

Methodological Annex – Chapter 11

ST&I Indicators in Health in São Paulo State

Lattes Platform

Information on the CNPq Research Group Directory was retrieved from the Census Tabular Plans for

2000, 2002, 2004, 2006 and 2008. The periods covered overlap, as shown in the following chart.

Census information was taken from the CNPq Research Group Directory registration database, the

Appendix Chart M1
Periods covered by CNPq census data used in Chapter 11

Census year	Period covered
2000	1997-2000
2002	1998-2001
2004	2000-2003
2006	2003-2006
2008	2005-2008

Source: CNPq, Research Group Directory Census (DGP), 2000, 2002, 2004, 2006, 2008.

Lattes CV database and the CAPES Data Collection System. The information analyzed here was supplied voluntarily by the individuals concerned. Nevertheless, the universe encompassed by the census has expanded over time and can be considered satisfactorily representative of the Brazilian scientific community and of national S&T output.

The Tabular Plan is segmented into seven units of analysis, comprising information on research groups, researchers, students, technical staff, research lines, interaction with business, and scientific, technological and artistic production. The analysis in this chapter is concerned only with the latter as an acceptable indicator of S&T outputs. Furthermore, the analysis focused on researchers with PhDs.

Two other methodological demarcations were made in order to restrict the analysis to the field of human health. First, the tabulations were limited to biological sciences and health sciences. The choice of biological sciences reflected the fact that the knowledge areas that constitute the foundations for the health sciences include general biology, immunology, genetics, pharma-

cology, biochemistry and microbiology, among others. Second, four subareas within biological sciences were excluded, namely biophysics, general biology, botany and zoology, because according to specialists in the field scientific and technological production relating to human health is minute in these subareas compared with total production in each subarea. While it is acknowledged that these subareas of biological sciences do not relate directly to health, the advancement of knowledge in these disciplines is likely to lead to important outcomes and opportunities for human health, albeit frequently with a considerable time lag. The next chart shows the knowledge areas covered by the analysis based on the CNPq census.

Tabulation was also limited to units of analysis in the category “scientific, technological and artistic production”. Some units were excluded in order to focus on the indicators most relevant to S&T production. The next chart describes the units of analysis selected.

A methodological reservation is necessary here. Although Brazilian scientific production has increased substantially in recent years, not least as a reflection of

Appendix Chart M2
Knowledge areas covered by analysis based on CNPq census

Knowledge area	Knowledge subarea
Biological sciences	Biochemistry
	Pharmacology
	Physiology
	Genetics
	Immunology
	Microbiology
	Morphology
	Parasitology
Health sciences	Physical education
	Nursing
	Pharmacy
	Physiotherapy, occupational therapy
	Speech-language therapy
	Medicine
	Nutrition
	Dentistry
	Collective health

government efforts to promote national post-graduate programs, the growth shown here may be overestimated because more recent censuses probably cover a larger proportion of total Brazilian production, given the significant expansion of coverage. The number of institutions surveyed by the census rose 81% between 2000

and 2008, while the number of doctors in the database rose 175%. This compares with 115% growth in the number of PhDs awarded annually, as can be seen from Appendix Table M1, which also shows a 20% fall in São Paulo State’s share of the number of doctors in the sample covered by CNPq’s database.

Appendix Chart M3
Units of analysis selected for analysis in Chapter 11 – CNPq census

Type of production	Unit of analysis	Specification
Bibliographical production	Complete articles published in Brazilian journals	Articles in the Portuguese language published by technical and scientific journals (including articles with no information on the language used)
	Complete articles published in international journals	Articles in any language except Portuguese published by technical and scientific journals, and by trade magazines
Technical production	Technological products (pilot projects, designs, prototypes) with or without registration or patents	Apparatus, instruments, equipment, drugs etc.
	Processes and techniques with or without registration or patents	Analytical, instrumental, pedagogical, therapeutic etc.

Source: CNPq, Research Group Directory Census (DGP), 2000, 2002, 2004, 2006, 2008.

