Assessing the regional policies of Italian regions in managing the Cesarean delivery phenomenon: a fractal analysis

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**Abstract**

Objectives. Assessing the 2017 administrative data on Cesareans delivery in Italy by using fractal statistic.

Methods. 2017 administrative data on Italian Cesarean deliveries are freely available as crude numbers and rates according to each Italian region, according to Italian health institute type and according to first or repeated Cesarean. As already reported, the Italian Cesarean delivery phenomenon is in relationship with hospital, regional, cultural perspectives in caring pregnancy and delivery. Fractal statistics can best assess the biocomplexity underlying the Italian Cesarean section phenomenon. Fractal shapes and self-organized criticality of the Cesarean section phenomenon for each Italian region were done. Fractal shapes were compared to find similarities by using global test of coincidence among regression lines. Results. In the regions where the health care institutes are more than a type, there are evanescent similar fractal shapes. Self-organized criticality assessment demonstrates that chaos is largely involved in Cesarean delivery phenomenon in all Italian regions and in Italy. The fractal images for each region are able to highlight the item causing the deviation from fractal shapes in each region. Conclusion. Fractal statistics could be used to compare regional or hospital policies in performing Cesareans, starting from Cesareans rates extracted from administrative data. (www.actabiomedica.it)

**Key words:** Cesarean section, hospital policies, fractal statistic.

**Introduction**

The 3 of April 2019, the 2017 administrative data of deliveries in Italy were published (1). The data were produced according to the mode of delivery (Cesarean delivery, non-Cesarean delivery), according to the type of health institution in which the deliveries have occurred and according to Italian regions. The topic is of special interest in Italy, where the Cesarean section rate has been higher than 30%. Remarkable, Cesarean section rate higher than 30% could increase maternal and neonatal mortality (2, 3). Cesarean section rates are in relationship with heterogeneous policies of caring pregnant and laboring women in Italy. Therefore, hospital standards and policies (4), along with regional cultural perspectives on Cesarean section, influence the rates of Cesareans (5). As a logical consequence, it’s hard to compare the Cesarean section rates among Italian regions for providing a unequivocal point of view (6).

By reading the 2017 administrative data on surgical delivery in Italy, it could be understood that each Italian region has an own behavior in managing the Cesarean delivery (1). If one would be able of build
The aim of this report is to build fractal images of the Cesarean deliveries for Italian regions and to compare them one by one and with the overall Italian image.

Materials and methods

The 2017 administrative data on Cesarean delivery in Italy were freely available from (1). They were reported in Table 1. The Italian health institutes are grouped as public institutes (group I and group II), accredited private institutes (group I and group II) and non-accredited private institutes.

Table 1. Rates of Cesareans: 2017 administrative data (modified from [1]).

