Data Resource Profile

Data Resource Profile: Results Analysis Base of Navarre (BARDENA)

†These authors contributed equally to this work.

**Key features**

* The Results Analysis Base of Navarre (BARDENA) is a population database of the Navarre Health Department (Spain)
* BARDENA includes individual-level data of approximately 97% of the Navarre population, totaling more than 660,000 people
* BARDENA integrates all the health information generated at any level of care, including administrative, socio-demographic, economic, lifestyle, diagnostic, medical and pharmaceutical data.
* BARDENA is a useful tool for improving quality of healthcare, decision-making and for research purposes.
* BARDENA interoperates with national and international databases, and has been used in multiple research projects and studies

**1 Data resource basics**

*1.1 Spanish National Health System*

Spain has a decentralised health system with national coordination [1]. While national planning and regulation remain the responsibility of the Ministry of Health, competences and primary jurisdiction over operational planning at the regional level, resource allocation, purchasing and provision are devolved to the 17 regional health authorities [1]. Therefore, the National Health System is the network of the 17 publicly funded regional health services, which is coordinated through the Spanish Ministry of Health and the regions.The regional health services are responsible for providing health care and access to health facilities to their population of influence. They include two levels of care (hospital and specialized outpatient care, and primary care). Regional health services are organized into Healthcare Departments, which correspond to hospitals influence areas. Healthcare Departments in turn include different Primary Healthcare Districts (among 5000–25000 people attented by each primary care centre).

The National Health System is publicly funded, mainly from taxes, and provides universal coverage to the population resident in Spain [1]. It provided needs-based care free of charge. However, medicines and medical devices (including orthoprosthetic devices such as wheelchairs, hearing aids and similar) are subject to a co-payment [1], which is established on the basis of the economic income and employment status of each individual.

*1.2 The Spanish region of Navarre*

Navarre is a region in the north of Spain with more than 660,000 inhabitants, representing a 1.4% of the Spanish population, and approximately 1.5 per thousand of the European population. The mean age of the Navarre population is 43,8 years, slightly lower than the overall mean age in Spanish (44,1 years). The age distribution in Navarre is the following: ≤19 years 20%; 20-39 years: 22%; 40-59 years: 31%; 60-79 years: 20%; and ≥80 years: 6%. The annual birth rate is around 7 per 1000 inhabitants (4765 births in 2022)[2].

Health care for the population of Navarre is provided through the publicly financed Navarre health service (NHS), which includes three Healthcare Departments and 56 Primary Healthcare Districts. The organization of the NHS is represented in Figure 1.

*1.3 The Results Analysis Base of Navarre (BARDENA)*

Each regional health system holds the health information of its reference population, and therefore develops and operates its own information system. The health information system in Navarre is the Results Analysis Base of Navarre (BARDENA).

BARDENA is a publicly funded database property of the Department of Health of the Government of Navarre, which is based in Pamplona (Navarre). It is managed by Administrators belonging to the Navarre health service, who are responsible for its operation, and for the validity and quality of the information. It was created in 2016 in order to audit processes, evaluate health results, generate reports for the different health decision-makers, and to promote health research.

BARDENA includes all the health information generated by the Navarre health service (NHS) for the population of the region, regardless of the area or setting from which the care has been provided. At this moment, BARDENA includes health records of more than 600,000 people, approximately 97% of the Navarre population. It covers information from Primary and Specialized Care (in and outpatient) as well as Emergencies, including visits, diagnostics and treatments, procedures, vaccines, Drug prescriptions and Laboratory among others. Data is anonymized and quality reviewed prior to final storage.

The database is continuously monitored and updated. It includes exhaustive longitudinal patient level information. It integrates all the information generated on a continuous basis, from each person´s first contact with the system (usually from birth) to the death, if this occurs, and without any time limit. It therefore provides a wide follow-up of the population, which will increase over time.

