

Distr.: General
31 March 2016

English only

Economic Commission for Europe

Conference of European Statisticians

Joint Eurostat/UNECE Work Session on Demographic Projections

Geneva, 18-20 April 2016

Item 4 of the provisional agenda

Assumptions on fertility

Estimation of Fertility in Colombia through an adjustment for coverage of births with immunization records

Prepared by the National Administrative Department Of Statistic (Dane), Colombia¹

Summary

DANE in his innovation efforts and statistical use of administrative records looks for generate alternatives to produce demographic information and suggest solutions to the limitations on coverage of vital statistics in the territories, which represents the greatest challenge to monitor dynamics of the population.

Currently, DANE explores the methodological use of immunization record generated by the Ministry of Health, through the PAI; this document compares the report of vital statistics births against the dose total BCG (Anti-tuberculosis) vaccines applied in children under one-year-old.

In this way, DANE explores the elaboration of fertility estimates using direct methods with administrative records. Focusing geographically in departments with the highest sub-coverage to achieve a detailed analysis of the information collected, locating territories where the DANE should strengthen capturing of vital statistics information. Finally, the usefulness of coverage analysis conducted provides an estimate of the total and age-specific fertility rate calculated directly.

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I. Introduction

1. The DANE, as the official entity of Colombia charge of producing and expanding statistics pertaining to fertility, should guarantee the quality of the information in the levels of required segregation and propose strategies to strengthen them.
2. In Colombia, there are conditions that make it difficult to collect data pertaining births, like the characteristics of the Colombian territory and its political division which make it so that there is no coverage in the collection of vital records; this is the case in the small areas inside of the towns. The above implicates a challenge for the DANE, in which strategies need to be established in order to lower the level of omission of information not collected, to elaborate the fertility indicators.
3. Through the process of modernization, the DANE looks to investigate, innovate and supplement statistical production methods to provide timely statistical information for the formulation of public policies that encourage national development taking into account the socio-economic impact of the demographic phenomena, especially in fertility.
4. This is why strengthening the technical measurement of fertility is a priority of the Department of Census and Demography given the constraints and limitations of the data sources in Colombia. In this sense, the population projection shows a gap unidentified in the estimation of births and overall growth of the population, especially in small areas.
5. Therefore, due to information gathered from the Expanded Program on Immunization (PAI²) implemented by the Ministry of Health and Social Protection (MSPS³) at the municipal level, we propose analysis coverage for birth registration of Vital Statistics (EEVV⁴) stockpiled by DANE for direct measurement of fertility.
6. Traditionally in Colombia, the study of fertility, specifically it derived from the following sources of information:
 - Population censuses, which provide information that allows to calculate and review the coverage from other sources.
 - Surveys (prospective and retrospective), in this case the Demographic and Health Surveys (DHS) and the Household Survey is used.
 - Vital Statistics (EEVV).
7. To these traditional sources adheres the increasing use of administrative records⁵, which have many advantages over their use for statistical purposes (ECLAC, 2003). They are: lower costs in obtaining it, provide a wide coverage in

² Acronym at Spanish of “Programa Ampliado de Inmunización”

³ Acronym at Spanish of “Ministerio de Salud y Protección Social”

⁴ Acronym at Spanish of “Estadísticas Vitales”

⁵ Administrative records correspond to the information entered entities to demonstrate the occurrence of an event in exercise of their functions (Arroyo, 2006) (Casanova, 2009)

the population and in time, facilitate the possibility of disaggregation in subpopulations, provide the ability to track the same individuals over extended periods of time and reduce duplication of efforts in public administration (Wallgren & Wallgren, 2007). For this study have the following administrative records:

- Expanded Program on Immunization (PAI) has the registration of biological information distributed to the entire population, including minors.
- Births Vital Statistics (EEVV) refers to the total of registered live births and occurred in the country in each calendar year.
- Individual Register of Providers of Health Services (RIPS) information about General System of Social Security System in health for the regulation and national control records.

8. Immunization record to minors is directly related to the information of birth registration in the country because they have the same target population; every child born alive in health institutions, with or without a certificate of vital fact (Registration Form vital statistics), because it should be given by law the necessary vaccines. From which it is achieved have information that can complement births for some reason or another failed to be included in the register of vital statistics.

9. From the availability of these records, DANE performed an analysis of national and departmental coverage for birth registration of EEVV through the PAI immunization register, to obtain an estimate of the overall fertility rate adjusted. Finally, geographically locating through registration RIPS it is possible to get the municipal coverage, emphasizing municipalities with centers able to receive deliveries health.