| Public health institutes | Private accredited institutes | Non-accredited private institutes |
|--------------------------|-------------------------------|----------------------------------|
| Group I                  | Group II                      | Group I                          | Group II                      | First Cesarean | Repeated Cesarean | First Cesarean | Repeated Cesarean | First Cesarean | Repeated Cesarean | First Cesarean | Repeated Cesarean |
| Piemonte                 | 19.7% 0.5%                    | 16.7% 8.9%                       |                                |                                |                  |                  |                  |                  |                  |                  |                  |
| Valle d’Aosta            | 26.7% 2.6%                    | 16.6% 8.3%                       |                                |                                |                  |                  |                  |                  |                  |                  |
| Lombardia                | 20.2% 7.5%                    | 19.5% 8.0%                       |                                |                                |                  |                  |                  |                  |                  |                  |
| Bolzano area             | 17.2% 7.4%                    | 13.6% 8.4%                       |                                |                                |                  |                  |                  |                  |                  |                  |
| Trento area              | 22.3% 10.0%                   | 14.1% 6.5%                       |                                |                                |                  |                  |                  |                  |                  |                  |
| Veneto                   | 16.4% 5.7%                    | 16.9% 5.5%                       |                                |                                |                  |                  |                  |                  |                  |                  |
| Friuli V. Giulia         | 26.9% 12.1%                   | 16.7% 9.4%                       |                                |                                |                  |                  |                  |                  |                  |                  |
| Emilia Romagna           | 19.0% 1.2%                    | 16.7% 7.3%                       |                                |                                |                  |                  |                  |                  |                  |                  |
| Toscana                  | 25.5% 9.1%                    | 16.5% 7.3%                       |                                |                                |                  |                  |                  |                  |                  | 37.5% 25.0% |
| Umbria                   | 24.1% 13.3%                   | 19.9% 11.1%                      |                                |                                |                  |                  |                  |                  |                  |                  |
| Marche                   | 26.9% 14.3%                   | 21.7% 12.4%                      | 23.7% 12.5%                    | 27.0% 15.0%                 |                  |                  |                  |                  | 47.1% 15.2% |
| Abruzzo                  | 20.8% 14.1%                   | 24.0% 18.1%                      |                                |                                |                  |                  |                  |                  |                  |                  |
| Campania                 | 23.7% 21.0%                   | 26.6% 24.1%                      |                                |                                |                  |                  |                  |                  |                  |                  |
| Puglia                   | 22.9% 7.1%                    | 24.3% 18.7%                      |                                |                                |                  |                  |                  |                  |                  |                  |
| Basilicata               | 22.5% 6.8%                    | 20.9% 13.3%                      |                                |                                |                  |                  |                  |                  |                  |                  |
| Calabria                 | 24.5% 12.5%                   | 23.0% 14.0%                      |                                |                                |                  |                  |                  |                  |                  |                  |
| Sicilia                  | 23.6% 18.8%                   | 21.9% 16.7%                      | 23.5% 18.7%                    | 18.7% 25.8%                |                  |                  |                  |                  |                  |                  |
| Sardegia                 | 28.9% 12.5%                   | 21.0% 12.1%                      |                                |                                |                  |                  |                  |                  |                  |                  |
| ITALY                    | 23.2% 12.9%                   | 18.6% 11.1%                      | 22.6% 12.9%                    | 27.2% 23.1%                |                  |                  |                  |                  |                  |                  |

Data are reported as rates, according to the type of health care institute in Italy for each Italian region and for Italy.

*The rates were estimated according to Quigley et al [8].
because the biocomplexity in relationship with health care institutes cannot be applied. Therefore, such regions have not been assessed in fractal analysis.

- The fractal dimension was calculated (9) as $d = \log \lambda / \log \lambda$.
- It was assessed if the Cesarean section rates describe a fractal image for each region of Italy and for Italy. The Theorem 2, reported by Baldado et al (9) was applied. The rule is $x_i/(1-d) = k$. If the Cesarean section rates depict a fractal shape, the $k$ values calculated for each $x_i$ should be similar. To test it, the values were transformed by applying the $\Gamma$ function. Those transformed values were plotted, and regression lines were calculated. For each $\Gamma(k)$ series, the regression line should be coincident with a horizontal line crossing the mean value of $\Gamma(k)$ series. An intercept test was used for inference ($p<0.05$ for significance).
- As additional calculations of fractal analysis, Zipf’ test and level of noise have been calculated. The Zipf’ test was performed on the log Cesarean section rates of each health institute in each Italian region and in Italy. The level of noise (beta or $\beta$) was calculated according to Glattre et al (7): $\beta = 2\lambda - 1$. To test if the Zipf’
line is significant, it was tested if the deviation from linearity of the plotted log rates of the Zipf’ test is significant. If it is significant, the Zipf’ test is considered negative. The level of noise was disclosed according to what reported by Glattre et al (7): white ($\beta=0$), pink ($0<\beta<2$), brown ($\beta=2$), black ($\beta>2$). Having a level of noise from white to pink was considered appropriate for meeting one of the Bak’ criteria for proving the self organized criticality (7), meaning no chaotic influence. The other ones Bak’ criteria are: proved fractal shape and Zipf’ test positive (7).

