VARIATIONS IN PRACTICES

Methodology and elements of interpretation

Selection of themes, elements of data interpretation and analysis method of variations in medical practices

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1. INTRODUCTION

The Appropriate Care Unit was created within the Research-Development-Quality Directorate of the NIHDI's Healthcare Service as a result of the NIHDI's 2016-2018 Administration Contract[1]. In Article 35, this Contract refers to 'the setting up of an Appropriate Care Unit targeting, more specifically, an integrated approach to the rational use of resources'. The Appropriate Care Unit was set up since the second quarter 2017.

The concrete implementation of the Unit was formalised in the '2016-2017 Healthcare Monitoring Action Plan', published by the NIHDI on 18 July 2016[2]. This plan lists around thirty measures aimed at optimizing health-care efficiency by encouraging appropriate practices and by avoiding unnecessary cares.

The plan states that the tasks of the Appropriate Care Unit include analysing the 'relevance of care', with the aim of identifying unexplained variations in consumption emerging after standardisation of the Belgian population. These variations are indeed potentially a sign of non-optimal use of resources.

The reports of 'variations in medical practice' contain the analyses carried out in this context. Each report focuses on a particular topic. The purpose of this document is to set out the overall shared methodology followed in all these analyses.

[1] (National Institute for Health and Disability Insurance, 2016)
[2] (National Institute for Health and Disability Insurance, 2016)

2. CHOICE OF TOPICS

Each 'variations in medical practice' report focuses on one practice. This practice generally covers several nomenclature codes that are selected for their direct link to the practice, whether in terms of volume of intervention or expenditure.

The choice of practices selected for analysis is made according to different criteria. These criteria, which are detailed below, are (in no particular order): availability of data, coverage of specialties, existence of complementary equipment, topicality, potential benefits, existence of a professional network and obsolescence of practices.

1. Availability of data

Our Unit can only carry out analyses when the necessary databases are available. Initially, the database used is mainly the NIHDI's N Documents. The use of this data base is a restricting factor in the choice of topics. For example, these data do not allow us to assess the redundancy of a practice or the combination of techniques for one patient. Later on, we will describe how we partially compensate for this lack by combining the analysis of the NIHDI's N Documents with those of P Documents.

2. Coverage of specialties

The topics chosen for analysis cover the various fields of medicine. Our objective is that as many specialties as possible be represented through these analyses in order, on the one hand, to be sufficiently extensive and, on the other hand, to avoid any stigmatisation of one specialty in relation to another. In addition, our ambition in the long run is that each specialty should benefit from a complete overview of its practice through an exhaustive analysis of its own nomenclature.

3. Existence of complementary equipment

Our analyses are consolidated by the existence of extra analytical documentation on medical practice. This documentation may be internal (e.g. a report from the MEID[3]), national (e.g. reports from insurance funds or the KCE[4]), or international (similar analyses carried out in other countries). The existence of this material undoubtedly strengthens our analysis through the different angles of approach and the comparability of the data that it allows.

4. Topicality

We may prioritise certain topics on the basis of current concerns or specific requests from the authorities, as long as the data are available.

[3] NIHDI's Medical Evaluation and Inspection Department
[4] Belgian Healthcare Knowledge Centre

5. Potential benefits

We have identified the most prescribed codes by each medical specialty over the past year. From these codes, we were able to deduce a number of common practices within these fields. Given the frequency of these practices, our analyses will be of greater benefit for the general public, in terms of accessibility and quality of care, if unexplained variations are indeed observed.

6. Existence of a professional network

Through their informed viewpoint and through the intermediary they represent with service providers, the availability of scientific contacts linked to the practice being analysed contributes greatly to the impact that this analysis can have on the improvement of practices.

7. Obsolescence of practices

The analysis of obsolete or questionable practices is of particular interest in identifying their residual or problematic use. Such practices are identified, inter alia, by referring to national (KCE) and international recommendations such as the NICE[5] or Choosing wisely[6] recommendations.

[5] National Institute for Health and Care Excellence (https://www.nice.org.uk)
[6] http://www.choosingwisely.org

3. ANALYSIS METHODOLOGY

A. Sources of data

1. N Documents

Initially, we base our analyses mainly on the data in the NIHDI's N Documents.

The N Documents are data sent monthly, within three months, by the insurer-organisations[7] to the NIHDI. These data include the number of services, their dates and the fees. Every six months these data are compiled and supplemented by the insurance funds by adding data on patients: age, gender, social category and district of residence.

Regarding patients' age, since 2009, data on people aged 95 and over have been grouped in N Documents. For the purpose of our analysis, we have also applied this rule to data prior to 2009 in order to ensure consistency.

The data in the N Documents does not allow us to group the services provided to an individual patient. As mentioned above, this limitation does have an impact on our initial selection of topics for analysis. Indeed, using N Documents alone, we cannot validly analyse services that are likely to be repeated within a year for the same patient or bilateral treatments that are potentially duplicated due to their bilateral nature. Nor can we analyse cases where various practices are combined to treat one patient. For these cases, we must use other databases, as explained in the next point.

From 2019 onwards, the analyses take into account the expenditure on services associated with the GPS system (global payment with standardization) introduced that year. The cost of these packages, if applicable, is systematically included in the expenditure mentioned.

2. Combined data

Analysis of combined data, taken from the P, ADH and SHA Documents, usually enables us to supplement data in the N Documents with further information on the redundancy of identical or similar practices for the same patient, as well as identifying the type of care (outpatient or hospital care).

The P Documents contain data sent semi-annually and within four months by the insurer-organisations to the NIHDI. These data include the services provided by health care providers in the outpatient and hospital sectors, per provider, per prescribing doctor or per hospital establishment.

The ADH and SHA data are sent annually and within six months by the insurer-organisations to the NIHDI. They include all the services provided respectively in day admission and standard hospitalisation, in general hospitals per hospital stay.

[7] By the Healthcare Service's Actuarial and Budget Directorate.

In certain cases where bilateral services or repetition of services per patient are customary, the number of services from Documents N has been divided by their redundancy value (specific to the province in which the patient lives). Examples include cataract tests, breast imaging, dental care, etc. The titles of these tests are then completed by the word "Adjusted", and the numbers and rates of services are adjusted throughout the document (with the exception of the tables and graphs in Appendix B- Frequency of practice occurrences and C-Patient Types of care, which remain based on raw numbers).

For the so-called « adjusted » analyses, as general rule, the redundancy values per province that are used for the division are those presented in the analysis report, appendix B-Frequency of practice occurrences (cfr. Figure 16 Example of graph of practice recurrence by province and variability relative to the national value, of this document). However in certain specific cases, the redundancy values come from other analyses on a specific subgroup of nomenclature codes. The details from these analyses and the redundancy values that are applied are available on demand.

Note : For the analyses on the year 2021, the redundancy values were calculated based on the P, ADH and SHA documents of 2019, seen the impact of COVID-19 on 2020.

B. Selection of analyses and extraction of raw data

The selections concern the nomenclature codes to be analysed as well as the population of insured persons taken into account in the analysis:

Selection of codes: Each analysis covers a number of codes relating to the practice under analysis that are used either in the analysis of the volume of services provided, or expenditures, or both. The nomenclature codes used to examine the number of services and expenses are therefore not necessarily identical.

Filter used for insured population: Where appropriate, certain filters may have been applied in order to limit the number of patients considered in the analysis. The filters may be based on gender or age or other criteria (for example, the number of caesarean sections will be reported at delivery, hysterectomies for women, prostatectomies for men).

By default, the period of analysis covers the last ten years of available data. This period may be shortened if the analysis over ten-year period does not give a sufficiently uniform analysis, because the number or coverage of the codes has fluctuated during this time.

For each nomenclature code, the following variables are extracted by district, gender, age [8] and reimbursement scheme:

- The **number of insured persons** for whom we know the district (of residence), gender, age and reimbursement scheme
- The **number of services provided** to patients for whom we know the district (of residence), gender, age and reimbursement scheme (as long as this code is included in the analysis of number of services, otherwise no services are taken into account)

[8] Since 2009, data on persons aged 95 and older are grouped together in the N Documents. For the purpose of our analyses, we also applied this rule to data previous to 2009.

- **Expenditure** for patients with known district (of residence), gender, age and preferential scheme (as long as this code is included in the expenditure being analysed – otherwise, the expenditure is not taken into account)

C. Standardisation of data

The standardised analysis documents present data from 5 different standardisations. These standardisations of the number of healthcare services and expenditures are based on:

i. the age, the gender and the reimbursement scheme of the patient in order to obtain data per **domicile** (district or province or region)
ii. the age and the gender of the patient in order to obtain data per **domicile** (district or province or region) and **reimbursement scheme**
iii. the age and the reimbursement scheme of the patient in order to obtain data per **domicile** (district or province or region) and **gender**
iv. the patient's reimbursement scheme in order to obtain data on the basis of the **residence (of the insured)** (district, province or region), **age group**[9] and **gender**. Standardisation is adjusted by a factor taking into account the age share per age group and per gender.
v. the patient's reimbursement scheme to obtain data per **age group** and per **gender**. Standardisation is adjusted by a factor taking into account the age share per age group and per gender.