Description of available sources

10. The geographical coverage of the above records is national and their level of disaggregation is the municipal per occurrence/residence for EEVV and occurrence in the PAI⁶. Its reference period is for PAI register from 1994 to 2014, while for EEVV births from 1998 to 2013, final figures (preliminary years 2014- 2015). The entire vaccination schedule; also it includes vaccines for women of childbearing age and pregnant women⁷ with vaccines given to children under one year, according to the National immunization schedule for 2016⁸. It is noted that the BCG, OPV, Anti hepatitis B, DPT and HiB vaccines, they aim population less than one year; BCG being most suitable for our exercise, because supplied at the time the child is born⁹ and besides having a single dose.

⁶ DANE only had access to information of occurrence of vaccines; however, the MSPS has the place of residence of the mother.

⁷ DANE currently does not have access to this information.

⁸ <https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VS/PP/PAI/ficha-vacunas-cara-a-b.pdf>. Historically, national vaccination scheme has had changes due to the inclusion of new vaccines, becoming currently the most complete and modern in Latin America.

⁹ The vaccine is not provided to children until they have a weight greater than 2500 mg. Although the percentage of children with low birth weight is 9% nationally, this lag effect is offset by the time children reach the weight and after receiving the vaccine.

11. It is noteworthy that the registration of PAI vaccines has problems, like vital statistics registration:

- Underreporting because not all children receive vaccines.
- Backwardness with children who are not applied vaccines on the dates suggested, but may be included in the register after that vaccines are applied later.

II. Methodology

12. For coverage analysis was done a comparison through the reporting of births by the place of occurrence¹⁰ of EEVV versus the total doses of vaccines of BCG (anti-tuberculosis) applied between 1998 and 2014 to newborn children and infants under one year old.

13. In this exercise, were analyzed: levels, trends, dispersion, absolute differences, relative differences, participation and coverage between records to show the results of statistical analysis based on administrative records (INEGI, 2012).

14. A similar exercise was carried out with the DPT vaccine, given that vaccine is a tracer to measure program performance. As a result of this exercise it was identified that the registration of the DPT vaccine against births in vital statistics, it has quality problems and natural lag (children aged 2, 4 and 6 months) in the registry, which can lead to wrong conclusions.

A. Analysis of coverage of EEVV births through the Administrative Register PAI

15. Coverage analysis was conducted at the national, departmental and municipal levels. In the domestic case, the goal was to make a comparison between records, determining trends, levels and dispersion. After, a correction is then proposed in the register of vital statistics, keeping movements or dispersion of the series, modifying the observed trend by the vaccination program and finally adjusting the level according to census data (reference point that allows us to measure the undercoverage of the registry in 2005).

16. At the departmental level, the absolute and relative differences between records were reviewed; identifying from participation in the national underreporting, departments that contribute most to underreporting of EEVV, according to the PAI registration. Thereby identifying the departments where they should have a better accompaniment by the DANE team.

17. At the municipal level the absolute and relative differences between records from a spatial vision also was reviewed, seeking to explain the spatial reasons why the PAI has more birth records regarding EEVV for a specific department. This type of representations facilitate comparison of statistical measures between

¹⁰ In the case of registration PAI, the occurrence of vaccine is associated with the place where the child was vaccinated. For quality issues in the report should be consider that doctors sometimes confuse the place of residence with the occurrence.

regions, showing the variability between regions depending on the intensity of the colors.

B. Estimation of fertility from the adjusted information births

18. After the national correction in the level and trend of EEVV births, these new totals are used to adjust the number of live births by age of the mother of EEVV, preserving the age structure. Then we calculated directly specific fertility rates per year. In these cases the numerator was the number of live births EEVV by age group of mother corrected, and as the denominator the total number of women of childbearing age projected in the same group.

19. We understand that, by relating information from a tight record with population projections, it can be introduced bias into the calculations which its size and geographical distribution is unknown; therefore it expected that the adjustment of births helps correct the omission in calculating the indicator. This illustrative exercise is a useful tool to size the overestimation of the projection of fertility in the country.