Appendix Table M1
Institutions & doctors in CNPq database with São Paulo State's share of doctors – 2000-2008

Census	Institutions	Doctors	São Paulo State's share of doctors %
2000	223	31,415	32.0
2002	268	41,111	30.0
2004	335	60,242	28.0
2006	403	73,461	27.0
2008	404	86,331	26.0
Growth 2008/2000 (%)	81.2	174.8	-20.0

Source: CNPq, Research Group Directory Census (DGP), 2000, 2002, 2004, 2006, 2008.

Health industrial complex

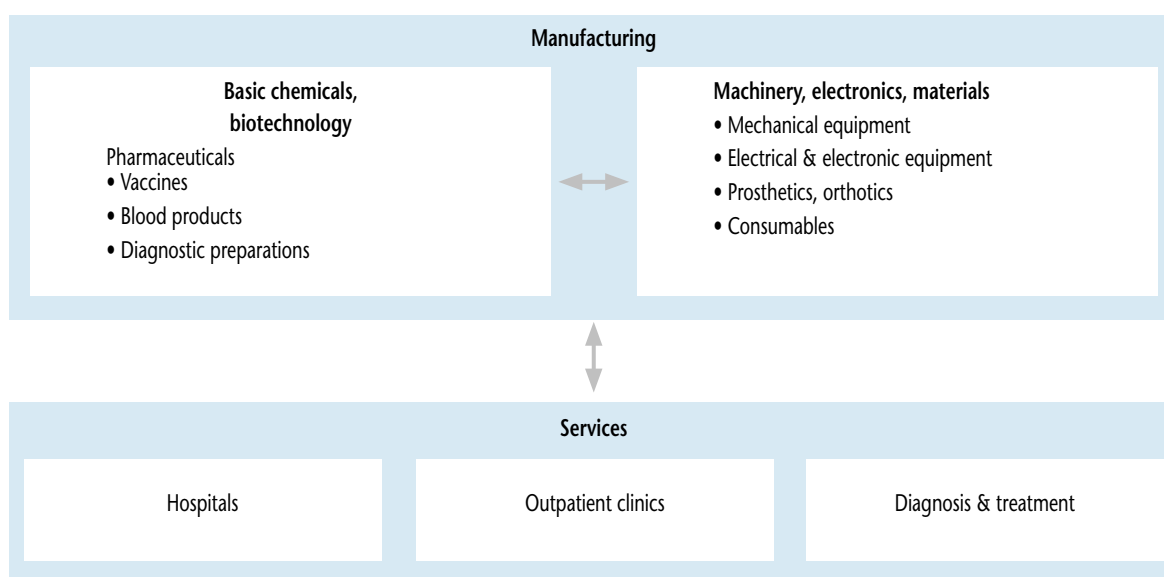
The analysis of industry's contribution to health-related R&D used selected data from PINTEC, the Survey of Technological Innovation in Industry conducted by IBGE, Brazil's national bureau of statistics and population census, and focused on two key sectors of the health industrial complex: the pharmaceutical industry and the medical and hospital equipment industry, as per Brazil's National Economic Activity Classification (CNAE 1.0, 1995):

- CNAE 24.5 – Manufacturing of pharmaceutical products, encompassing:
 - Manufacturing of medicinal chemicals
 - Manufacturing of pharmaceutical preparations for human use, including blood products
 - Manufacturing of pharmaceutical preparations for veterinary use
 - Manufacturing of materials for medical, hospital and dental use, including diagnostic preparations
- CNAE 33 – Manufacturing of medical and hospital instrumentation equipment, precision and optical instruments, industrial automation, clocks, watches and chronometers, encompassing:

- Manufacturing of equipment and instruments for use in medical, hospital and dental practice and in laboratories, and orthopedic appliances
- Manufacturing of instruments and appliances for measuring, checking, testing and control, except industrial process control equipment
- Manufacturing of machinery, equipment and electronic systems for industrial automation and process control
- Manufacturing of optical, photographic and cinematographic instruments, equipment and materials
- Manufacturing of watches, clocks and chronometers

It is important to stress that CNAE 1.0 Division 33 includes industrial activities that have nothing or very little to do with human health. However, IBGE's PINTEC data are available only at the level of two-digit aggregates. The figure below offers a schematic view of the health industrial complex as analyzed here, showing that all the key segments are covered, the main exception being consumables manufacturing.