The standardisation consists of 3 steps, which are described in the paragraphs below:

1. Calculation of the non-standardised annual rates of use
2. Calculation of the distribution in the total population of the last year of the analysis period
3. Calculation of the standardised annual rates of use

1. Calculation of the non-standardised annual rates of use

For standardisations used to obtain data per location (patient's domicile) (standardisations i, ii, iii and iv), we calculate the annual number of healthcare services per 100,000 patients, and the expenditure per patient per location (district, province or region), broken down by gender, age and reimbursement scheme. For the standardisation where data should not be obtained on the basis of the patient's domicile (standardisation v), these values are calculated by gender, age and reimbursement scheme.

2. Calculation of the distribution in the total population

Different distributions are used for the different standardisations, and these are calculated on the basis of the total Belgian population of the last year of the analysis period, i.e. all insured persons residing in Belgium for which the district, the gender, age and reimbursement scheme are known or estimated. The calculated distributions are as follows:

[9] Since 2009, data on persons aged 95 and older are grouped together in the N Documents. For the purpose of our analyses, we also applied this rule to data previous to 2009.

i. the **age-gender-reimbursement scheme** distribution, to standardise the data on the basis of the age, the gender, and the reimbursement scheme of the patient
   - The age-gender-reimbursement scheme distribution is calculated as the number of insured persons by age, gender and reimbursement scheme relative to the total number of insured persons in the Belgian population.

ii. the **age-gender** distribution, to standardise the data on the basis of the age and the gender of the insured person.
   - The age-gender distribution is calculated as the number of insured persons by age and gender relative to the total number of insured persons in the Belgian population.

iii. the **age-reimbursement scheme** distribution, to standardise the data on the basis of the age and the reimbursement scheme of the patient
   - The age-reimbursement scheme distribution is calculated as the number of insured persons by age and reimbursement scheme relative to the total number of insured persons in the Belgian population.

iv. & v. the **reimbursement scheme** distribution, to standardise the data on the basis of the patient's reimbursement scheme
   - The distribution of the reimbursement scheme is calculated as the number of insured persons per reimbursement scheme compared to the total number of insured persons in the Belgian population.
   - For data presented per age group and sex, the standardisation is adjusted by a factor taking into account the age share per age group and per sex.

3. Calculation of standardised annual rates of use

The standardised annual rates of use are calculated by multiplying the non-standardised rates by the concerned breakdown and adding them together on the basis of the insured person's domicile (standardisation i), the patient's domicile and reimbursement scheme (standardisation ii), the patient's domicile and gender (standardisation iii), the patient's domicile, age group and gender (standardisation iv) and by age group and gender (standardisation v).

D. Indicators: graphs and tables

Note: 2020 was indicated on the evolution graphs by a vertical dashed line, in order to draw the attention on the impact of the COVID-19 crisis.

Note 2 : On January 1, 2019, several modifications were made to the geographical division of the districts of the province of Hainaut. These modifications have an impact on the results published for the province of Hainaut starting from 2019.
The list of districts affected by these changes is available at https://statbel.fgov.be/en/news/modification-nsi-codes-municipalities-and-administrative-districts-1st-january-2019.

1. Table: NIHDI nomenclature codes selected for the analysis

The table 'NIHDI nomenclature codes selected for the analysis' contains the outpatient and hospital nomenclature codes covered by the analysis, specifying whether or not these codes are included in the number of healthcare services ('used for rates?') and/or in the expenditure ('used as expenditure?'). It also gives their wording, their creation date, their possible deletion date, the N group to which the codes belong, and their value. The table also has two columns entitled 'Inclusive' and 'Exclusive': these are to be filled in where there is an additional conditional rule stating that the code is used to include certain services in the analysis (*this code must be attested to account for the service*) or to exclude them (*the service can only be accounted for if this code is not attested*).

The list of codes used for 'expenditure' is not intended to be exhaustive. Only those codes directly related to the practice under review are included here, as well as, depending on the case, additional codes (fees, equipment, etc.), if they are exclusively related to the practice under review. The evaluation of expenses is therefore underestimated, since, in order to be complete, we would need to take into account a whole series of related costs which we do not intend to analyse here.

2. Table: History of nomenclature codes

The table 'History of nomenclature codes' shows how the nomenclature codes have changed within the period considered with regard to their wording, their N group and their value. If there have been no changes during the target period, only the current data is displayed.

3. Table: Specialty of healthcare providers

The table *Specialty of healthcare providers* contains the following non-standardised data per speciality:

- Total number of healthcare providers: the number of healthcare providers per specialty who have certified more than one service
- Relevant healthcare providers: the number of providers who have certified, more than once, one of the nomenclature codes covered by the analysis
- % providers: the percentage of the 'total number of healthcare providers' per specialty, compared to the number of 'relevant healthcare providers'
- Median number of healthcare services: the median number of healthcare services per 'relevant healthcare provider'

- Q3 of the healthcare services, or the third quartile or the P75 : Value of the number of healthcare services that is higher than the annual number of healthcare services of 75% of the healthcare providers, but lower than the number of healthcare services of the 25% remaining providers.
- % services: the annual number of healthcare services certified per specialty, as a percentage of the total number of services
- % Expenditure: the expenditure per specialty as a percentage of the total expenditure

Specialties which account for less than 1% of the total number of services provided are grouped together in the 'Other specialties' category.

As the data per specialty comes from the P documents that are eventually available later, it is possible that the numbers are calculated based on one accounting semester and extrapolated in order to correspond to a complete year. In this case, a note will be mentioned in the table.

4. Table: Specialty of prescribers

The *Specialty of prescribers* table contains the following non-standardised data per specialty:

- Total number of prescribers: the number of prescribers per specialty who have prescribed more than one of the codes under analysis
- Relevant prescribers: the number of prescribers prescribing the nomenclature codes under analysis
- % prescribers: the 'relevant prescribers' as a percentage of the 'total number of prescribers'
- Median prescription: the median number of services prescribed by each 'relevant prescriber'
- Q3 of the services prescribed, or the third quartile or the P75 : value of the number of services that is higher than the annual number of healthcare services of 75% of the healthcare prescribers, but lower than the number of services of the 25% remaining prescribers.
- % Prescriptions: the number of prescriptions per year per specialty, as a percentage of the total number of prescriptions
- % Expenditure: expenditure per specialty as a percentage of total expenditure

Specialties accounting for less than 1% of the total number of healthcare services provided are grouped in the 'Other specialties' category.

If there was no prescriber for the service being analysed, "Not Applicable" is entered in the "Prescriber Specialization" field and only the service and expense totals are displayed.

As the data per specialty comes from the P documents that are eventually available later, it is possible that the numbers are calculated based on one accounting semester and extrapolated in order to correspond to a complete year. In this case, a note will be mentioned in the table.

5. Table: Trends in the standardised rate of use per 100 000 insured persons

	TOTAL	Statistical significance
Average number of interventions per year	***126.147***	
Trend (2012-2022)	**3,30%**	***** (3,61%)**
Trend (2012-2019)	3,24%	NS
Trend (2019-2022)	3,41%	

This table shows on the national level:

- The average yearly growth percentage for the entire analysis period
- The average yearly growth percentage for the first period of analysis (that precedes the last three or four years[10])
- The average yearly growth percentage for the last three of four years of analysis
- The statistical significance of the trend test on the whole period of analysis, based on a regression model (if the model allows) and the corresponding average yearly growth (between brackets) as estimated by the regression model
- The statistical significance of the test for the change in trend for the last three or four years, based on a regression model (if the model allows)

To know whether the trend on the entire analysis period is significant, a linear mixed model is fitted on the log of the rate of use per 100.000 insured. This model defines a regression line per province and calculates the slope. A significance test for the slope is done at the level of each province, region and at the national level. The test at the national level is shown in the table. Data for 2020 are excluded from the model.

The test for the change in slope is described below in the section «*Table: Trends in rates of use by province and region* ».

The significance level is fixed at 5%. The significance of the tests is indicated by *** (P-value $\leqslant$ 0.001) very significant, ** (P-value $\leqslant$ 0.01), * (P-value $\leqslant$ 0.05) or NS (P-value > 0.05) for a non-significant result. If the significance tests are not available, the significance is indicated as NA.

6. Table: Trends in rates of use by province and region

The table '*Comparison of trends per province and per region*' relates to the last ten years (as long as the data are available for each year). The title of each column indicates for which periods the data are available. All the data (years, regions and provinces) were standardised with respect to the structure of the population of insured persons of the last year (age , gender and scheme of reimbursement).

[10] Usually, the trend over the last three years is compared with the trend over the preceding years. For analyses up to the year 2022, the trend for the last four years is compared with the trend for previous years to avoid the problem associated with the COVID year 2020.