**2. Data collected**

BARDENA is supplied from different data sources, which together constitute BARDENA Core. BARDENA Core is the backbone where the different data sources are stored in the backend and then linked all together in a star schema design (Fig. 1). It is made up of main five dimensions tables common for all the facts tables: patient (The main data of all the person that has been treated by the NHS or lived in Navarre), location (Geolocation of patients and the care sites), diagnosis (The main International Classification of diseases and procedures), unity (Which Health care sites and providers has been involved), and professional (The main characteristics of the Health Workers).

BARDENA Suite includes and the Analytic Countability Component (ACC) with all the cost.

2.1 *Data included in BARDENA*

BARDENA incorporates the following type of information: administrative data, socio-demographic data, economic data, lifestyle data, clinical data, pharmaceutical data, healthcare though hospitals, emergency services, specialized care centers (including mental and obstetrics care, among others), primary care centers, and other services provided by the Navarre health service. Table 1 summarizes data available in BARDENA.

**Table 1.** Data included in BARDENA

|  |  |
| --- | --- |
| **Data category** | **Data available** |
| Administrative data | Health coverage, date of birth, date of the first contact with the Navarre health service, date of death, referring physician |
| Socio-demographic data | Age, gender, Country of birth, nationality, employment status, risk of social exclusion, address |
| Economic data | Pharmaceutical co-payment according to income level  Unit cost of all interventions carried out in the Navarre health service |
| Lifestyle data | Smoking, alcohol intake |
| Diagnostic procedures | Analytical, biochemical, micriobiológical, anatomophatological, radiological results |
| Medical diagnoses | Medical diagnoses registered at any level of care |
| Preventive procedures | Vaccination (type of vaccine, manufacturer, batch number, number of doses, administration date and location, adverse reactions related to vaccines, rejected vaccinations and, if applicable, risk groups). |
| Medical interventions | Surgical and non-surgical medical procedures |
| Nursing interventions | Vital signs, weight, height, body mass index |
| Social assistance | Interventions of social workers |
| Pharmaceutical data | Drug prescription (date of prescription, treatment duration, drug prescribed, dose, prescriber, etc.) both in the inpatient and in the outpatient setting  Drug dispensing to outpatients (number of packages dispensed, date of dispensation, etc.) |
| Contact with health services | Contact with hospitals, emergency services, specialized care centers (including mental and obstetrics care, among others), primary care centers, and other services provided by the Navarre health service  Both visits and admissions (including the date of admission and discharge) are registered |

2.2 *Sources of data*

The different sources of information from which BARDENA draws are shown in figure 2 and described below.

The Population Information System (LAKORA) is the module that provides administrative, socio-demographic, and economic data. LAKORA is the source of the exclusive and permanent pseudonymized identifier associated to each individual. This identifier is shared between the different sources of information that supply BARDENA It allows data linkage across the multiple databases, and ensures the traceability of the individuals in the Navarre Health service.

The module of primary care information (ATENEA) was implemented in 2003 and includes the electronic medical records of primary care, reaching 95% coverage in 2008. ATENEA includes information on both paediatric and adult primary care, as well as any related social assistance and nursing care. Diagnoses are coded in ATENEA vía the 2nd Edition of the International Classification of Primary Care (ICPC-2) [3].

The pharmaceutical data is registered in two modules: LAMIA and FARHO. LAMIA includes drugs prescriptions and dispensations in outpatients (drug prescription in primary care), and FARHO includes drugs prescription in inpatients and in ambulatory patients (drugs prescription in the hospital or other specialized care setting). Both tools use the Anatomical Therapeutic Chemical (ATC) classification system [4] and the (Spanish) National Pharmaceutical Catalogue for drug prescription, which allow the identification of the exact content of each drug prescription and dispensation. LAMIA includes a comprehensive e-prescription connected to all community pharmacies in Spain, that links each drug prescription to the corresponding dispensation from the community pharmacy through a specific prescription identification number.

The Hospital Medical Records module was created in 2001 and provides comprehensive information covering all

areas of specialized care. Includes data on hospitals admissions (both convention and home hospitalization), specialized care consultations (including mental health care and prenatal care, among others), emergencies, diagnostic procedures, medical and nursing procedures, surgeries, prevention and safety measures, and interventions by social workers in inpatients.