Appendix Figure M1
Health industrial complex – schematic view



Source: Gadelha (2003).

ISI database

Scientific production data were retrieved from ISI Web of Science in the deluxe version (106 categories) by aggregate count for each year, knowledge area and region of Brazil.

Health sciences were defined so as to cover the following disciplines:

Basic sciences

1. Biochemistry & biophysics
2. Microbiology
3. Pharmacology & toxicology
4. Biotechnology & applied microbiology
5. Genetics & molecular biology
6. Pharmacology & medical toxicology
7. Cell biology & developmental biology
8. Neuroscience & behavioral science
9. Physiology
10. Immunology
11. Oncogenesis & cancer research
12. Research, laboratory medicine and medical technology

Medicine

1. Anaesthesia & intensive care
2. Gastroenterology & hepatology

3. Otorhinolaryngology
4. Research in cardiology & haematology
5. Internal & general medicine
6. Pediatrics
7. Cardiovascular & respiratory medicine
8. Haematology
9. Psychiatry
10. Clinical immunology & infectious diseases
11. Medical research in diagnosis & treatment
12. Psychology
13. Clinical psychology & psychiatry
14. Medical research in general
15. Radiology, nuclear medicine & imaging
16. Dentistry, oral surgery & dental medicine
17. Medical research in organs & systems
18. Rehabilitation
19. Dermatology
20. Neurology
21. Reproductive medicine
22. Endocrine & metabolic disorders, nutrition
23. Oncology
24. Rheumatology
25. Endocrinology, metabolism & nutrition
26. Ophthalmology
27. Surgery
28. Food & nutrition sciences
29. Orthopedics, rehabilitation & sports medicine
30. Urology

Public health

1. Entomology & pest control
2. Science & healthcare services
3. Environmental medicine & public health
4. Public health & healthcare services

The following disciplines were classified as other knowledge areas:

1. Management
2. Law
3. Agriculture & agronomy
4. Economics
5. History
6. Environment & ecology
7. Education
8. Instrumentation & measurement
9. Anthropology
10. Materials science & engineering
11. Artificial intelligence & robotics
12. Archaeology
13. Mechanical engineering
14. Language & linguistics
15. Art & architecture
16. Mining, geological & petroleum engineering
17. Literature
18. Performing arts
19. Nuclear engineering
20. Mathematics
21. Biology
22. Electrical & electronic engineering
23. Veterinary medicine & animal health
24. Experimental biology
25. General & production engineering
26. Metallurgy
27. Agrarian & plant sciences
28. Aeronautical & aerospace engineering
29. Multidisciplinary
30. Library & information sciences
31. Environmental engineering & energy
32. Optics & acoustics
33. Computer science & engineering
34. Civil engineering
35. Physical chemistry & chemical physics
36. Space sciences
37. Mathematical engineering
38. Chemistry
39. Polymer science & organic chemistry
40. Chemical engineering
41. Chemical analysis
42. Veterinary & animal sciences
43. Spectroscopy, instrument engineering, analytical science
44. Agricultural chemistry

45. Political science & public administration
46. Environmental studies, geography, development
47. Inorganic & nuclear chemistry
48. Aquatic sciences
49. Classical studies
50. Religion & theology
51. Biological, animal & plant sciences
52. Philosophy
53. Social service & social policy
54. Earth sciences
55. Physics
56. Sociology & social sciences
57. Communication
58. Applied physics, condensed matter physics, materials science
59. Information & communications technology

Regions were recognized by manual checking of 43,143 addresses found in the ISI database. São Paulo State was separated from the Southeast region, leaving only Rio de Janeiro, Minas Gerais and Espírito Santo. Continents were recognized by manual checking of 185 countries.