The table contains the following data per province and per region, as well as for the entire Belgian population. The rates of use are standardised per 100,000 insured persons :

- The standardised rate of use for the last year
- The average annual growth percentage for (maximum) the entire analysis period
- The average annual growth percentage in the last three or four years of analysis
- The average annual growth percentage for the years before the last three or four years
- The significance of the test for change in slope from the regression analysis, where available

The average annual growth percentage is calculated using the following formula:

$$Annual\ growth\ percentage = \left(\frac{standardised\ ratio_{last\ year}}{standardised\ ratio_{first\ year}}\right)^{\frac{1}{last\ year - first\ year}} - 1$$

In order to find out whether the trend of the data in the last years has changed compared to the trend in the years before, a linear mixed model in two steps was used on the log of the rate of use per 100.000 insured. On the one hand, each model fits a separate regression line per province and on the other hand it calculates the change in slope for the last three years of the analysis period compared to the period before.

The first step tests whether the trend in the last years is different from the trend in the years before at the national level. If that change in slope is significant, a second model is fitted that allows the change in slope to vary by province. The report shows the results of the statistical tests for the change in slope. The first model shows the significance at the national level only. If the test at the national level is significant, the second model shows the significance at the level of the province, region and for Belgium.

The significance level is fixed at 5%. The significance of the tests is indicated by *** (P-value ≤ 0.001) very significant, ** (P-value ≤ 0.01), * (P-value ≤ 0.05) or NS (P-value > 0.05) for a non-significant result. If the significance tests are not available the significance is indicated as NA.

The data of 2020 are excluded from these models.

The graphs below (see Figure 1) are examples of provinces in which the change in slope for the last three years of the analysis period compared to the years before is significant (L) and not significant (R).

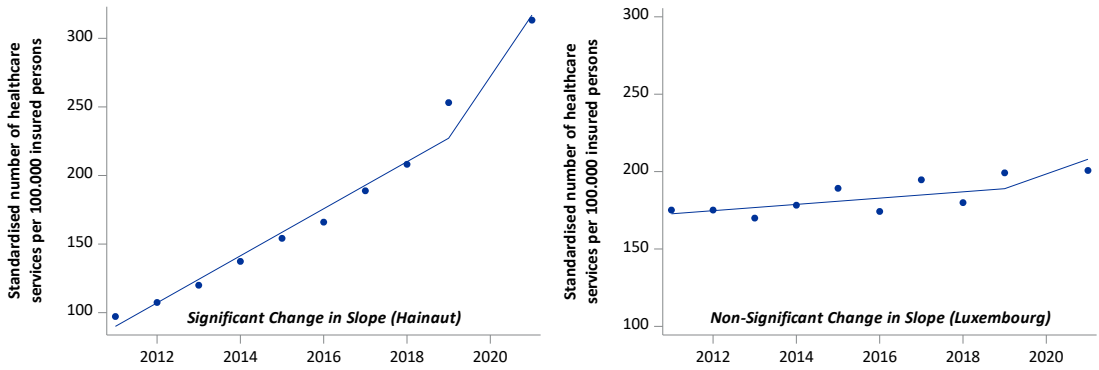


Figure 1 Significant (on the left) and non-significant (on the right) change in slope for the last three years of the analysis period compared to the years before (fictitious examples)

The following table corresponds to the analysis from which the graphs above are issued.

	Standardised rate of use per 100,000 insured persons in 2021	Annual growth of standardized rate of use 2011-2021	Annual growth of standardized rate of use 2011-2019	Annual growth of standardized rate of use 2019-2021	P Value t-test
Province					
Flandre occidentale	241,26	7.39%	6.10%	12.73%	0,027 *
Flandre orientale	220,38	4.25%	3.84%	5.91%	0,076 NS
Anvers	266,76	8.69%	7.59%	13.16%	0,017 *
Limbourg	318,99	5.02%	4.50%	7.12%	0,020 *
Brabant flamand	266,21	5.80%	4.12%	12.78%	0,022 *
Bruxelles	175,46	12.12%	9.48%	23.34%	0,011 *
Brabant wallon	278,36	7.67%	4.87%	19.61%	0,012 *
Hainaut	313,25	12.42%	12.71%	11.24%	0,008 **
Liège	255,46	8.96%	8.63%	10.29%	0,021 *
Namur	279,41	10.13%	9.97%	10.80%	0,011 *
Luxembourg	200,72	1.37%	1.62%	0.39%	0,227 NS
Région					
Flandre	255,41	6.42%	5.39%	10.63%	0,273 NS
Bruxelles	175,46	12.12%	9.48%	23.34%	0,011 *
Wallonie	278,32	9.62%	9.29%	10.96%	0,090 NS
TOTAL	253,50	7.74%	6.85%	11.36%	0,000 **

As a visual illustration of the evolution of the rate of use by province as estimated by the mixed regression model, Figure 2 Evolution of the rate of use by province, as estimated by the mixed regression model was added to the report. As the data of 2020 were excluded from this analysis, they were indicated on the graph for information.

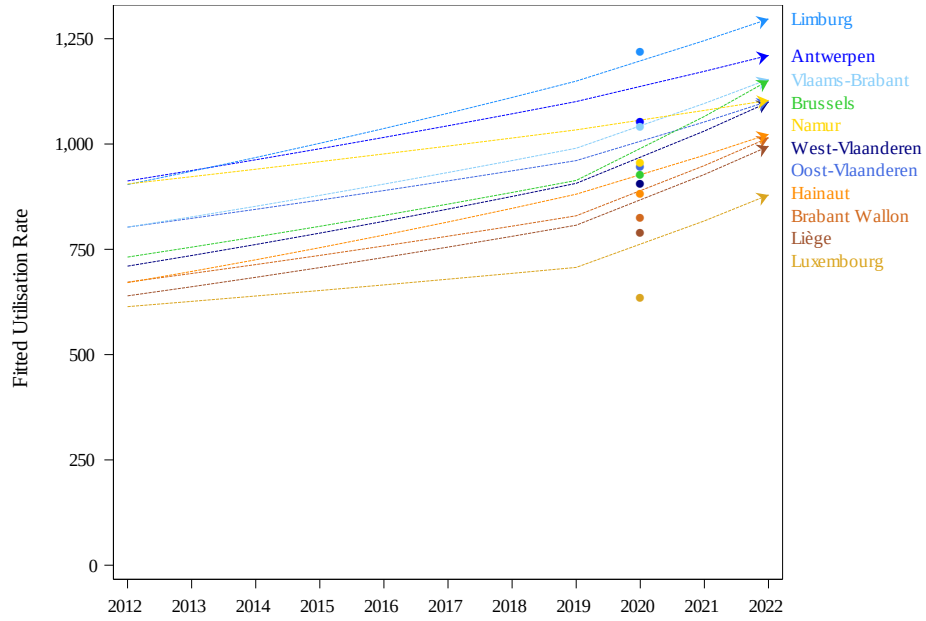


Figure 2 Evolution of the rate of use by province, as estimated by the mixed regression model

7. Table: Trends in expenditure per healthcare service and per nomenclature code

This table shows, for each year of the period of analysis, expenditure per healthcare service, i.e. total expenditure divided by the total number of services, expressed by the combined nomenclature code (outpatient and hospital care).

For example:

Nomenclature	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average annual growth rate
453110-453121	196,30	197,21	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NA
453132-453143	301,12	328,68	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NA
453574-453585	630,08	615,01	568,03	503,80	458,61	482,93	488,58	489,14	488,72	446,06	504,20	-2,20%
453596-453600	705,11	0,00	539,83	0,00	0,00	538,59	543,91	546,57	549,17	552,04	560,52	-2,27%
458570-458581	162,41	164,37	136,74	131,66	131,43	130,67	132,85	133,03	134,17	135,33	137,57	-1,65%
464111-464122	197,76	196,30	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	NA
464133-464144	298,48	280,81	285,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	326,20	0,89%
464170-464181	624,80	587,44	496,58	483,87	483,11	482,76	487,90	488,66	488,57	491,73	499,18	-2,22%
464192-464203	698,63	657,26	555,92	540,68	540,02	539,69	545,41	545,86	546,17	549,79	557,97	-2,22%

Figure 3 Change over time in expenditure, by service and by nomenclature code

In this table, the average annual growth rate is calculated using the following formula:

$$Average\ annual\ growth\ rate = \left(\frac{Expenditure\ per\ service_{last\ year}}{Expenditure\ per\ service_{first\ year}}\right)^{\frac{1}{last\ year - first\ year}} - 1$$

This rate is therefore calculated by taking into account only the values for the first and last years of the period of analysis, without considering the intermediate variations.