Information on medical diagnoses and procedures in the hospital and the specialized care setting included in the Hospital Medical Records module is obtained from the Minimum Basic Data Set at Hospital Discharge (MBDS). This is a synopsis of clinical and administrative information on all hospital admissions and major ambulatory surgery that hospitals from the national health system are mandatorily required to complete since 1987. Since then information from public partnership hospitals and private hospitals has been progressively incorporated. To date, MBDS is the largest administrative and clinical database available in the Spanish health system[5].

MBDS includes information on age, sex, geographical area and hospital, hospital admission and discharge dates, principal and secondary diagnoses at hospital discharge, diagnostic and therapeutics procedures conducted during the hospital stay, complications, in-hospital mortality, destination at discharge and readmission within 30 days. In each hospital, the MBDS database is completed by trained coding staff based on the medical discharge report and other information available in the clinical records[5]. Medical diagnoses and procedures are coded in MBDS through the International Statistical Classification of Diseases (ICD) [6]. The 9th version of the ICD (ICD-9) was used until December 2015 and the 10th version (ICD-10) was adopted thereafter.

All the data related to laboratory analyses are recorded in SILNA module. There is also a specific module that includes information of blood management (blood transfusions, donations and use of other blood-derived products like platelets, etc., .)

The Vaccine Information System (INMUNIS) module stores all the information on vaccination in Navarre since 2000. Available data includes the type of vaccine, manufacturer, batch number, number of doses, administration date and location, adverse reactions related to vaccines, rejected vaccinations and, if applicable, risk groups. Besides, COVID-19 vaccine data is included.

Each information module was created at different times and their information have been progressively integrated into BARDENA.

In addition, BARDENA also includes information from specific databases and registries, such as acute stroke or diabetes registries.

*2.3 Data integration, traceability, validation*

BARDENA Data collection started in 2012, but gathered all historical data from the existing information systems in Navarre Health Service as far as 1996 for hospitalizations and clinical diagnosis.

All the information coming from different sources and belonging to the same individual are coded with the same identifier, which is a personal pseudonymized identification code. This allows linking all the information of a individual regardless of the source of the data. In addition, it guarantees confidentiality of the information.

In all the modules that provide information to BARDENA, individual level data are collected weekly as part of the routine clinical care provided to patients. Accordingly, datasets are updated daily and hence data are generally available in BARDENA from the same day they are extracted. In the case of ¡MBDS, data are subject to a consolidation, quality check and validation processes before data are available in BARDENA, so in this case data from the last quarter before the data extraction may be missing or non-consolidated in BARDENA. In case of any inconsistency or incorrect value detected during the validation processes, they are flagged and returned to the module of origin for revision, not being transformed ine BARDENAe.

We are developing an OMOP Common Data Model v5.4, in collaboration with the EHDEN initiative to improve the use of our data in biomedical research studies with real-World clinical data.

Bardena is to host on premise servers using SQL Server 2016. It is use SQL Server Integration Service for the ETL Process to make up Bardena Data Ware House. For business Intelligent software, it is used Tableau platform and also work with R and Phyton, providing advanced functionality.

Due to Bardena compliances the OMOP Common Data Model, it is possible to other organizations analyze or consult our database, using OHDSI tools as ATLAS.

Moreover, Process Mining analysis are carry on by ProM tools framework.

2.3 *Access to BARDENA information, data visualization, and data mining*

The information stored in the BARDENA Core can be accessed by health decision-makers and researchers via Tableau server[7]. This the BARDENA diffusion product that allows producing analysis tables and visuals of the key information of the BARDENA Core.

BARDENA Milenia is the tool that BARDENA Suite could perform data mining of its data through thetool, which permits BARDENA Suite to perform data mining at the same time as the data are generated in clinical practice.

**3. Ethical clearance**

The Health Department of the Gobernment of Navarre ensures the pseudonymization of the data extracted from BARDENA by providing to the recipients (health decision-makers or researchers) de-identified datasets, unless informed consent are obtained from patients allowing the access their data. In addition, ethical approval by an accredited ethical research committee is required when data from BARDENA are used for research purposes.