III. Results

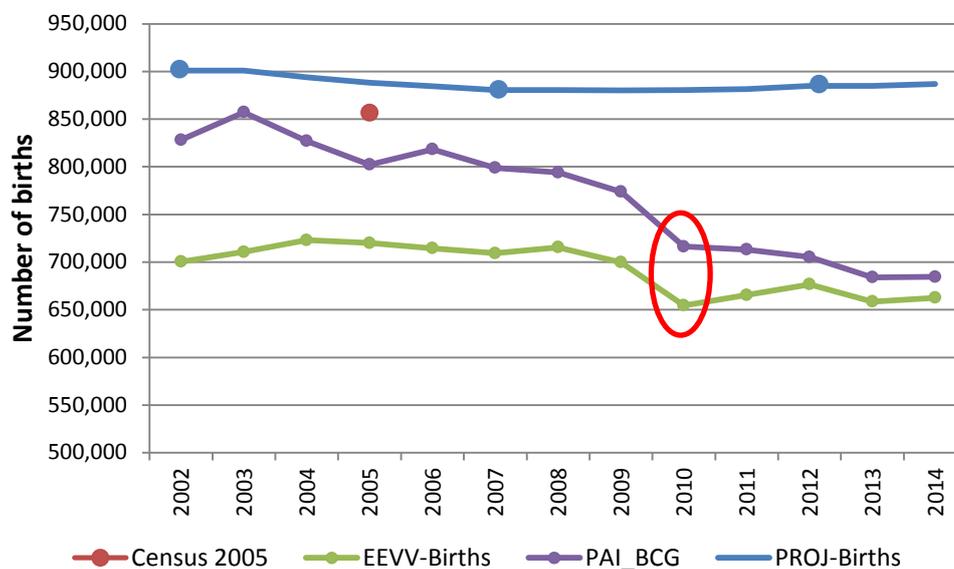
A. Analysis of coverage at national level

20. In **Figure 1** are presented 4 sources of information related to total births per year from 2002 to 2014. These information sources are as follows:

- **PROJ-Births:** Estimated number of births by DANE for five years. Currently this information is estimated from 1985 to 2020. In the illustration this information is represented as blue dots in the middle of the 2000-2004, 2005-2019 and five-year periods from 2010 to 2014. Likewise, the blue line drawn is calculated from the polynomial interpolation between these points.
- **EEVV- Births:** Total births in the register of EEVV of DANE at national level. Currently this information is estimated from 1998-2014 (preliminary).
- **PAI_BCG:** Total vaccine against tuberculosis (BCG) applied in the country as recorded by PAI. This information was shared by the MSPS from 1994 to 2014.
- **Census 2005:** All children under one year reported since the last census conducted by the DANE in 2005. This figure unlike the information live births last year in women aged 12 and older (fertility module in the census), contains the total number of children born living the previous year regardless of the age of the mother; which makes it more comparable with vital statistics.

21. An overestimation in the projections of the number of births generated by DANE is identified. In addition, an average coverage of 75% of EEVV against projections of births (PROJ-Births) for the last four years is observed. While EEVV against immunization record (PAI-BCG) is 96% for the last four years.

Figure 1. Births vital statistics registration, PAI register (BCG) and quinquennial estimates from 2002 to 2014



Source: DANE and MSPS – Expanded Program on Immunization (PAI). Own calculations

22. To further analyze these two sources were studied:

23. **Trend:** A linear regression analysis¹¹, suggests that the two series are described by negative slopes. In terms of fertility, negative slope is referred to a decline in the natality year after year. The distance between this series represents the improvement that has been taking EEVV registration with respect to PAI.

24. **Level:** For 2002, the difference between the two records was around 150,000 children, while in 2014 the difference is around 20,000 infants.