8. Table: Summary of key data

The 'Summary of Key Data' table contains the following data for the Belgian population (data which are also contained in the different chapters of the report and whose methodological details are given in the relevant paragraphs of this document):

- Main healthcare providers:
  - The specialty identified as providing the majority of the practice under analysis, with the percentage of the total number of services provided
- Main prescribers:
  - The specialty identified as prescribing predominantly for the practice analysed, with percentage of total volume prescribed. If the practice is mostly not prescribed (provided at the initiative of the healthcare provider), the term 'not applicable' is displayed.
- Standardised rates of use:
  - Average number of services per year
  - Standardised rate of use per 100,000 insured persons
  - Repetition rate of a practice per year for the same patient (≥ 2 occurrences per patient)
  - Percentage of healthcare services provided as outpatient services, including one-day hospitalisation
- Population:
  - Median age of the patient, per provision of service
  - Max/min ratio of the median age of the patient (based on district)
  - Percentage of services provided to women
  - Ratio of standardised rate of use for patients under a preferential scheme, in relation to the standardised rate of use for patients not eligible for a preferential scheme
- Trends:
  - Average annual growth percentage over the whole period of analysis
  - Average annual growth percentage for the last three or four years of the period of analysis
  - Average annual growth percentage for the years before the last three or four years
  - Statistical significance of the slope over all the years of the analysis period
  - Statistical significance of the change in trend for the last three or four years of the analysis compared to the years before
- Geographical variations
  - On the one hand, the coefficient of variation (of the standardised use rate by district) calculated in the first three years of the analysis period and, on the other hand, this coefficient of variation for the last three years of the analysis period. The coefficient of variation is a measure of relative spread and is calculated as the standard deviation divided by the average. The coefficients of variation for the first and last three years of analysis are compared with each other with a test that is based on a Bootstrap procedure. The difference between the coefficients of variation is considered significant if the p-value is less than or equal to 0.05.

As the coefficient of variation is a relative value, the importance of a dispersion can essentially be evaluated in a comparative logic.

- Max/min ratio of the standardised rate of use (based on the regions)
- Max/min ratio of the standardised rate of use (based on the districts)

– Expenditure
  - Average annual expenditure of the health insurance system
  - Average annual (standardised) expenditure of the health insurance system per person insured
  - Max/min ratio of the (regional) expenditure per person insured
  - Max/min ratio of the expenditure per person insured (per district)
  - Average cost of services per patient to the health insurance system

– Coding variations and practice alternatives:
  - Variations in practice coding, by choice of nomenclature codes, observed by province with indication of the degree of statistical significance of the Chi-squared test (see Statistical analysis)
  - Variations in the choice of practice alternatives, observed by province with an indication of the degree of statistical significance of the Chi-squared test (see Statistical analysis)

If the max/min ratio cannot be calculated because the minimum is 0, it is indicated NA (not available) in the table.

If the period between the base year (i.e. the first year of the period of analysis) and the last year is less than three years, NA (not available) is indicated for the trend.

If the results show a significant difference, the degree of statistical significance is symbolised by one to three asterisks, in increasing order of significance: * P-value ≤ 0.05 / ** P-value ≤ 0.01 / *** P-value ≤ 0.001. Otherwise, NS is displayed ("not significant").

9. Graph: Volume distribution of the nomenclature codes provided

This graph is a 100% stacked bar chart, showing the relative distribution of the percentages of services delivered, by nomenclature code, over the years. The graph only represents the nomenclature codes used to determine the volume of services provided, excluding those that would be used only in expenditures. If more than 15 nomenclature codes (or combinations of codes) were to be presented in a graph, only those nomenclature codes representing **more than 5% of services** in at last one year are shown. Nomenclature codes representing less than 5% of services are then grouped in a category called 'Other'.

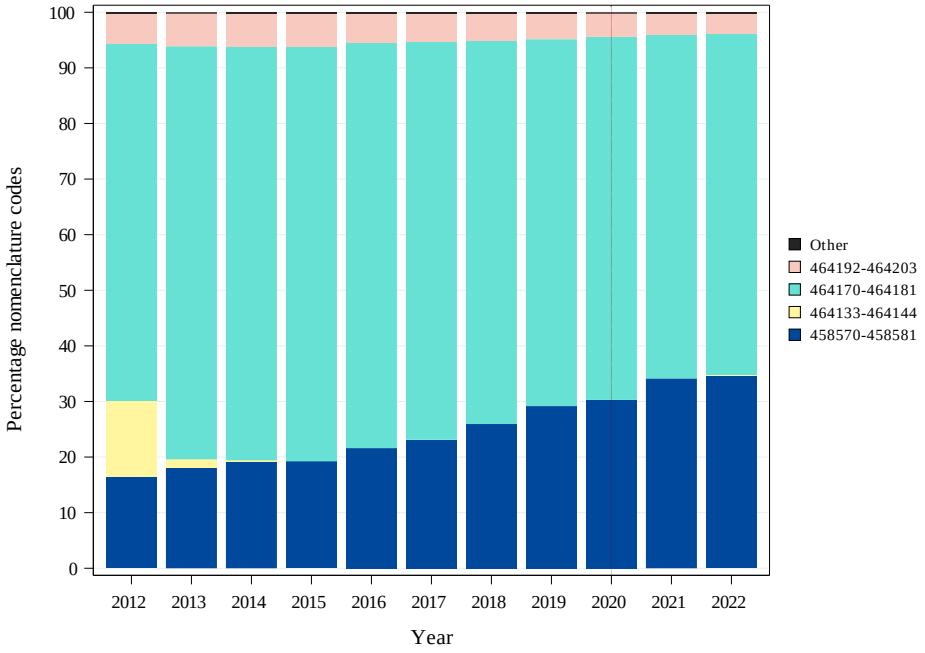


Figure 4 Example of a graph showing the trend in percentages of services provided, by nomenclature code

10. Graph: Rate of use and coefficient of variation by age group and by gender

The annual rate of use by age group (see Figure 5) is presented in a bar chart by gender. The associated coefficient of variation is shown by a red line above the bar chart. The coefficient of variation is a relative measurement of the magnitude of geographical variations. To calculate this coefficient, the standard deviation is divided by the average standardised rate of use per district. The vertical axis on the left side of the graph shows the standardised annual rate of use, and the right-hand axis shows the coefficient of variation. The horizontal axis shows the distribution by age groups. The horizontal blue dashed lines represent the total annual rate of use, and the red dashed lines show the overall coefficient of variation (i.e. all age groups combined).

The line of the coefficient of variation is thicker for those age groups for which the value of the coefficient can be validly interpreted, i.e. if that age group is sufficiently represented by its size and by its rate of use of the particular practice.

If a selection is made by gender, only the graph relating to the selected gender is presented. If a selection is made by age, the value of the bars will be zero for groups that contain none of the selected ages.

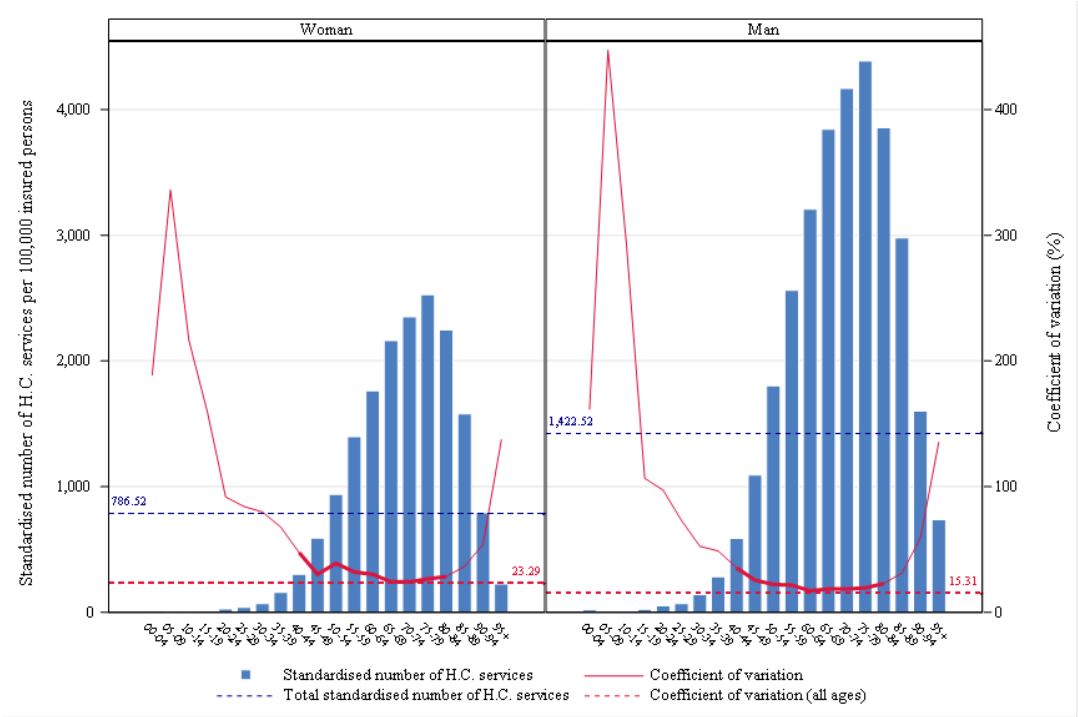


Figure 5 Example of a graph by age group and by gender, with the coefficient of variation

11. Graph: Comparison of standardised rates of use, by gender

On this graph, annual rates of use are shown, by age group, for each gender. A green curve is used for women, and a grey curve for men.