4. **Data resource use**

*4.1 Experience with the use of BARDENA in research projects and studies*

Information in BARDENA has been used as a basis for multiple research projects and studies on various clinical and epidemiological issues, both nationally and internationally. Table 2 includes mention of these studies.

**Table 2.** Studies conducted with information from BARDENA

|  |  |  |
| --- | --- | --- |
| **Thematic area** | **Specific topic** | **Reference** |
| Infectious diseases | COVID-19 | [8–16] |
| Mental health | Incidence of Attention Deficit Hyperactivity Disorder (ADHD) | [17] |
| Cardiovascular diseases | Diabetes | [18–23] |
| Cancer | Breast cancer | [24] |
| Chronic conditions |  | [25] |
| Obesity |  | [26] |
| Safety | Adverse events during hospitalization | [27] |

BARDENA also contributes to Spanish national networks, such as the Atlases of Medical Practice Variation in the National Health Service[28–34].

4.2 *BARDENA interoperability with national and international databases*

At this moment BARDENA information on the hospital setting is integrated with that of other regions in the MBDS, which is piloted at national level[5]. Also, BARDENA information is integrated in the Spanish database for pharmacoepidemiological research in the public sector, managed by the Spanish Agency for Drugs and Medical Devices. This database was created in 2001 and at this moment includes more than 20 million medical records[35, 36].

Moreover, at this moment BARDENA is in the process of being integrated into the European European Health Data & Evidence Network (EHDEN), a European network of data sources [37]. For this purpose, standardization of the information following the Observational Medical Outcomes Partnership (OMOP) Common Data Model (CM) is being carried out [38]. Work is also underway to integrate information from BARDENA into the Spanish Data lake that will be created soon[39].

**5. Strengths and weaknesses**

BARDENA has several strengths and some differential features with regard to other information resources. First, it links population-wide individual healthcare data including administrative, sociodemographic and clinical information. This allows the study of the impact social determinants of health (including age, sex, ethnicity, income level) in access and use of health resources and in clinical outcomes at an individual level in the Navarre population.

Second, BARDENA includes information from almost all the Navarre population, being therefore representative. This makes it possible to carry out observational studies in specific subpopulations excluded from clinical trials, such as the people from ethnic minorities, elderly, people with multiple chronic diseases[25], polymedicated people, people with cancer[19, 24], paediatric population, and pregnant women, among others, with a high precision.

Third, information is BARDENA is constantly updated, which means that information is available in almost real time. This facilitates decision-making in situations that require an agile response, such as in COVID-19 pandemic, and also makes it possible to make forecasts about the material and human resources that will be needed in a near future.

Forth, BARDENA allows the construction and follow-up of large cohorts of patients over time and the development of longitudinal studies, enabling monitoring of health outcomes in the long-term.

Fifth, data quality in most of the information modules is distinctively high, such as in LAKORA, MBDS or the vaccines registry, providing insight into a population of more than 660,000 inhabitants. Sixth, the availability of unit cost data per patient and activity allows economic evaluation studies with high specificity and granularity.

Seventh, as a source of population health records, it can contribute to pragmatic studies by providing a sample of patients undergoing routine practice This reduces the cost and the timing of access to the data compared to studies with experimental designs, such clinical trials.

Eighth, BARDENA is a ultimate tool for pharmacoepidemiology, since it integrates linked information on clinical conditions, drug prescriptions and dispensation at the individual level. This can be used for conducting accurate drug utilization and adherence studies.

Ninth, BARDENA Core can interact with other integrated tools and information systems besides health, such as education, open government and transparency, and social information systems.

Tenth, the information stored in the BARDENA Core can be easily visualized by health decision-makers and researchers via the Tableau server, which provides statistics of aggregated data, tables and figures.

Eleventh, BARDENA allow data mining, which can be used for discovering clinical processes that allow the application of improved protocols, checking the performance of current processes, detecting and removing bottlenecks, accelerating clinical processes, and simulating how the introduction of changes in the processes affect the system.

Twelfth, BARDENA interoperates with national and European databases, promoting the development of knowledge and population research at a macro level. Finally, the verification and quality processes to which BARDENA is subjected, guarantee the validity of the information. In the regard, a high effort is being made to integrate and audit information, resulting in a high quality data that strengthens data exploitation capabilities.