- As a final step, the fractal images of each region were compared one by one and with the fractal image of Italy. It was applied a global test of coincidence between regression lines calculated on the cumulative distribution of $x$ (9): $f(x)=1-(x/\theta)^{1-\lambda}$. If the test proves that the regression lines are coincident, the fractal images are similar. The null hypothesis is that the regression lines are coincident. The $p$ level for accepting the null hypothesis was set at $p\geq 0.80$.

- It was also analyzed the data set by applying the Cochrane’s Q-statistic, aiming to assess differences between fractal statistic and Q-statistic. The effect size was established as the proportion of Cesarean section rate, and was encoded according to Lipsey et al (10). The Cochrane’s Q-statistic assesses the heterogeneity among samples. Thus, it was expected that a low heterogeneity index ($I^2$) means similar behavior in managing the Cesarean delivery among Italian regions, while higher heterogeneity index means different behavior in managing Cesarean delivery among Italian regions. A $I^2$ of more than 60% was considered heterogeneous.

The intercept test for the $\Gamma(k)$ values is significant for the Campania region, proving that the shape built for Campania is not fractal. Table 4 reports the Bak’ criteria for self organized criticality. The level of noise is high for all regions and for Italy. The Lombardia, Veneto, Liguria, Lazio, Puglia and Italy have also a Zipf’ test negative.

The Q-statistic for the whole Italy (excluding the Valle d’Aosta, Trento area, Bolzano area, Abruzzo, Molise data) is: $Q=56082.8$ with $I^2$ 99.99%. Moreover, the heterogeneity is not improved if the Q-statistic is performed by excluding the Campania region (non fractal shape): $Q=59124.86$ with $I^2$ 99.99%.

The fractal shapes comparisons (with the high level of probability set at 80%) find similarities between Basilicata and Calabria, and between Emilia Romagna and Sicilia. Table 5 provides the $p$ values for each comparison. By taking a lower level of $p$, evanescent similarities can be found for more regions.

Figure 1 shows trends of the cumulative distributions of $x$ ($f(x)=1-(x/\theta)^{1-\lambda}$) for each region. The fractal shapes lose their self-similarity in some points; identifying which is the institutions group responsible of abnormal treatment of Cesarean delivery (the first Cesareans or the repeated Cesareans). For example, in the Puglia region, the repeated Cesarean section in type II health institute causes the lost of the self-similarity, while in the Friuli V. Giulia seems to have same self-similarity for each institute in both first and repeated Cesareans. Figure 2 provides the fractal shape of Italy.

**Discussion**

The study demonstrates that the Cesarean section phenomenon in Italy is widely chaotic in each region. Similarities were found for only 4 regions. However, evanescent similarities can be seen for many other regions (Figure 1). Figure 1 illustrates the shapes for each region, identifying where each shape loses its self-similarities. This finding cannot be proved by the Q-statistic. The heterogeneity observed with Q-statistic demonstrates that there is not homogeneous rates of Cesarean sections (confirming chaos), leading to conclude that there are different behaviors of managing
Table 3. $\Gamma(k)$ values distributions.