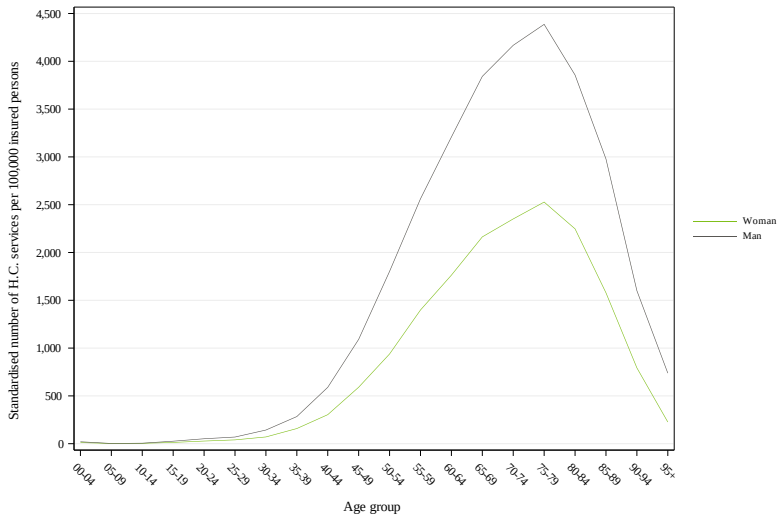


Figure 6 Example of a graph showing annual rates of use, by age group and by gender

12. Graph: Standardised rates of use by gender and by province

Standardised annual rates of use by province (based on the place of residence of the patient), and by gender, are represented by a bar chart with double bars (see Figure 7). The grey bars correspond to the standardised annual rates of use for men, while the green bars show the standardised annual rates of use for women. The grey and green dashed lines show the total annual rates of use for men and women, respectively. If a selection is made by gender on the population, this graph will not be displayed.

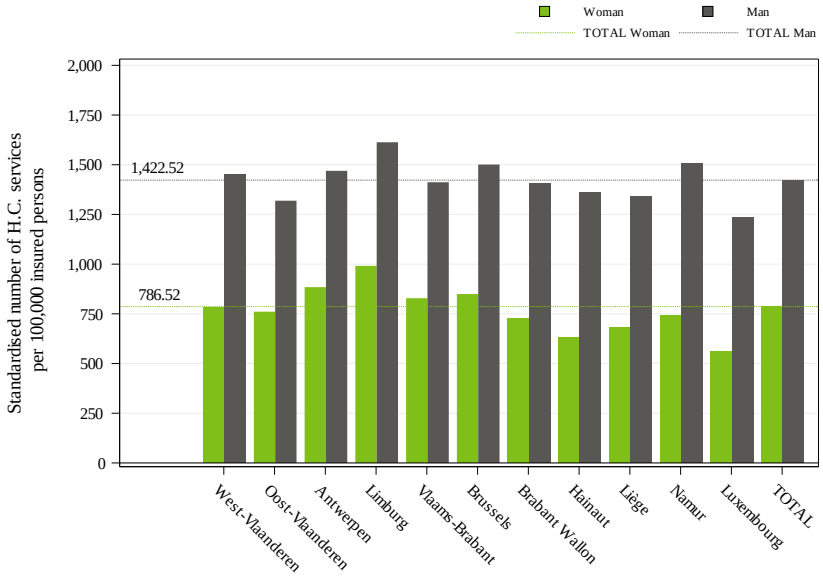


Figure 7 Example of a graph showing rates of use by province and by gender

13. Graph: Percentage of outpatient services

The percentage of outpatient services, i.e. the number of outpatient services provided as a proportion of all services provided (outpatient and hospital), is shown by a bar chart (see Figure 8). This contains one bar per region, as well as a bar for Belgium as a whole which is also represented by a dotted line.

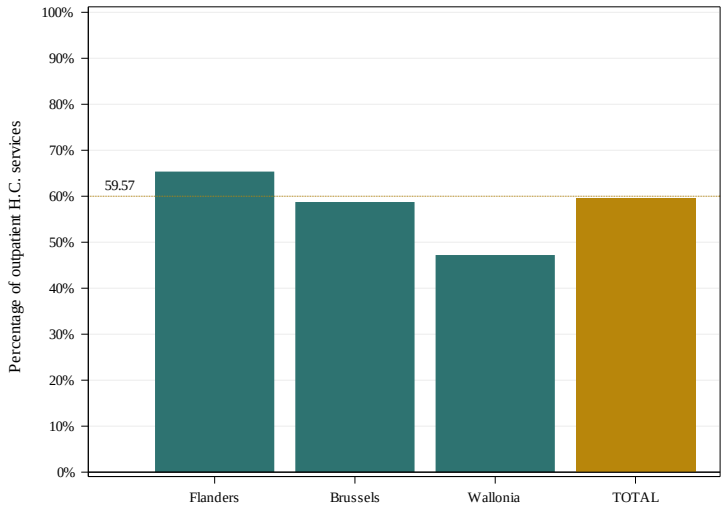


Figure 8 Example of a graph showing the percentages of outpatient services, by region

14. Graph: trend in the percentage of outpatient services provided

The graph relating to the evolution of the percentage of outpatient services over the years contains a dashed coloured line per province, and a continuous black line for the Belgian population as a whole (see Figure 9). The horizontal axis shows the years, from the first to the last year of the period of analysis for which the services are recorded. The vertical axis gives the percentage of outpatient services. The colors are specific to each region : blue for Flanders, green for Brussels and ochre for Wallonia.

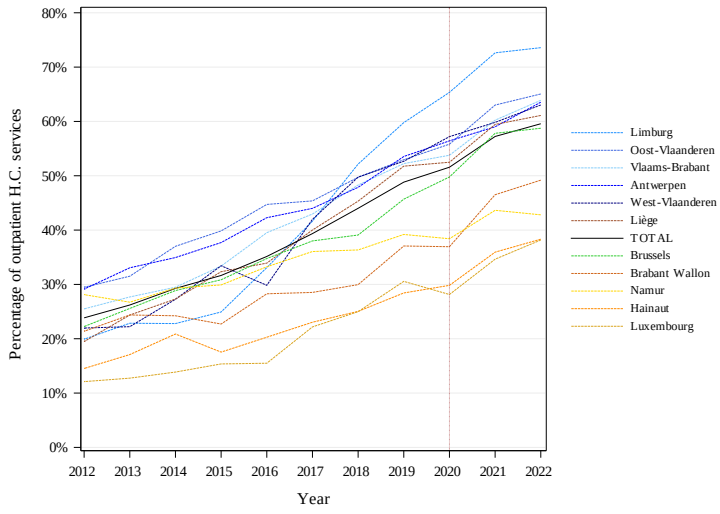


Figure 9 Example of a graph showing the change in the percentage of outpatient services per province

15. Graph: Standardised rate of use, by reimbursement scheme and by region

The standardised annual rates of use by region of the patient's residence and by applicable reimbursement scheme are shown by a bar chart (see Figure 10). The red bars are the standardised annual rates of use of insured persons eligible for a preferential scheme. The grey bars are the standardised annual rates of use of insured persons without a preferential scheme. The red dashed line shows the total annual rates of use for patients covered by a preferential scheme, while the grey dashed line shows these rates for patients not covered by a preferential scheme.

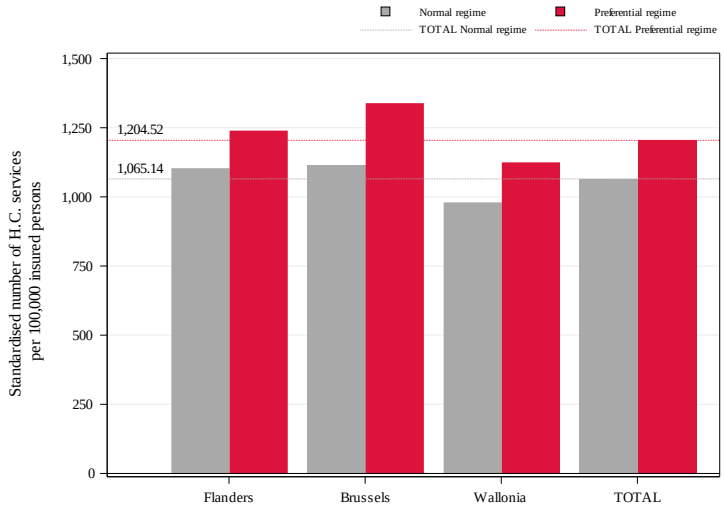


Figure 10 Example of a graph showing the rates of use by region and by reimbursement scheme

16. Graph: trend in standardised rates of use

The change in the rates of use is illustrated by two graphs, one showing the regions and the other showing the districts (see Figure 11). These graphs contain a dashed coloured line by place (region or district) and a continuous black line for the Belgian population as a whole. On the horizontal axis are indicated the years, from the first up to and including the last, of the period of analysis for which services are recorded. The vertical axis shows the standardised rate, i.e. the standardised number of services per 100,000 persons insured. The colors are specific to each region : blue for Flanders, green for Brussels and ochre for Wallonia.

The graph showing trends per region shows all the regions and the standardised rates of use per year. The graph on the evolution by district shows trends over a three-year period of the average of the standardised rate (moving average). For example, for 2015 it is the average of the rates from 2013 to 2015 included that is represented, and for 2016 it is the average of the rates from 2014 to 2016 included.