Indicators of human resource potential were calculated as follows. A sample was taken of academic staff accredited to teach post-graduate programs in collective health and medicine I, II and III, as classified by CAPES for knowledge areas in health sciences. For every program with at least 20 teachers, a random sample was taken of one in every five teachers, or all in the case of programs with fewer than 20 teachers. The sample comprised 3,784 out of 5,131 teachers identified for these areas. The Hirsch index (h) was found for each individual in the ISI Web of Science. The data collection process took three months, during which it was assumed that the information concerned did not change. The dataset was aggregated by knowledge area and region of Brazil. An exponential probability density function was calculated for each knowledge area and region, as follows: $f(h) = l \cdot \exp(-l \cdot h)$. Least squares fitting was performed using SPSS statistical software.

The literature on each technological topic was searched via PubMed, maintained by the U.S. National Library of Medicine at the National Institutes of Health (<http://www.ncbi.nlm.nih.gov/pubmed/>), using a range of different search terms for each item. The dataset collected was then manually reviewed to identify the collection of articles or papers pertinent to the topic in question. Information on the use of technological topics was obtained via the internet from DataSUS, the Health Informatics Department of the Brazilian Ministry of Health, or by direct contact from the ministry's Medication Logistics Control System (SICLOM). The data were entered into Microsoft Excel spreadsheets, which were used to calculate the indicators.

FAPESP's annual reports

Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) publishes annual reports on its activities on its website (<http://www.fapesp.br/materia/3808>), chiefly with the aim of informing taxpayers in São Paulo State on the uses made of its funding, which by law corresponds to 1% of the state's tax receipts.

From the administrative standpoint, FAPESP's support for research is structured into three lines of funding: Regular Programs, which meet spontaneous demand from researchers, constituting the most longstanding channel for research development; Special Programs, designed to induce research in core areas and fill gaps in the São Paulo State S&T system; and Technological Innovation Research Programs, which support research with the potential to develop new technology or contribute to public policy formulation (FAPESP, 2008a). The full list of FAPESP's programs is set out below.

Scholarships

Brazil

Scientific and/or technological initiation

Master's

Doctorate

Direct doctorate

Post-doctorate

Abroad

Research

New frontiers

Regular Research Grants

Regular research grants

Thematic projects

Visiting fellows

Organization of S&T meetings

Participation in S&T meetings

Scientific publications

Equipment repair

Special Programs

Support for young researchers

Inter-Institutional Cooperation to Support Brain Research (CInAPCe)

Public education

Technical training

Scientific journalism (MídiaCiência)

Research infrastructure program

São Paulo Academic Network (Rede ANSP)

FAP - Books

Multiuser equipment program

Technical reserve for institutional research infrastructure

Technical reserve for connectivity to ANSP Network

FAPESP-CNPq agreements

Junior science initiation program

First project program

Pronex thematic projects (centers of excellence)

National S&T institutions, by agreement with the Brazilian Ministry of Science & Technology (MCT)

Technological Innovation Research Programs

BIOTA-FAPESP

FAPESP Bioenergy Research Program (BIOEN)

FAPESP Research Program on Global Climate Change

Research, Innovation & Dissemination Centers (CEPID)

Information Technology for Advanced Internet Development (TIDIA)

Genome

Public Policy Research (PP)

Public Policy Research for the Unified Health System (PP-SUS)

São Paulo State Integrated Hydrometeorology System (SIHESP)

Science Center Research – Fundação Vitae

Technological Innovation in Small Business (PIPE)

Business Research Support (PIPE Phase 3: PAPPE/FINEP)

Partnership for Technological Innovation (PITE)

Partnership for Technological Innovation Program/Unified Health System (PITE-SUS)

Sectoral Consortia for Technological Innovation (ConSITec)

Intellectual property support

The CEPID program supports the following Research, Innovation & Dissemination Centers (those most closely related to health are in italics):

- *Center for Applied Toxinology*. Linked to Instituto Butantan, conducts research on animal and microbial toxins and their use in drug development.
- *Center for Structural Molecular Biotechnology*. Based at the São Carlos campus of the University of São Paulo (USP), conducts research in protein engineering for drug development. This center is staffed by researchers from the Protein Crystallography and Molecular Biophysics Laboratories at USP's Institute of Physics, the Department of Chemistry and the Synthesis & Natural Product Laboratory at the Federal University of

São Carlos (UFSCar), and the Center for Structural Biology at the National Synchrotron Light Laboratory (LNLS) in Campinas, attached to MCT.

