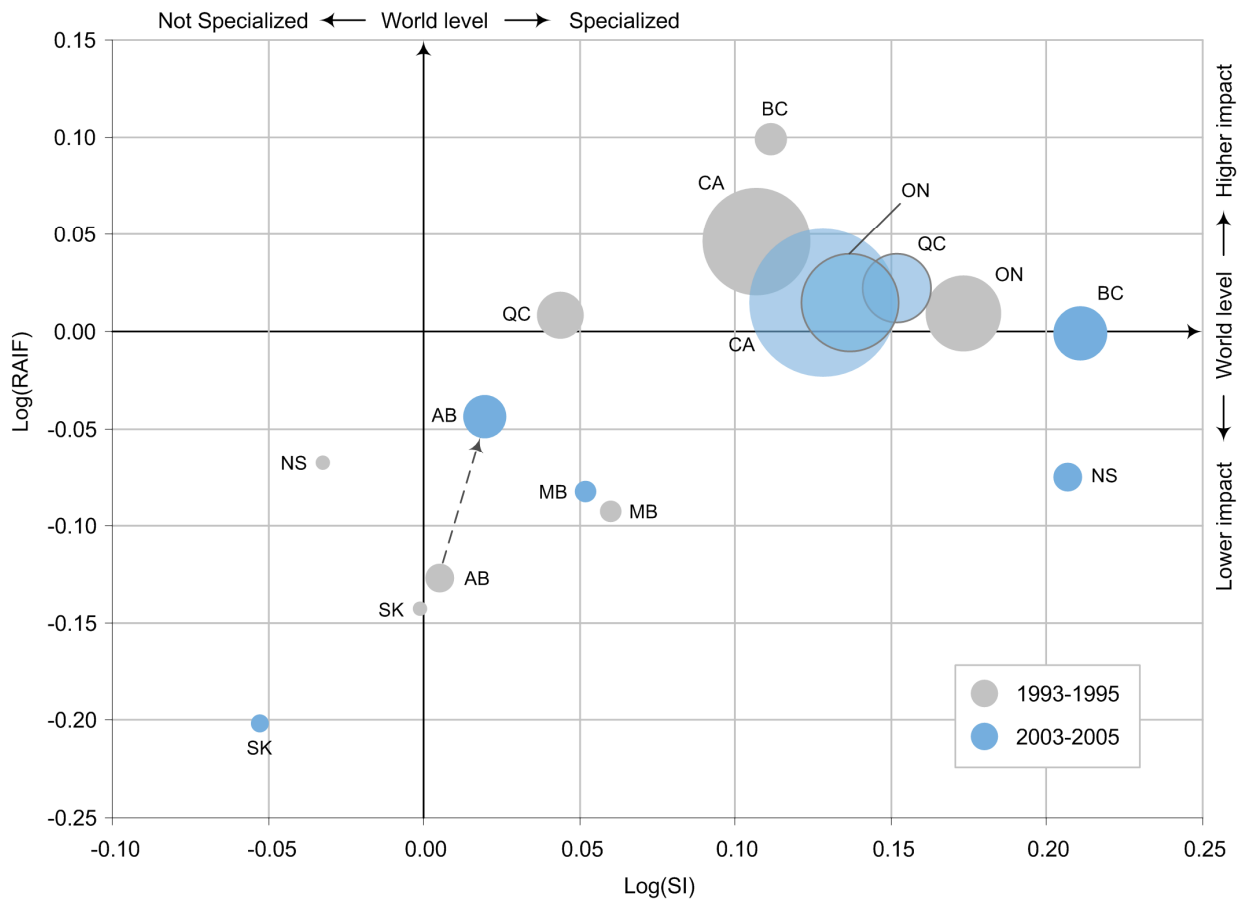


Figure 14 Trends in the scientometric positioning of provinces based on their specialization and scientific impact in MHMIA, 1993–1995 to 2003–2005