The trend in the average rate of use is not presented for all 43 Belgian districts. Only the districts with the five highest and the five lowest average standardised rates of use over the last three years of the period of analysis are shown.

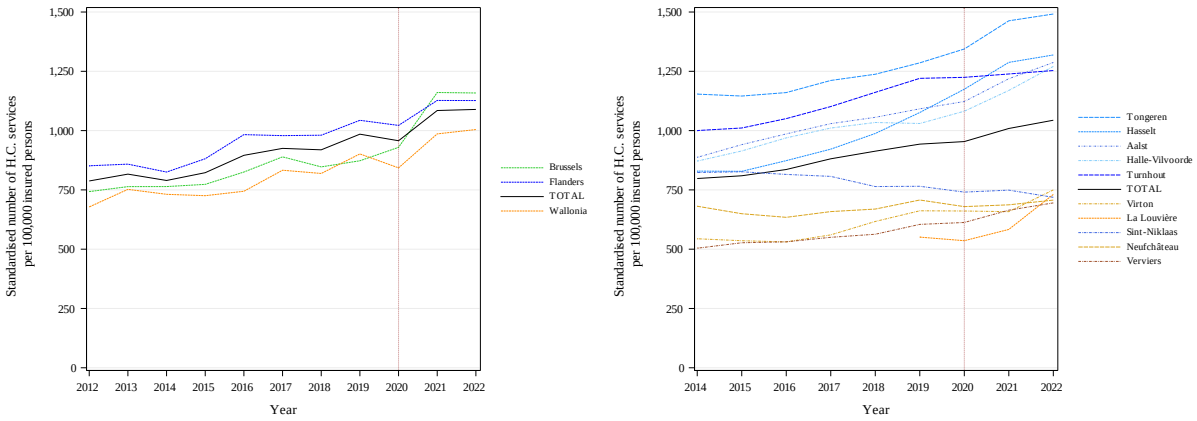


Figure 11 Example of graphs showing annual trends, by region (left) and by district (right)

17. Graph: 'Dot plot' distribution of rates of use

A dot plot graph is a scatter plot in which, for each observation, the points are plotted on a categorical scale. These simple graphs can be used to highlight groupings and gaps, as well as outliers. Here, the dot plot is used to present the distribution of the standardised annual rates of use by district, with each dot representing a district, first for all patients, and then by gender (see Figure 12). If a selection is made on the basis of gender, only the data for the selected gender are shown.

In order to convert the continuous data into categorical data, the rates of use are rounded to the nearest multiple (unit, ten, hundred, etc.), depending on the size of the maximum rate.

The graph also shows boxes with the 25th, 50th and 75th percentile of the unrounded rates, first for all patients, and then by gender. The 25th percentile is indicated by the bottom line of the box, the 75th percentile by the top line, and the 50th percentile by the middle line of the box.

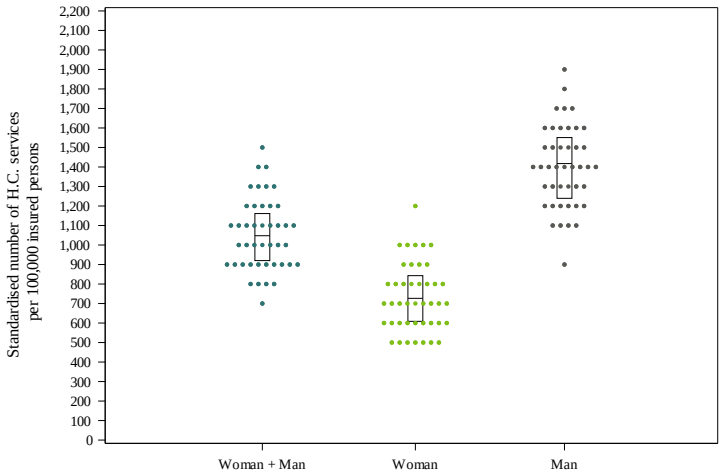


Figure 12 Example of a 'dot plot' graph of rates of use

18. Graph: Maps showing distribution by district

On a map of Belgium (see Figure 13), where the district boundaries are represented by thin lines and the province boundaries by thick lines, the districts are coloured according to a comparative scale with, firstly,

the median rate of use, and, secondly, the median expenditure. This comparative scale is expressed as a percentage of difference compared to the median rate or median expenditure: between -10 and 10 %, the value for the district is considered as equal to the median value; between 10 and 30 %, the value for the district is considered as 20 % higher than the median value; between -10 and -30 %, the value for the district is considered to be 20 % below the median value, etc. These percentages are calculated based on standardised rates of use for the last year of the analysis. They are divided into categories of 20 %. The following colours have been defined for the different categories of the comparison scale:

Colour	Category	Description
	Below - 50 %	The rate for the district is at least 50% below the overall rate.
	Between -50 % and -30 %	The rate for the district is between 30 % and 50 % below the overall rate.
	Between -30 % and -10 %	The rate for the district is between 10% and 30% below the overall rate.
	Between -10 % and 10 %	The rate for the district is between 10% below and 10% above the overall rate.
	Between 10 % and 30 %	The rate for the district is between 10 % and 30 % higher than the overall rate.
	Between 30 % and 50 %	The rate for the district is between 30% and 50% higher than the overall rate.
	Above 50 %	The rate for the district is at least 50% higher than the overall rate.
	No service	No services of this type have been provided in this district.

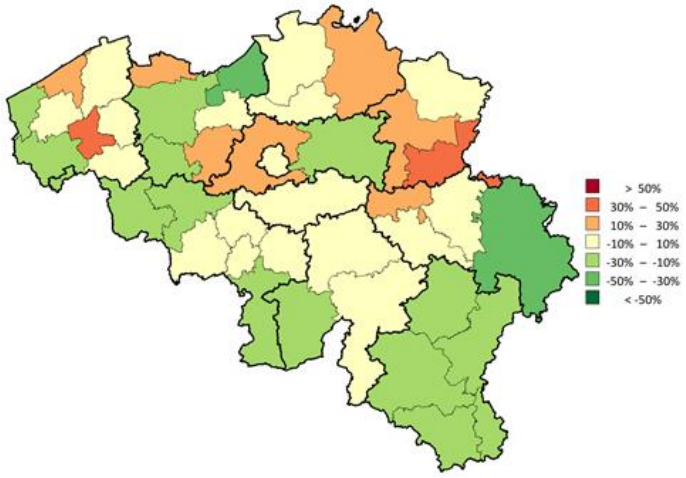


Figure 13 Example of the map of Belgium showing the geographical variation in the rates of use

In order to best interpret these maps, it is useful to put them into perspective with the maps of attendance to the various health professionals available in the "Patient analysis" file.

19. Graph: 'Funnel plot' of rates of use per district

This funnel plot is a scatter plot which shows the annual rates of use (i.e. the standardised number of services provided per 100,000 insured persons) per district, in relation to the size of the population of the district. In addition to the dots per district, the confidence limits are also displayed on the graph. The confidence intervals have a typical shape of a funnel: the smaller the population of a district, the greater the expected variation, and, conversely, the larger the population, the smaller the expected variation.

The graph below (see Figure 14) is an example of a funnel plot showing the standardised rate of use of a service, per 100,000 insured persons, per Belgian district. The horizontal line represents the national annual rate of use (i.e. the number of times the service was provided per 100,000 insured persons in the Belgian population). The funnel-shaped lines show the 95% (two standard deviations from the national mean) and the 99.7% (three standard deviations from the national mean) confidence limits.

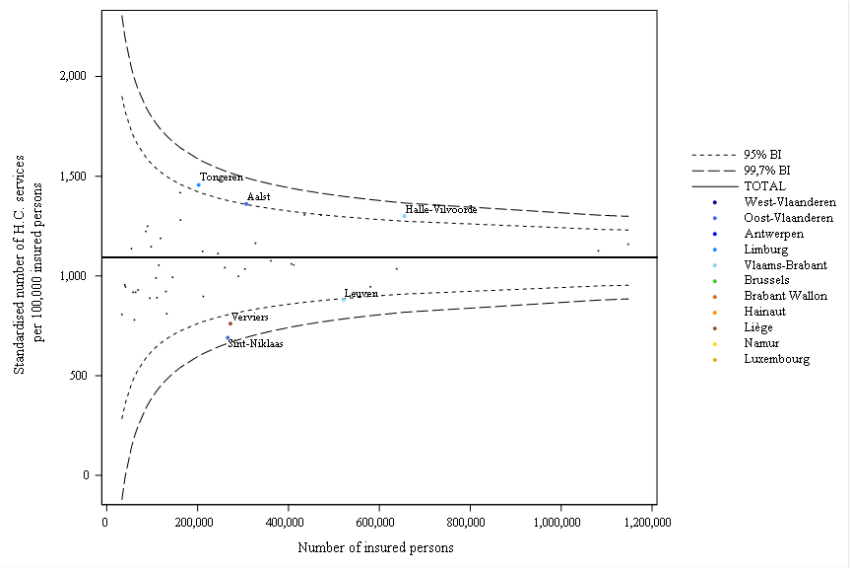


Figure 14 Example of a 'funnel plot'

The districts between the curves are considered to be 'average'. The districts outside the upper and lower 99.7% confidence limits are considered 'outliers'. The zone between the confidence limits at 95% and those at 99.7% is considered as a 'warning zone'. Only the titles of the districts outside the 95% confidence limits are spelled out.