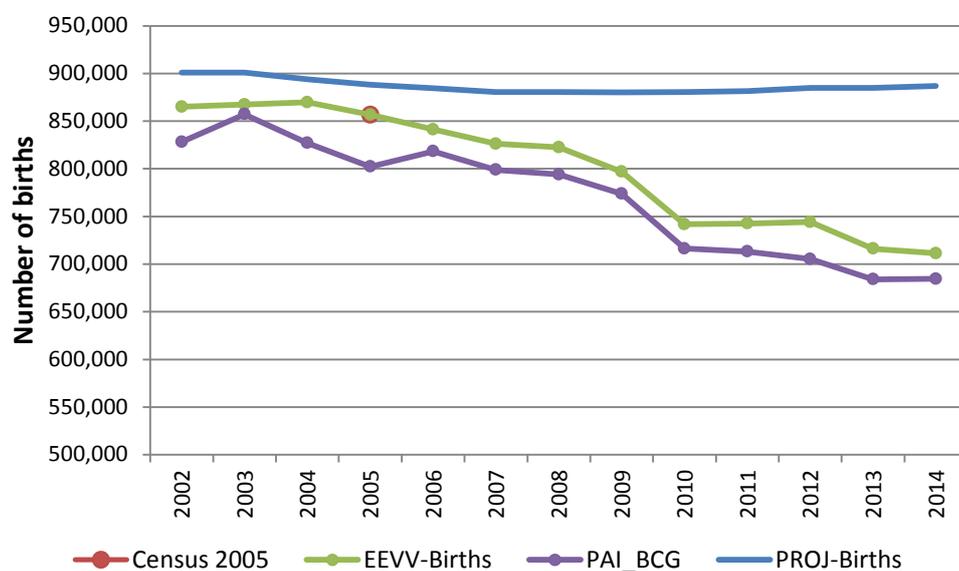
25. **Dispersion:** the Pearson correlation coefficient showed a direct dependence of 0.904¹², meaning that about 90% of the variation in one variable is explained by the another. Considering that the two series have the same target population, this analysis to suggest that the number of EEVV and PAI match the movements (increases and decreases).

26. The exercise shown in Figure 2, is the adjustment level and trend EEVV series, retaining the movements described by EEVV. In particular, the trend adjustment means adjusting the slope of PAI identified to EEVV, maintaining historical movements EEVV series. Likewise, the level adjustment was to take the series of EEVV our most reliable data is the census of 2005. In short, we are talking about a correction around 160,000 births since 2002 and a final correction of 48,000 by 2014.

¹¹ In this regression analysis the significance of the estimated coefficients and compliance with the assumptions of the model was checked.

¹² The correlation is significant at 0.01 according to the test.

Figure 2. Trend setting and level applied to the birth of the EEVV from immunization record



Source: DANE and MSPS – Expanded Program on Immunization (PAI). Own calculations

B. Coverage analysis at the departmental level

27. In Table 1 are shown:

- Relative differences: to illustrate, in the case of Valle 2014 the number of births of EEVV represented 96% of the administered vaccines.
- Absolute differences: Continuing the above example, 4% missing for the EEVV and PAI were equal in the department of Valle was 2,543 records.
- Percentage distribution of the national undercoverage¹³: in particular, underreporting of Valle, representing 9% of 100% of the national undercoverage between the EEVV, according to the PAI.

Table 1. Differences absolute, relative and percentage distribution of national undercoverage at the departmental level *, from 2011 to 2014 **.

DEPARTMENTS	Relative difference (EEVV/PAI)					Absolute difference (PAI-EEVV)					Percentage distribution of	
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2013	2014
NACIONAL	91%	93%	96%	96%	97%	61.657	47.638	28.434	25.202	20.683		
AMAZONAS	78%	81%	87%	83%	89%	369	328	241	296	192	1%	1%
ANTIOQUIA	99%	99%	95%	99%	100%	724	919	4.058	740	100	2%	0%
ARAUCA	107%	132%	102%	101%	97%	-304	-1.082	-67	-44	117	0%	0%
ATLANTICO	100%	101%	105%	98%	99%	-72	-345	-1.866	772	351	2%	1%
BOLIVAR	82%	91%	94%	94%	95%	6.804	3.457	2.203	2.303	1.877	7%	7%
BOYACA	98%	102%	97%	99%	99%	369	-324	474	230	146	1%	1%
CALDAS	101%	107%	103%	102%	102%	-160	-673	-270	-245	-205	0%	0%
CAQUETA	76%	76%	89%	75%	92%	2.309	2.369	1.007	2.607	658	8%	2%
CASANARE	96%	86%	91%	92%	89%	274	999	652	553	753	2%	3%
CAUCA	78%	73%	94%	96%	86%	4.437	5.478	1.089	690	2.640	2%	9%
CESAR	81%	82%	79%	90%	95%	4.338	4.648	5.301	2.405	1.087	7%	4%
CHOCO	51%	52%	51%	58%	55%	4.921	5.149	5.353	4.384	4.825	13%	17%
CORDOBA	72%	89%	99%	98%	101%	9.182	3.732	296	537	-323	2%	0%
CUNDINAMARCA	100%	101%	105%	105%	105%	-341	-864	-6.456	-5.996	-6.408	0%	0%
GUAINIA	68%	66%	54%	66%	66%	256	312	402	296	302	1%	1%
GUAVIARE	90%	85%	84%	89%	94%	148	222	237	133	68	0%	0%
HUILA	98%	101%	120%	107%	104%	443	-156	-3.628	-1.295	-763	0%	0%
LA GUAJIRA	80%	74%	75%	75%	78%	3.071	4.533	4.469	4.474	3.915	14%	14%
MAGDALENA	85%	97%	95%	92%	90%	3.771	765	1.319	2.072	2.352	6%	8%
META	96%	96%	97%	100%	99%	590	596	451	73	235	0%	1%
NARIÑO	83%	86%	90%	92%	91%	3.767	3.011	2.049	1.595	1.833	5%	6%
NORTE DE SANTANDER	93%	91%	98%	96%	95%	1.527	2.194	335	864	1.143	3%	4%
PUTUMAYO	61%	77%	77%	89%	89%	2.496	1.193	1.169	499	479	2%	2%
QUINDIO	87%	102%	101%	100%	101%	906	-103	-71	2	-44	0%	0%
RISARALDA	98%	100%	100%	100%	100%	265	3	48	1	-15	0%	0%
SAN ANDRES	91%	100%	99%	105%	100%	82	1	7	-39	-2	0%	0%
SANTANDER	98%	95%	94%	94%	95%	694	1.795	2.072	1.866	1.676	6%	6%
SUCRE	93%	98%	101%	98%	103%	1.068	248	-101	264	-395	1%	0%
TOLIMA	85%	91%	94%	97%	99%	3.184	1.820	1.246	461	251	1%	1%
VALLE	90%	89%	91%	93%	96%	6.026	6.808	5.984	3.957	2.543	12%	9%
VAUPES	71%	74%	92%	79%	43%	247	225	62	163	508	0%	2%
VICHADA	73%	63%	70%	60%	49%	266	380	369	584	792	2%	3%