BARDENA has also some limitations. Some of the information modules that comprise BARDENA Core are subject to the inherent limitations of the routine clinical practice electronic databases. In some specific processes, there may be an information bias due to absent registration (data incompleteness), delay in the registration in the database (e.g. in cases of acute stroke or cardiorespiratory arrest) or due to differing data recording practices (data inaaccuracies, misclassification, and heterogeneity), although this is an intrinsic problem of any repository using data from routine clinical practice. In addition, different information modules were created at different moments, and therefore cover different time periods. Moreover, there is lack data on specific mortality causes and on drug prescriptions in patients from private nursing-homes However, pharmacologic information from private nursing-homes is being progressively integrated and is expected to be completely integrated in BARDENA in the forthcoming years. Finally, BARDENA does not include information on people who do not receive assistance from the Navarre Health Service, that is, who are attended exclusively through private centers. However, this is an inusual situation in Navarre, estimated at approximately 3% of the population.

**6. Data resource access**

BARDENA is owned by the Health Department of the Government of Navarre, and operated by managers from the Navarre Health Service. BARDENA information can be used for improving quality of healthcare, decision making and for research purposes. Data are currently available for health decision-makers and researchers (internal and external to the Navarre Health Service). Industry funded studies are not accepted. Access to data is free of charge.

In the research filed, access to BARDENA information requires a formal application to access to BARDENA information accompanied by: (i) a complete study protocol that details the planned purpose of the use of data, (ii) the approval of the project by an accredited ethics committee, iii) informed consent of patients or a waiver granted by an ethics committee, and (iii) in some cases the classification of the study by the Spanish Agency of Medicines and Medical Devices.

BARDENA has a committee (BARDENA Data committee) that revise the applications, approves or refuses access BARDENA information, and establishes priorities. The applications to access to BARDENA information under these requirements should be submitted electronically to the Management Office of the BARDENA Data Commission ([salsedrs@navarra.es](mailto:salsedrs@navarra.es)). Following authorization, researchers must sign a document in which they commit to keep the data in a secure environment, not attempt to re-identify patients or to cross data with other databases, not using the data for purposes or projects other than those specified in the project protocol (including commercial purposes) (although a new application may be presented for these purposes), and not transferring the data to third parties. These latter commitments limit the possibility of storing data in open data repositories or including individual level data as supplementary material in published articles.

**7. Ethical approval**

Not applicable

**8. Author contributions**

**9. Supplementary data**

Not applicable

**10. Funding**

Not applicable

**11. Acknowledgements**

**12. Conflicts of interest**

**13. References**

1. OECD/European Observatory on Health Systems and Policies (2021), Spain: Country Health Profile 2021, State of Health in the EU, OECD Publishing, Paris/European Observatory on Health Systems and Policies, Brussels.

2. Instituto Nacional de Estadística. https://www.ine.es/

3. International Classification of Primary Care, 2nd edition (ICPC-2). https://www.who.int/standards/classifications/other-classifications/international-classification-of-primary-care

4. Anatomical Therapeutic Chemical (ATC) Classification. https://www.who.int/tools/atc-ddd-toolkit/atc-classification

5. de Miguel Díez J, López de Andrés A, Jiménez García R (2020) The Minimum Basic Data Set (MBDS), Our Big Data for the Epidemiological Investigation of Respiratory Diseases. Arch Bronconeumol 56:267–268. https://doi.org/10.1016/j.arbres.2019.04.009

6. International Statistical Classification of Diseases and Related Health Problems (ICD)

7. Tableau server

8. Fresán U, Guevara M, Elía F, et al (2021) Independent Role of Severe Obesity as a Risk Factor for COVID-19 Hospitalization: A Spanish Population-Based Cohort Study. Obesity 29:29–37. https://doi.org/10.1002/oby.23029

9. Martínez-Baz I, Miqueleiz A, Casado I, et al (2021) Effectiveness of COVID-19 vaccines in preventing SARS-CoV-2 infection and hospitalisation, Navarre, Spain, January to April 2021. Eurosurveillance 26:1–7. https://doi.org/10.2807/1560-7917.ES.2021.26.21.2100438