As we represent the standardised number of services provided per 100,000 insured persons on the vertical axis, the confidence intervals per district are based on a Poisson distribution and are dependent on the national yearly usage rate and on the volume of the population in the district. The 95% and 99.7% confidence intervals for the 43 Belgian districts are calculated as follows :

1. Calculation of the standardised annual rate of use (number of services per 100,000 insured persons) per district *i:*

$$Y_i = (standardised\ rate\ of\ use)_i$$

2. Calculation of the national annual rate of use (number of healthcare services per 100,000 insured persons)

$$\theta = \frac{\sum_i (number\ of\ insured\ persons)_i * Y_i}{\sum_i (number\ of\ insured\ persons)_i}$$

3. Calculation of the standard error in the district *i* on the basis of aggregate data

$$SE_i = \sqrt{\frac{100{,}000 * \theta}{(number\ of\ insured\ persons)_i}}$$

4. Calculation of overdispersion

When the confidence intervals are calculated directly based on the Poisson distribution, many districts are outside the confidence intervals. This has to do with overdispersion (more variability in the usage rates than what is expected based on a Poisson distribution). To remedy this issue, the overdispersion is calculated and taken into account in the confidence intervals.

For each district, a z-score is calculated:

$$z_i = \frac{Y_i - \theta}{SE_i}$$

In order to avoid that the most aberrant districts influence the calculation of the overdispersion too much, the 10% smallest z-scores are replaced by the P10 and the 10% largest z-scores are replaced by the P90 before the overdispersion is calculated as follows.

$$\rho = \frac{\sum_i {z_i}^2}{43}$$

5. Determination of confidence intervals by district i

$$\text{lower 95\% confidence interval}_{\,i} = \theta - 2 * SE_i * \sqrt{\rho}$$

$$\text{upper 95\% confidence interval}_i = \theta + 2 * SE_i * \sqrt{\rho}$$

$$\text{lower confidence interval 99.7\%}_{\,i} = \theta - 3 * SE_i * \sqrt{\rho}$$

$$\text{upper confidence interval 99,7\%}_{\,i} = \theta + 3 * SE_i * \sqrt{\rho}$$

20. Table and graph: Frequency of practice occurrences

Some services may be invoiced several times for the same patient in the same year, even on the same day. This may be due to a repetition of the service, but also when two services are invoiced on the same day, due to the bilateral nature of the anatomical topography of the operation.

The table and pie-chart graph illustrate the importance of repetition of the service under analysis provided to the same patient over the course of a year: twice or more than three times in the year (see Figure 15).

The frequencies of occurrences presented here are based on the raw number of services from the P, SHA and ADH documents, even when the analysis is "adjusted", i.e. when the numbers and use rates have been divided by the annual occurrence per patient.

When there is an adjustment, the number of services is divided by the value of the occurrence by province of residence of the patients. In most cases, these values are shown in Figure 16 Example of graph of practice recurrence by province and variability relative to the national value (See also Combined data).

Frequency	Per year	*Per day*
2 occurrences	9,7%	*0,3%*
≥ 3 occurrences	0,8%	*0,0%*
≥ 2 occurrences	10,4%	*0,3%*

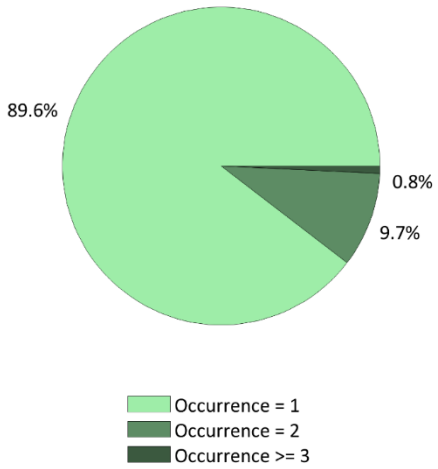


Figure 15 Example of a table and pie chart showing the distribution of practice recurrences per year

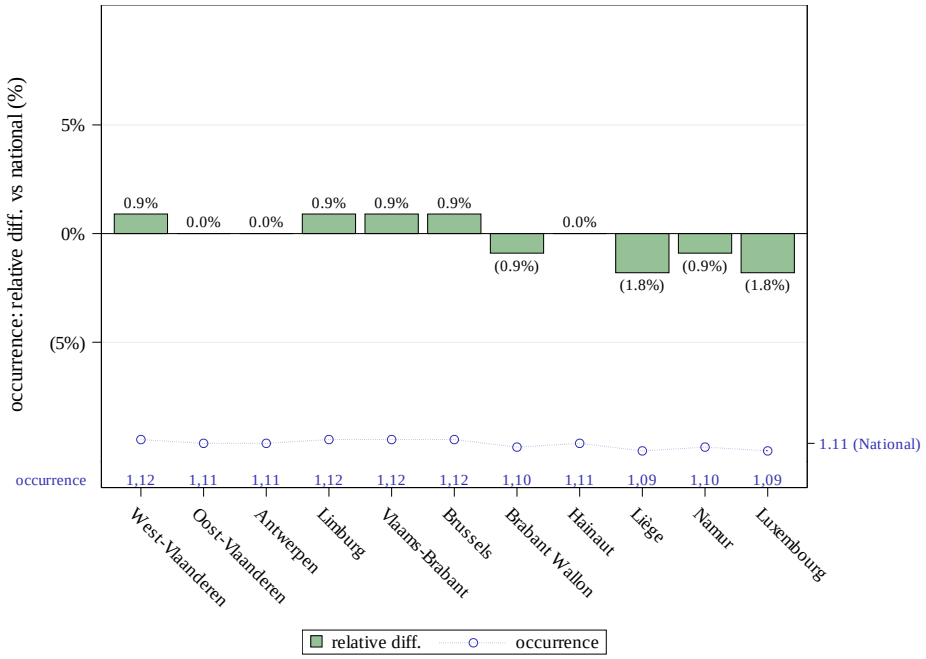
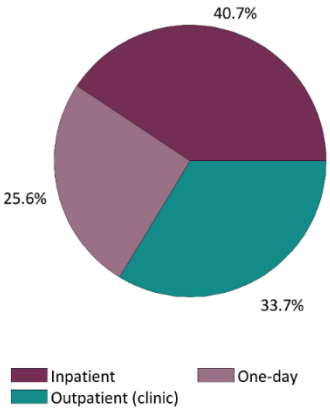


Figure 16 Example of graph of practice recurrence by province and variability relative to the national value

21. Table and graph: Distribution of types of care

This pie chart shows the type of care (for the service or practice under analysis) provided to patients, broken down by the various sectors and sub-sectors: outpatient (private or polyclinic), hospital care (one-day or inpatient) (see Figure 17).

These occurrence frequency analyses are performed using the data in the P, ADH and SHA documents (See also Combined data).

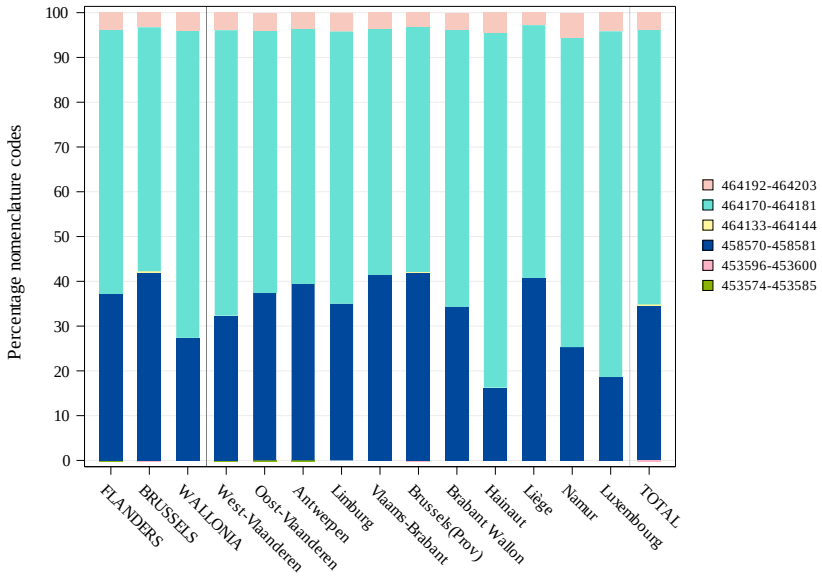


Care Settings	
Outpatient (private)	*0,0%*
Outpatient (polyclinic)	*33,7%*
(Day) Hospital	*25,6%*
Hospital (stay)	*40,7%*

Figure 17 Example of a pie chart and table illustrating the distribution of types of care

22. Graph: Distribution of coding variations

There may be variations in the choice of codes used to record the same practice. This potential variation is illustrated by a 100% stacked histogram graph for both regions and provinces (see Figure 18).