| Region               | Health care institutes                  | $\Gamma(k)$ | Intercept test |
|----------------------|----------------------------------------|-------------|----------------|
| Piemonte             | Public health institutes               |             |                |
|                      | Group I: First Cesarean                | -3.598      | n.s.           |
|                      | Group II: First Cesarean               | -3.810      |                |
|                      | Repeated Cesarean                      | -88.843     |                |
|                      | Repeated Cesarean                      | -5.782      |                |
| Lombardia            | Public health institutes               |             |                |
|                      | Group I: First Cesarean                | -4.329      | n.s.           |
|                      | Group II: First Cesarean               | -6.167      |                |
|                      | Repeated Cesarean                      | -34.869     |                |
|                      | Repeated Cesarean                      | -11.411     |                |
|                      | Accredited private health institutes   |             |                |
|                      | Group I: First Cesarean                | -5.273      |                |
|                      | Group II: First Cesarean               | -4.419      |                |
|                      | Repeated Cesarean                      | -12.545     |                |
|                      | Repeated Cesarean                      | -11.809     |                |
|                      | Non-accredited private health institutes|             |                |
|                      | First Cesarean                         | -9.609      |                |
|                      | Repeated Cesarean                      | -9.609      |                |
| Veneto               | Public health institutes               |             |                |
|                      | Group I: First Cesarean                | -3.757      | n.s.           |
|                      | Group II: First Cesarean               | -4.942      |                |
|                      | Repeated Cesarean                      | -6.488      |                |
|                      | Repeated Cesarean                      | -9.478      |                |
|                      | Accredited private health institutes   |             |                |
|                      | Group I: First Cesarean                | -4.328      |                |
|                      | Group II: First Cesarean               | -4.222      |                |
|                      | Repeated Cesarean                      | -8.232      |                |
|                      | Repeated Cesarean                      | -11.644     |                |
| Friuli V. Giulia     | Public health institutes               |             |                |
|                      | Group I: First Cesarean                | -4.447      | n.s.           |
|                      | Group II: First Cesarean               | -4.361      |                |
|                      | Repeated Cesarean                      | -10.692     |                |
|                      | Repeated Cesarean                      | -11.052     |                |
|                      | Accredited private health institutes   |             |                |
|                      | Group I: First Cesarean                | -4.222      |                |
|                      | Group II: First Cesarean               | -4.222      |                |
|                      | Repeated Cesarean                      | -11.644     |                |
| Liguria              | Public health institutes               |             |                |
|                      | Group I: First Cesarean                | -3.578      | n.s.           |
|                      | Group II: First Cesarean               | -3.932      |                |
|                      | Repeated Cesarean                      | -5.683      |                |
|                      | Repeated Cesarean                      | -7.010      |                |
|                      | Accredited private health institutes   |             |                |
|                      | Group I: First Cesarean                | -3.932      |                |
|                      | Group II: First Cesarean               | -6.006      |                |
|                      | Repeated Cesarean                      | -6.006      |                |

(Continued)
Table 3. $\Gamma(k)$ values distributions (Continued)