- *Multidisciplinary Center for the Development of Ceramic Materials*. Based at UFSCar and staffed by researchers from UFSCar, Unesp, USP (São Carlos campus), the Brazilian Physics Research Center (CBPF/MCT), and the Nuclear Energy Research Institute (IPEN).
- *Center for Human Genome Research*. Based at USP and staffed by researchers at USP's Bioscience Institute; conducts research on genetic disorders and treatment options.
- *Center for Metropolitan Studies*. Based at CEBRAP and staffed by researchers at USP's School of Architecture and CEBRAP.
- *Center for the Study of Violence*. Based at USP, an offshoot of Núcleo de Estudos da Violência (NEPO).
- *Antonio Prudente Center for Cancer Research & Treatment*. Based at and staffed by researchers at Hospital do Câncer A.C. Camargo, Brazil's foremost cancer hospital.
- *Center for Cell-Based Therapy*. Based at USP's Ribeirão Preto School of Medicine, with researchers from the Blood Center, the University Hospital Bone Marrow Transplant Unit and Protein Chemistry.
- *Center for Research in Optics & Photonics*. Based at Unicamp and staffed by researchers from the Physics Institute; conducts research on optical communications.
- *Center for Research in Optics & Photonics*. Based at USP's São Carlos campus and staffed by researchers from the Physics Institute; conducts research on spectroscopy of atoms and solids and biophotonics.
- *Center for Sleep Research*. Based at the Federal University of São Paulo (UNIFESP), conducts research on sleep-related disorders.

Description of IPC Class A61 (Medical or Veterinary Science; Hygiene) and its subclasses

The International Patent Classification (IPC) classifies health-related activities in Section A – Human Necessities, and more specifically in Class A61 – Medical or Veterinary Science: Hygiene, which has the following 13 subclasses:

A61B – Diagnosis; Surgery; Identification
This subclass covers instruments, implements, and

processes for diagnostic, surgical and person-identification purposes, including obstetrics, instruments for cutting corns, vaccination instruments, finger-printing, psycho-physical tests.

A61C – Dentistry; Oral or Dental Hygiene – appliances, equipment, methods.

A61D – Veterinary Instruments, Implements, Tools or Methods

This subclass covers only instruments, implements, tools, or methods specially adapted for use with animals and is therefore not covered by the analysis of patenting in Chapter 11.

A61F – Filters implantable into blood vessels; prostheses; devices providing patency to, or preventing collapsing of, tubular structures of the body, e.g. stents; orthopedic, nursing or contraceptive devices; fomentation; treatment or protection of eyes or ears; bandages, dressings or absorbent pads; first-aid kits.

A61G – Transport, personal conveyances or accommodation specially adapted for patients or disabled persons; operating tables or chairs; chairs for dentistry; funeral devices.

A61H – Physical therapy apparatus, e.g. devices for locating or stimulating reflex points in the body; artificial respiration; massage; bathing devices for special therapeutic or hygienic purposes or specific parts of the body.

In this subclass, the following expression is used with the meaning indicated: “Physical therapy” or “physiotherapy” covers the treatment of disease or disability by various means, e.g. mechanical means, as opposed to drugs or surgery. It includes, by way of example, massage, whirlpool baths and devices for exercising a passive body member.

A61J – Containers specially adapted for medical or pharmaceutical purposes; devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms; devices for administering food or medicines orally; baby comforters; devices for receiving spittle.

A61K – Preparations for Medical, Dental or Toilet Purposes.

This subclass covers the following subject matter, whether set forth as a composition (mixture), process of preparing the composition or process of treating using the composition:

- a) Drugs or other biological compositions capable of:
 - preventing, alleviating, treating or curing abnor-

mal or pathological conditions of the living body by such means as destroying a parasitic organism, or limiting the effect of the disease or abnormality by chemically altering the physiology of the host or parasite (biocides A01N 25/00-A01N 65/00);

- maintaining, increasing, decreasing, limiting, or destroying a physiological body function, e.g. vitamin compositions, sex sterilants, fertility inhibitors, growth promoters, or the like (sex sterilants for invertebrates, e.g. insects, A01N: plant growth regulators A01N 25/00-A01N 65/00); [1,7]
- diagnosing a physiological condition or state by an in vivo test, e.g. X-ray contrast or skin patch test compositions (measuring or testing processes involving enzymes or micro-organisms C12Q; in vitro testing of biological material, e.g. blood, urine, G01N, e.g. G01N 33/48);

b) Body treating compositions generally intended for deodorizing, protecting, adorning or grooming a body, e.g. cosmetics, dentifrices, tooth filling materials.