10. Kissling E, Hooiveld M, Sandonis Martín V, et al (2021) Vaccine effectiveness against symptomatic SARS-CoV-2 infection in adults aged 65 years and older in primary care: I-MOVE-COVID-19 project, Europe, December 2020 to May 2021. Euro Surveill 26:1–7. https://doi.org/10.2807/1560-7917.ES.2021.26.29.2100670

11. Martínez-Baz I, Trobajo-Sanmartín C, Miqueleiz A, et al (2021) Product-specific COVID-19 vaccine effectiveness against secondary infection in close contacts, Navarre, Spain, April to August 2021. Eurosurveillance 26:1–7. https://doi.org/10.2807/1560-7917.ES.2021.26.39.2100894

12. Enguita-Germán M, Librero J, Leache L, et al (2022) Role of the AB0 blood group in COVID-19 infection and complications: A population-based study. Transfus Apher Sci 103357. https://doi.org/10.1016/j.transci.2022.103357

13. Kissling E, Hooiveld M, Martinez-Baz I, et al (2022) Effectiveness of complete primary vaccination against COVID-19 at primary care and community level during predominant Delta circulation in Europe: multicentre analysis, I-MOVE-COVID-19 and ECDC networks, July to August 2021. Eurosurveillance 27:. https://doi.org/10.2807/1560-7917.ES.2022.27.21.2101104

14. Leache L, Gutiérrez-Valencia M, Enguita-Germán M, et al (2022) COVID-19 infection and complications according to ABO blood group in the elderly: A population-based subcohort and meta-analysis. Vox Sang 117:1230–1234. https://doi.org/10.1111/vox.13334

15. Fresán U, Guevara M, Trobajo-Sanmartín C, et al (2021) Hypertension and related comorbidities as potential risk factors for covid-19 hospitalization and severity: A prospective population-based cohort study. J Clin Med 10:1–12. https://doi.org/10.3390/jcm10061194

16. Castilla J, Guevara M, Miqueleiz A, et al (2021) Risk factors of infection, hospitalization and death from SARS-CoV-2: A population-based cohort study. J Clin Med 10:1–13. https://doi.org/10.3390/jcm10122608

17. Leache L, Arrizibita O, Gutiérrez‐valencia M, et al (2021) Incidence of attention deficit hyperactivity disorder (ADHD) diagnoses in navarre (Spain) from 2003 to 2019. Int J Environ Res Public Health 18:. https://doi.org/10.3390/ijerph18179208

18. Martínez-Velilla N, Valenzuela PL, Sáez De Asteasu ML, et al (2021) Effects of a Tailored Exercise Intervention in Acutely Hospitalized Oldest Old Diabetic Adults: An Ancillary Analysis. J Clin Endocrinol Metab 106:E899–E906. https://doi.org/10.1210/clinem/dgaa809

19. Jansana A, Domingo L, Ibañez B, et al (2022) Use of health services among long-term breast cancer survivors in Spain: longitudinal study based on real-world data. J Cancer Surviv 16:132–141. https://doi.org/10.1007/s11764-021-01011-z

20. Tamayo I, Librero-Lopez J, Galbete A, et al (2023) Cohort Profile: CArdiovascular Risk in patients with DIAbetes in NAvarra (CARDIANA cohort). BMJ Open 13:e066052. https://doi.org/10.1136/bmjopen-2022-066052

21. Enguita-Germán M, Tamayo I, Galbete A, et al (2021) Effect of physical activity on cardiovascular event risk in a population-based cohort of patients with type 2 diabetes. Int J Environ Res Public Health 18:. https://doi.org/10.3390/ijerph182312370

22. Galbete A, Cambra K, Forga L, et al (2019) Achievement of cardiovascular risk factor targets according to sex and previous history of cardiovascular disease in type 2 diabetes: A population-based study. J Diabetes Complications 33:. https://doi.org/10.1016/j.jdiacomp.2019.107445