Source: DANE and MSPS – Expanded Program on Immunization (PAI). Own calculations

* Bogotá is contained in the department of Cundinamarca. Because of the large volume of human mobility due to the quality of health centers in the capital city.

** Data for 2014 is preliminary.

¹³ Part of the undercoverage, is explained by the population temporarily mobilized to access better health services

28. It can be seen as departments with coverage problems for 2010 have shown an improvement in their coverage EEVV registration; in cases of Córdoba and Bolívar, for example. Córdoba, presents by the year 2010 a difference of 9182 children under one year at the recorded in the system PAI (with a relative difference of 72%) and not in EEVV, for 2014 improved, reaching 323 cases not registered at the PAI (with a relative difference of 101%).

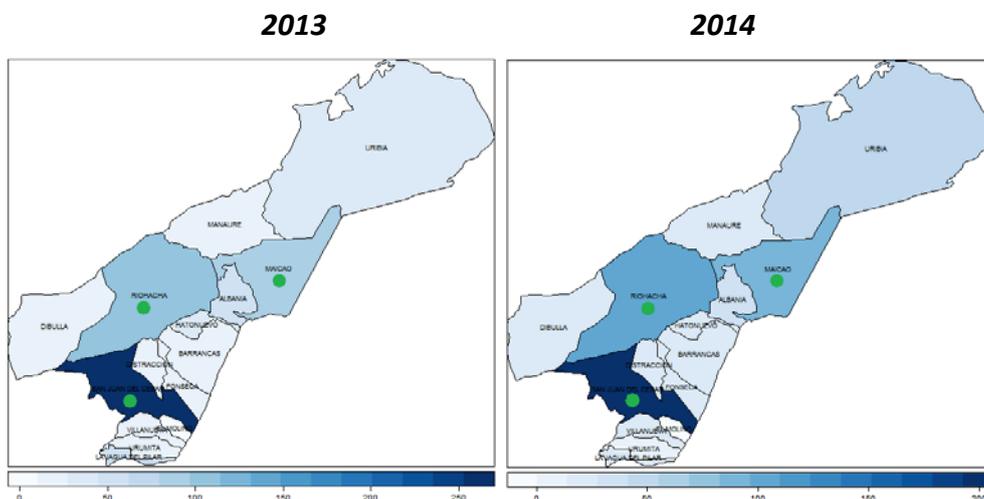
29. However, in relation to the departments that do not show improvement in these periods, we find La Guajira and Chocó, which concentrated about 40% of national undercoverage in 2014. In addition, 2013 was La Guajira the department that reached the highest undercount nationwide.