Source: Compiled by Science-Metrix from Medline

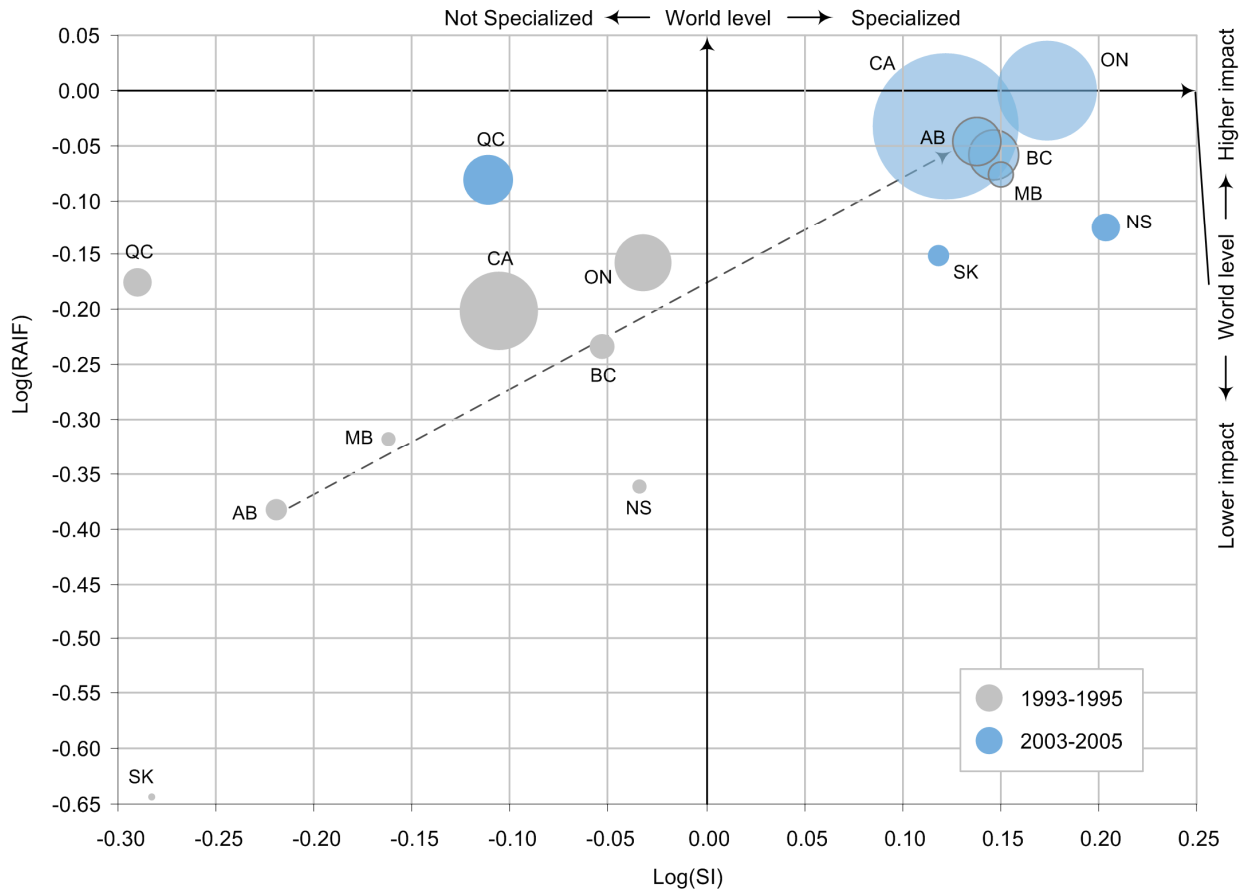


Figure 15 Trends in the scientometric positioning of provinces based on their specialization and scientific impact in HSS, 1993–1995 to 2003–2005

Source: Compiled by Science-Metrix from Medline