A61L – Methods or apparatus for sterilizing materials or objects in general; disinfection, sterilization, or deodorization of air; chemical aspects of bandages, dressings, absorbent pads, or surgical articles; materials for bandages, dressings, absorbent pads, or surgical articles.

Inventions relating to processes using enzymes or micro-organisms in order to liberate, separate or purify a pre-existing compound or composition, or to treat textiles or clean solid surfaces of materials.

A61M – Devices for introducing media into, or onto, the body; devices for transducing body media or for taking media from the body; devices for producing or ending sleep or stupor.

This subclass covers suction, pumping or atomising devices for medical use (e.g. cups, breast relievers, irrigators, sprays, powder insufflators, atomisers, inhalers), apparatus for general or local anaesthetics, devices or methods for causing a change in the state of consciousness, catheters, dilators, apparatus for introducing medicines into the body other than orally. In this subclass, group A61M 36/00, which relates to the application of radioactive material to the body, takes precedence over other groups.

A61N – Electrotherapy; Magnetotherapy; Radiation Therapy; Ultrasound Therapy.

In this subclass, the following term is used with the meaning indicated: “Therapy” implies that the treatment, when it aims at destroying sick or abnormal cells, is performed within the limits of healthy cell life, the destruction thereof being undesired, contrary

to that which takes place with instruments, devices or methods covered by group A61B 18/00.

A61P – Therapeutic Activity of Chemical Compounds or Medicinal Preparations.

This subclass covers therapeutic activity of chemical compounds or medicinal preparations already classified as such in subclasses A61K or C12N, or in classes C01, C07 or C08. In this subclass, the term “drugs” includes chemical compounds or compositions with therapeutic activity.

A61Q – Specific Use of Cosmetics or Similar Toilet Preparations for Personal Hygiene.

This subclass covers the use of cosmetics or similar toilet preparations already classified as such in main group A61K 8/00, in subclasses C11D or C12N, or in classes C01, C07 or C08. This subclass is not covered by the analysis of patenting in Chapter 11.

Source: INPI (<http://pesquisa.inpi.gov.br/ipc/index.php>).

Description of selected knowledge areas according to CAPES

According to the CAPES website, knowledge areas are classified in an eminently practical manner so as to enable S&T agencies to aggregate information quickly and functionally. Above all, the classification is designed to enable information on S&T development to be systematized, especially with regard to research projects and human resources. The following areas were selected for Chapter 11: medicine I, medicine II, medicine III and collective health.

Medicine I encompasses clinical medicine, angiology, dermatology, cancerology, endocrinology, cardiology, gastroenterology, pulmonology, nephrology, physical medicine & rehabilitation, and legal medicine & deontology.

Medicine II encompasses allergy and clinical immunology, haematology, neurology, pediatrics, infectious & parasitic diseases, rheumatology, mother & child health, psychiatry, anatomical & clinical pathology, radiology, nutrition, nutritional biochemistry, dietetics, population nutrition analysis, malnutrition & physiological development.

Medicine III encompasses gynaecology & obstetrics, ophthalmology, orthopedics, surgery, plastic & reconstructive surgery, ear, nose & throat surgery, eye

surgery, cardiovascular surgery, thoracic surgery, gastroenterological surgery, pediatric surgery, neurosurgery, urological surgery, colorectal surgery, orthopedic surgery, trauma surgery, anaesthesiology, and experimental surgery.

Collective health encompasses epidemiology, public health, and preventive medicine.

Source: CAPES (http://www.capes.gov.br/images/stories/download/avaliacao/TabelaAreasConhecimento_042009.pdf).