Significance	By region	By province
Use of **Nomenclature codes**[11]	***	***

Figure 18 Example of coding variation

In this representation, the distribution by region and province of the volumes of the nomenclature codes defined for the analysis is analysed in order to determine whether this distribution is homogeneous across the territory. The data are those of the latest year available.

In order to verify whether the variations observed are significant, a Chi-square test was applied. The results are displayed in a table below the graph. The number of asterisks represents the degree of statistical significance: * P-value ≤ 0.05 / ** P-value ≤ 0.01 / *** P-value ≤ 0.001 and NS for a non-significant result.

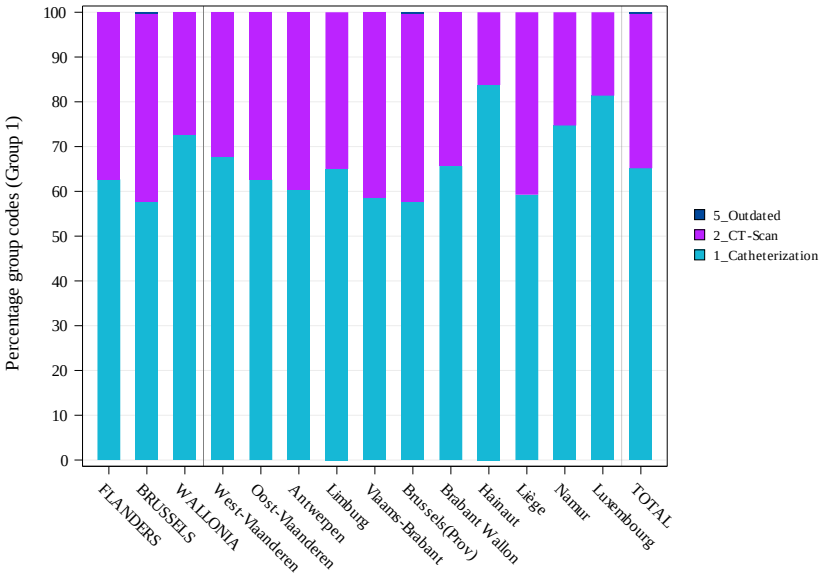
23. Graph: Distribution of variations in the choice of practice alternatives

If different practice alternatives could be identified for the practice analysed through groupings of nomenclature codes, they are illustrated in this histogram, which makes it possible to visualise the distribution of choice between the different techniques over the whole territory on the one hand, but also by region and by province (see Figure 19). The graph is a 100% stacked histogram. For the same analysis, up to two distribution logics can be presented, identified in the reports as "Group 1" and "Group 2".

11 The calculation of significance is carried out here by comparing the geographical differences in the use of the different nomenclature codes to code the practice.

In some cases, among the identified practice alternatives, sub-alternatives exist. If they can be clearly identified, they will be illustrated in the histogram in a gradient of the same colour in order to clearly visualise the different sets of alternatives.

The groupings of nomenclature codes corresponding to each alternative are presented in a separate table, together with the degree of statistical significance of the Chi-square test.



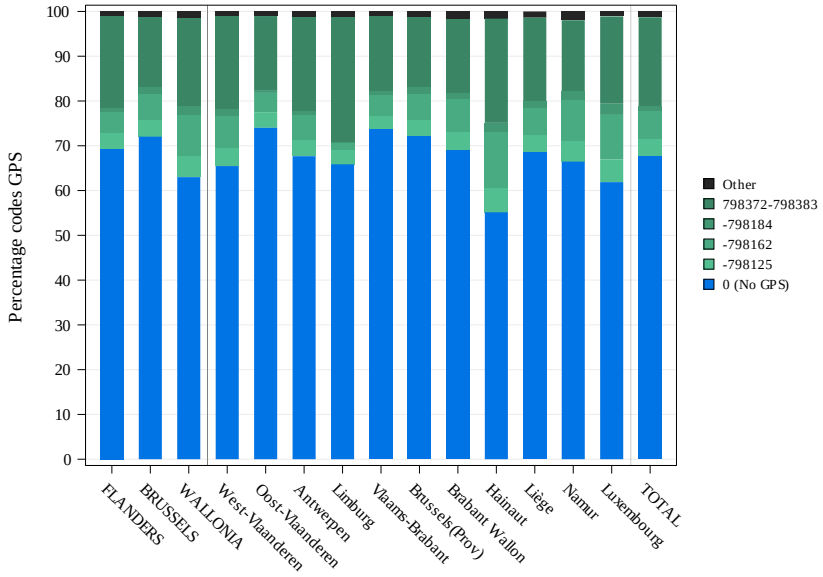
Significance	By region	By province
Choice of **Practice alternatives**	***	***

Figure 19 Example of a histogram illustrating the distribution of alternative techniques for the same practice (alternative 1 in blue, alternative 2 in purple - with colour gradient for identified sub-alternatives)

24. Graph: Distribution of variations in the use of low-variability care

Analyses from 2019 onwards take into account the expenditure on services associated with GPS (Global Payment with Standardization). The graph below represents the proportion in volume of GPS codes associated with services for the latest year available, again in the form of a 100% stacked histogram broken down by region and by province (see Figure 20). Services that are not associated with a GPS code are represented by the code 0 (No GPS).

As for the two previous graphs, the statistical significance of the variations observed between regions and provinces is summarised in a separate table. Pseudocodes descriptions of relevant packages are also presented in addition to the graph.



Significance	By region	By province
Use of **Global Payment with Standardisation**[12]	***	***

Figure 20 Example of variations in the use of low-variability care

12 The calculation of significance is carried out here by comparing the use of Global Payment with Standardisation as a whole compared to the non-use of these packages.

4. STATISTICAL ANALYSIS

In order to ensure that the rate of use and the expenditure can be properly compared, all the data were standardised on the basis of age, gender, and preferential reimbursement scheme for the Belgian population of the last year of the analysis period.

All the data presented in this document are based on the entire population, and are summarised by descriptive statistics (average, median). Nevertheless, some statistical analyses may be relevant to perform on these data. The following hypotheses were tested in this report :

1) To what extent do region, gender and reimbursement scheme explain differences in rates of use?
   A linear mixed model ANOVA was used based on the standardised data with respect to age for each district, region, gender and reimbursement scheme. Region, gender and reimbursement scheme were taken into account in the model as fixed effects as well as all two-way interactions and the 3-way interaction. Type III significance tests were used to find out which effects have a significant influence on the usage rate. For a correct interpretation of the analysis, first the significance of the 3-way interaction should be checked, followed by the two-way interactions and then by the main effects. If the 3-way interaction is significant, the interpretation of differences should be done on this level and two-way interactions and main effects should not be interpreted. If the 3-way interaction is not significant, the 2-way interactions can be checked for significance. Each effect that is part of a significant interaction should be interpreted at the level of the interaction and not at the level of the main effect. Only if an effect is not part of a significant interaction, the main effect can be interpreted directly. This analysis only covers the last year of the data presented in the report and only used data from Flanders and Wallonia.

2) To what extent do the trends observed differ from one period to another?

To check whether there is a break in trend for the 3 most recent years of the analysis period compared to the years before (for the whole country, by province and by region), a linear mixed model was fitted on the data of all provinces and a significance test was done to find out whether the change in slope for the last three years was significant (see

25. Table: Trends in the standardised rate of use per 100 000 insured persons

	TOTAL	Statistical significance
Average number of interventions per year	***126.147***	
Trend (2012-2022)	**3,30%**	***** (3,61%)**
Trend (2012-2019)	3,24%	NS
Trend (2019-2022)	3,41%	

This table shows on the national level:

- The average yearly growth percentage for the entire analysis period
- The average yearly growth percentage for the first period of analysis (that precedes the last three or four years)

- The average yearly growth percentage for the last three of four years of analysis
- The statistical significance of the trend test on the whole period of analysis, based on a regression model (if the model allows) and the corresponding average yearly growth (between brackets) as estimated by the regression model
- The statistical significance of the test for the change in trend for the last three or four years, based on a regression model (if the model allows)

To know whether the trend on the entire analysis period is significant, a linear mixed model is fitted on the log of the rate of use per 100.000 insured. This model defines a regression line per province and calculates the slope. A significance test for the slope is done at the level of each province, region and at the national level. The test at the national level is shown in the table. Data for 2020 are excluded from the model.

The test for the change in slope is described below in the section «*Table: Trends in rates of use by province and region* ».

The significance level is fixed at 5%. The significance of the tests is indicated by *** (P-value $\leqslant$ 0.001) very significant, ** (P-value $\leqslant$ 0.01), * (P-value $\leqslant$ 0.05) or NS (P-value > 0.05) for a non-significant result. If the significance tests are not available, the significance is indicated as NA.

Table: Evolution of usage rates).

3) To what extent does the geographical variation differ from one period to another?
The coefficient of variation for the first three years of the analysis and that of the three most recent years were compared using a test based on a Bootstrap procedure (see Table: Summary of key data).

4) To what extent do the distributions of coding choices, practice alternatives and use of use of low variability care differ between geographical areas?
A chi-squared test is used to determine whether the differences in the distribution of the different choices between geographical areas are significant.