23. Ibáñez B, Galbete A, Goñi MJ, et al (2018) Socioeconomic inequalities in cardiometabolic control in patients with type 2 diabetes. BMC Public Health 18:1–9. https://doi.org/10.1186/s12889-018-5269-0

24. Jansana A, Del Cura I, Prados-Torres A, et al (2020) Use of real-world data to study health services utilisation and comorbidities in long-term breast cancer survivors (the SURBCAN study): Study protocol for a longitudinal population-based cohort study. BMJ Open 10:. https://doi.org/10.1136/bmjopen-2020-040253

25. Bretos-Azcona PE, Ibarrola Guillén C, Sánchez-Iriso E, et al (2022) Multisystem chronic illness prognostication in non-oncologic integrated care. BMJ Support Palliat Care 12:E112–E119. https://doi.org/10.1136/bmjspcare-2019-002055

26. Sayon-Orea C, Moreno-Iribas C, Delfrade J, et al (2020) Inverse-probability weighting and multiple imputation for evaluating selection bias in the estimation of childhood obesity prevalence using data from electronic health records. BMC Med Inform Decis Mak 20:1–10. https://doi.org/10.1186/s12911-020-1020-8

27. Mira JJ, Martin-Delgado J, Aibar C, et al (2020) Bed 13 is not worse than any other. A retrospective cohort study. J Healthc Qual Res 35:79–85. https://doi.org/10.1016/j.jhqr.2019.11.002

28. Librero J, Ibañez B, Martínez-Lizaga N, et al (2017) Applying spatio-temporal models to assess variations across health care areas and regions: Lessons from the decentralized Spanish National Health System. PLoS One 12:1–12. https://doi.org/10.1371/journal.pone.0170480

29. Librero J, Ibañez-Beroiz B, Peiró S, et al (2016) Trends and area variations in Potentially Preventable Admissions for COPD in Spain (2002-2013): A significant decline and convergence between areas. BMC Health Serv Res 16:1–10. https://doi.org/10.1186/s12913-016-1624-y

30. Ibañez-Beroiz B, Librero J, Bernal-Delgado E, et al (2014) Joint spatial modeling to identify shared patterns among chronic related potentially preventable hospitalizations. BMC Med Res Methodol 14:1–9. https://doi.org/10.1186/1471-2288-14-74

31. Bernal-Delgado E, García-Armesto S, Peiró S (2014) Atlas of Variations in Medical Practice in Spain: The Spanish National Health Service under scrutiny. Health Policy (New York) 114:15–30. https://doi.org/10.1016/j.healthpol.2013.07.013

32. Angulo-Pueyo E, Comendeiro-Maaløe M, et al (2022) Atlas VPM: two decades informing on unwarranted variations in health care in Spain. Res Heal Serv Reg 1:1–10. https://doi.org/10.1007/s43999-022-00005-3

33. Castaño-Riera E, Ridao M, Librero J, et al (2022) Revisiting systematic geographical variations in tonsils surgery in children in the Spanish National Health System: Spatiotemporal ecological study on hospital administrative data. BMJ Open 12:. https://doi.org/10.1136/bmjopen-2022-064009

34. Jesús Quintana M, Gich I, Librero J, et al (2019) Variation in the choice of elective surgical procedure for abdominal aortic aneurysm in spain. Vasc Health Risk Manag 15:69–79. https://doi.org/10.2147/VHRM.S191451

35. bifap

36. Maciá-Martínez MA, Gil M, Huerta C, et al (2020) Base de Datos para la Investigación Farmacoepidemiológica en Atención Primaria (BIFAP): A data resource for pharmacoepidemiology in Spain. Pharmacoepidemiol Drug Saf 29:1236–1245. https://doi.org/10.1002/pds.5006

37. European Health Data & Evidence Network (EHDEN)

38. Observational Medical Outcomes Partnership (OMOP) Common Data Model (CDM)

39. Data Lake Sanitario. Gobierno de España

He metido estas referencias, pero habría que confirmar si realmente se hicieron con BARDENA o con las bases de datos de salud pública:

Fresán, U., Guevara, M., Trobajo-Sanmartín, C., Burgui, C., Ezpeleta, C., & Castilla, J. (2021). Hypertension and related comorbidities as potential risk factors for SARS-CoV-2 (COVID-19) hospitalization and severity: a prospective population-based cohort study. Journal of clinical medicine, 10(6), 1194.  
    