| Region                 | Health care institutes                          | $\Gamma(k)$ | Intercept test |
|------------------------|-------------------------------------------------|-------------|----------------|
| Emilia Romagna         | Public health institutes                        |             | n.s.           |
|                        | Group I: First Cesarean                         | -3.632      |                |
|                        | Repeated Cesarean                              | -37.377     |                |
|                        | Group II: First Cesarean                        | -3.810      |                |
|                        | Repeated Cesarean                              | -6.815      |                |
| Toscana                | Public health institutes                        |             | n.s.           |
|                        | Group I: First Cesarean                         | -3.596      |                |
|                        | Repeated Cesarean                              | -7.030      |                |
|                        | Group II: First Cesarean                        | -4.429      |                |
|                        | Repeated Cesarean                              | -8.534      |                |
|                        | Non-accredited private health institutes        |             |                |
|                        | First Cesarean                                 | -3.961      |                |
|                        | Repeated Cesarean                              | -3.614      |                |
| Umbria                 | Public health institutes                        |             | n.s.           |
|                        | Group I: First Cesarean                         | -3.668      |                |
|                        | Repeated Cesarean                              | -5.835      |                |
|                        | Group II: First Cesarean                        | -3.696      |                |
|                        | Repeated Cesarean                              | -5.401      |                |
| Marche                 | Public health institutes                        |             | n.s.           |
|                        | Group I: First Cesarean                         | -3.573      |                |
|                        | Repeated Cesarean                              | -4.314      |                |
|                        | Group II: First Cesarean                        | -3.510      |                |
|                        | Repeated Cesarean                              | -4.879      |                |
| Lazio                  | Public health institutes                        |             | n.s.           |
|                        | Group I: First Cesarean                         | -4.128      |                |
|                        | Repeated Cesarean                              | -6.584      |                |
|                        | Group II: First Cesarean                        | -4.746      |                |
|                        | Repeated Cesarean                              | -7.442      |                |
|                        | Accredited private health institutes            |             |                |
|                        | Group I: First Cesarean                         | -4.467      |                |
|                        | Repeated Cesarean                              | -7.390      |                |
|                        | Group II: First Cesarean                        | -4.119      |                |
|                        | Repeated Cesarean                              | -6.326      |                |
|                        | Non-accredited private health institutes        |             |                |
|                        | First Cesarean                                 | -3.610      |                |
|                        | Repeated Cesarean                              | -6.256      |                |
| Campania               | Public health institutes                        |             |                |
|                        | Group I: First Cesarean                         | -3.556      | p=0.033        |
|                        | Repeated Cesarean                              | -3.652      |                |
|                        | Group II: First Cesarean                        | -3.560      |                |
|                        | Repeated Cesarean                              | -3.550      |                |
|                        | Accredited private health institutes            |             |                |
|                        | Group I: First Cesarean                         | -3.544      |                |
|                        | Repeated Cesarean                              | -3.728      |                |
|                        | Group II: First Cesarean                        | -3.709      |                |
|                        | Repeated Cesarean                              | -3.917      |                |
Table 3. \( \Gamma(k) \) values distributions (Continued)

| Region               | Health care institutes                  | \( \Gamma(k) \)     | Intercept test |
|----------------------|----------------------------------------|---------------------|----------------|
| **Puglia**           | Public health institutes               |                    |                |
| Group I:             | First Cesarean                         | -3.981             | n.s.           |
| Group II:            | Repeated Cesarean                      | -10.018            |                |
| Accredited private health institutes |                       |                    |                |
| Group I:             | First Cesarean                         | -3.863             |                |
| Group II:            | Repeated Cesarean                      | -4.499             |                |
| **Basilicata**       | Public health institutes               |                    |                |
| Group I:             | First Cesarean                         | -3.545             | n.s.           |
| Group II:            | Repeated Cesarean                      | -7.245             |                |
| **Calabria**         | Public health institutes               |                    |                |
| Group I:             | First Cesarean                         | -3.634             | n.s.           |
| Group II:            | Repeated Cesarean                      | -5.413             |                |
| Accredited private health institutes |                       |                    |                |
| Group II:            | First Cesarean                         | -3.771             |                |
| Group II:            | Repeated Cesarean                      | -5.447             |                |
| **Sicilia**          | Public health institutes               |                    |                |
| Group I:             | First Cesarean                         | -3.919             | n.s.           |
| Group II:            | Repeated Cesarean                      | -4.483             |                |
| Accredited private health institutes |                       |                    |                |
| Group I:             | First Cesarean                         | -4.079             |                |
| Group II:            | Repeated Cesarean                      | -4.869             |                |
| **Sardegna**         | Public health institutes               |                    |                |
| Group I:             | First Cesarean                         | -3.548             | n.s.           |
| Group II:            | Repeated Cesarean                      | -5.413             |                |
| Accredited private health institutes |                       |                    |                |
| Group II:            | First Cesarean                         | -3.858             |                |
| Group II:            | Repeated Cesarean                      | -5.553             |                |
|                      |                                        | -3.615             |                |
|                      |                                        | -4.166             |                |