Castilla, J., Guevara, M., Miqueleiz, A., Baigorria, F., Ibero-Esparza, C., Navascués, A., et al & Working Group for the Study of COVID-19 in Navarra. (2021). Risk factors of infection, hospitalization and death from SARS-CoV-2: a population-based cohort study. Journal of Clinical Medicine, 10(12), 2608.  
   
Juanbeltz, R., Pérez-García, A., Aguinaga, A., Martínez-Baz, I., Casado, I., Burgui, C., et al & EIPT-VHC Study Group. (2018). Progress in the elimination of hepatitis C virus infection: A population-based cohort study in Spain. PLoS One, 13(12), e0208554. Esta no la he metido. ¿Se hizo con BARDENA?

**Figures**

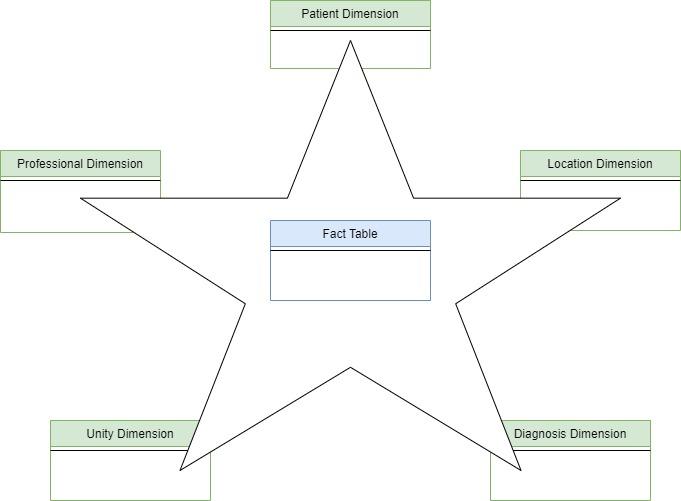


Figure 1. The star schema of BARDENA Core.

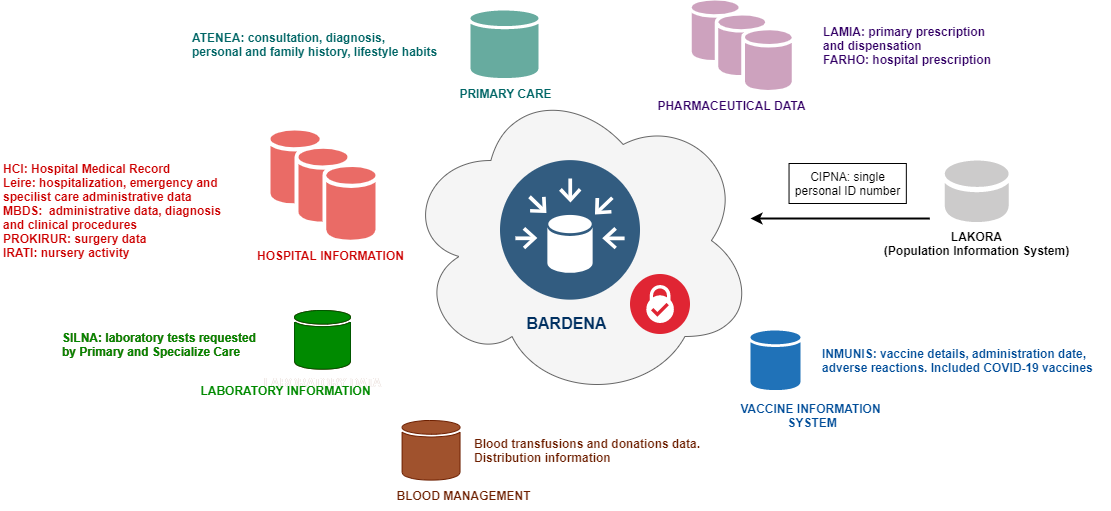


Figure 2. The BARDENA Core data sources