(Continued)
Table 3. $\Gamma(k)$ values distributions (Continued)

| Region | Health care institutes | $\Gamma(k)$ | Intercept test |
|--------|------------------------|-------------|----------------|
| ITALY  | Public health institutes |             | n.s.           |
|        | Group I: First Cesarean  | -5.443      |                |
|        | Repeated Cesarean       | -8.975      |                |
|        | Group II: First Cesarean | -6.514      |                |
|        | Repeated Cesarean       | -10.294     |                |
|        | Accredited public private health institutes | | |
|        | Group I: First Cesarean  | -5.556      |                |
|        | Repeated Cesarean       | -8.975      |                |
|        | Group II: First Cesarean | -4.829      |                |
|        | Repeated Cesarean       | -5.461      |                |
|        | Non-accredited public private health institutes | | |
|        | First Cesarean          | -3.643      |                |
|        | Repeated Cesarean       | -7.254      |                |

$\Gamma(k)$ distributions are reported according to Italian regions and health care institute type. The significance of intercept test is also reported.

Table 4. Self organized criticality assessment.

| Italian region     | Fractal | Zipf’ test | Noise (beta) | Self organized criticality |
|--------------------|---------|------------|--------------|---------------------------|
| Piemonte           | Yes     | +          | Black (2.951)| No                        |
|                    |         | n.s.       |              |                           |
| Lombardia          | Yes     | -          | Black (4.806)| No                        |
|                    |         | p=0.002    |              |                           |
| Veneto             | Yes     | -          | Black (3.869)| No                        |
|                    |         | p<0.001    |              |                           |
| Friuli V.Giulia    | Yes     | +          | Black (3.962)| No                        |
|                    |         | n.s.       |              |                           |
| Liguria            | Yes     | -          | Black (2.957)| No                        |
|                    |         | p<0.001    |              |                           |
| Emilia Romagna     | Yes     | +          | Black (2.971)| No                        |
|                    |         | n.s.       |              |                           |
| Toscana            | Yes     | +          | Black (3.983)| No                        |
|                    |         | n.s.       |              |                           |
| Umbria             | Yes     | +          | Black (2.879)| No                        |
|                    |         | n.s.       |              |                           |
| Marche             | Yes     | +          | Black (2.833)| No                        |
|                    |         | n.s        |              |                           |
| Lazio              | Yes     | -          | Black (4.835)| No                        |
|                    |         | p=0.001    |              |                           |
| Campania           | No      | +          | Black (4.002)| No                        |
|                    |         | n.s.       |              |                           |
Table 4. Self organized criticality assessment. (Continued)

| Region    | Type | Sign | p-Value | Black (5.007) | No |
|-----------|------|------|---------|---------------|----|
| Puglia    | Yes  | -    | p=0.023 | Black (5.007) | No |
| Basilicata| Yes  | +    | n.s.    | Black (2.927) | No |
| Calabria  | Yes  | +    | n.s.    | Black (3.892) | No |
| Sicilia   | Yes  | +    | n.s.    | Black (4.914) | No |
| Sardegna  | Yes  | +    | n.s.    | Black (3.832) | No |
| ITALY     | Yes  | -    | p=0.006 | Black (4.717) | No |

Bak’ criteria for the self organized criticality [7] are reported. The regions without more than a type of health care institute are not reported.

the Cesarean section phenomenon. This is mainly due to different rates of Cesareans. Differently, the fractal statistics, checking for similarities among shapes, is able to depict both similar behavior and chaos involvement, despite different overall rates of Cesareans.

To date, the concern about the assessment of Cesarean section rates has pushed to order the Cesarean sections according to the type of patients underwent surgical delivery. This is the well know Robson’ classification (11). The Robson’ classes are useful to compare Cesarean sections among hospitals, regions, countries (12,13). The Robson’ classification, however, is only able to mach the rates of classes, but it cannot provide the image of the overall policies of conceding the Cesarean section. Critical issues of hospitals and health system (5,14-19), along with perspectives of patients (20,21), obstetricians, and other stakeholders (5,22) could condition the behavior of performing the Cesarean sections in each Robson’ classes. By applying a fractal statistics to the rate of Cesareans according to Robson classes, it could be best compared the trend of the overall hospital or regional behavior in conceding the Cesareans.

In conclusion, fractal statistics applied to administrative data on Cesarean section is able to provide an image of the surgical delivery biomedical process. It can also easily identify the items responsible of the chaotic shapes, where health managers can intervene.

Conflict of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.
Table 5. Coincidence test results.

|                  | Lombardia | Veneto | Friuli V. G. | Liguria | E. Romagna | Toscana | Umbria | Marche | Lazio | Puglia | Basilicata | Calabria | Sicilia | Sardegna | ITALY |
|------------------|-----------|--------|--------------|---------|------------|---------|--------|--------|-------|-------|-----------|----------|---------|----------|-------|
| Piemonte         | 0.019     | <0.001 | 0.435        | 0.097   | 0.441      | 0.278   | 0.447  | <0.001 | 0.019 | 0.446 | 0.502      | 0.588    | 0.553   | <0.001   | 0.360 |
| Lombardia        | <0.001    | 0.024  | 0.192        | 0.037   | 0.052      | 0.097   | <0.001 | 0.293  | 0.160 | <0.001| 0.240      | 0.240    | <0.001  | <0.001   | 0.124 |
| Veneto           | <0.001    | <0.001 | <0.001       | <0.001  | <0.001     | <0.001  | <0.001 | 0.041  | <0.001| <0.001| <0.001     | 0.532    | 0.414   | <0.001   | <0.001|
| Friuli V. G.     | 0.591     | 0.435  | 0.122        | 0.261   | <0.001     | 0.024   | 0.058  | 0.435  | 0.234 | 0.408 | <0.001     | 0.240    | <0.001  | 0.255    |
| Liguria          | 0.143     | 0.170  | 0.250        | <0.001  | 0.797      | 0.336   | 0.343  | <0.001 | 0.400 | <0.001| 0.240     | 0.400    | <0.001  | 0.239    |
| E. Romagna       | 0.286     | 0.447  | <0.001       | 0.037   | 0.446      | 0.504   | 0.588  | 0.941  | <0.001| 0.460| 0.360      | <0.001   | 0.360   |
| Toscana          | 0.032     | <0.001 | 0.052        | 0.384   | 0.525      | 0.687   | 0.420  | <0.001 | 0.263 |
| Umbria           | <0.001    | 0.097  | 0.156        | 0.447   | 0.588      | 0.565   | <0.001 | 0.097  |       |
| Marche           | <0.001    | <0.001 | <0.001       | <0.001  | <0.001     | <0.001  | <0.001 | <0.001 | <0.001|
| Lazio            | <0.001    | 0.213  | 0.160        | <0.001  | 0.240      | 0.240   | <0.001 | 0.124  |
| Puglia           | 0.052     | 0.126  | 0.301        | <0.001  | 0.167      |         |       |        |
| Basilicata       | 0.805     | 0.553  | 0.588        | 0.360   |
| Calabria         | 0.127     | <0.001 | 0.065        |         |
| Sicilia          | <0.001    | 0.240  |             |         |
| Sardegna         | <0.001    |        |              |         |

p values for the coincidence tests. The p values represent the likelihood that the regression lines are coincident (meaning similarities among shapes). The p value set to be significant has been ≥80%; significant results have been highlighted in bold.
Figure 1. Images of the cumulative distributions for each region with fractal shape. On the ordinate axis: 1=Public health institutes (Group I) – First Cesarean; 2=Public health institutes (Group I) – Repeated Cesarean; 3=Public health institutes (Group II) – First Cesarean; 4=Public health institutes (Group II) – Repeated Cesarean; 5=Accredited private health institutes (Group I) – First Cesarean; 6=Accredited private health institutes (Group II) – Repeated Cesarean; 7=Accredited private health institutes (Group I) – First Cesarean; 8=Accredited private health institutes (Group II) – Repeated Cesarean; 9=Non-accredited private health institutes – First Cesarean; 10=Non-accredited private health institutes – Repeated Cesarean.
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