30. Finally, the departments that meet the highest undercoverage of birth registration, according to the PAI said. So, 10 of the 32 departments concentrated between 81% and 83% of the under-coverage of birth registration, for 2013 and 2014 respectively.

31. This departmental analysis was useful for the team EEVV of the Department of Census and Demography of DANE because it helped identify areas that were included in the improvement plan, where they carry out a strengthening in the collection of the information

C. Analysis of coverage at the municipal level

Figure 3. Choropleth map of relative differences (EEVV / PAI) for the department of La Guajira



Source: DANE and MSPS – Expanded Program on Immunization (PAI). Own calculations

32. For this exercise, the differences relative, absolute and percentage distribution of undercoverage registration is spatially; in the municipalities of the department with the highest undercount (La Guajira) for the years 2013 and 2014.

33. This spatial analysis shows the information presented in Table 2 but illustrated for municipalities in the department of La Guajira, identifying the main health centers and hospitals (according to levels 2 and 3 of care attention¹⁴) with a green dot in the municipalities of Maicao, Riohacha and San Juan del Cesar.

34. For a correct reading of the Figure 3, it must take into account that regions with darker color, represents a good coverage in capturing information births. In the case of San Juan del Cesar a higher concentration of births is observed at 100% which is associated with a good service to births, compared to other nearby centers.

Table 2. Absolute and relative differences for the department of La Guajira.

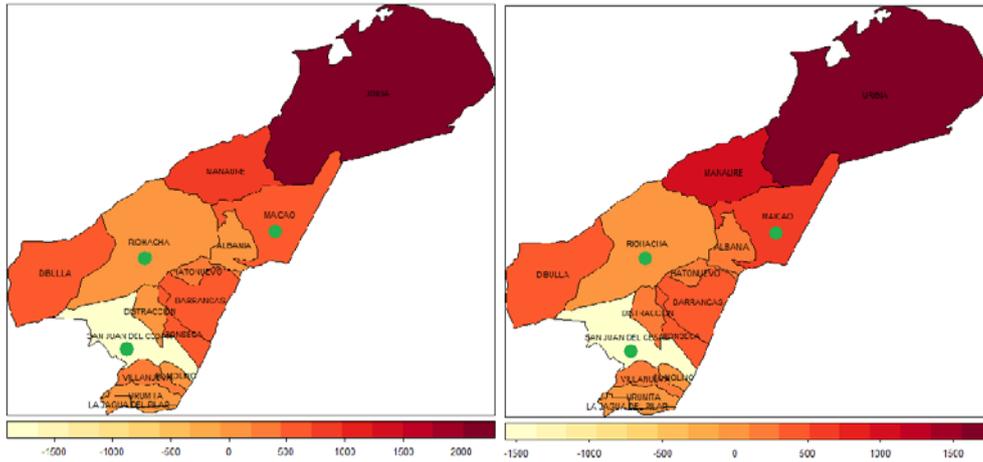
DEPARTMENT: LA GUAJIRA	Relative difference (EEVV/PAI)		Absolute difference (PAI-EEVV)		Percentage distribution of undercoverage	
	2013	2014	2013	2014	2013	2014
MUNICIPALITIES						
TOTAL	75%	78%	4.474	3.915		
RIOHACHA	99%	101%	41	-39	1%	0%
ALBANIA	57%	35%	97	186	1%	2%
BARRANCAS	25%	25%	469	345	6%	5%
DIBULLA	16%	20%	495	360	7%	5%
DISTRACCIÓN	21%	19%	141	120	2%	2%
EL MOLINO	10%	0%	89	82	1%	1%
FONSECA	14%	17%	630	451	8%	6%
HATONUEVO	30%	16%	240	213	3%	3%
LA JAGUA DEL PILAR	56%	26%	7	17	0%	0%
MAICAO	82%	84%	636	610	8%	8%
MANAURE	23%	18%	841	1.063	11%	14%
SAN JUAN DEL CESAR	253%	193%	-1.642	-1.369	0%	0%
URIBIA	43%	52%	2.026	1.561	27%	21%
URUMITA	19%	9%	116	85	2%	1%
VILLANUEVA	25%	26%	288	230	4%	3%

Source: DANE and MSPS – Expanded Program on Immunization (PAI). Own calculations

¹⁴ Information obtained from the Individual Register of Providers of Health Services (RIPS)

35. In Figure 4, the absolute difference between the total reported by EEVV compared with PAI is represented. In this case specifically, if we wanted to see more detail, because the municipality of Uribia has a relative difference of 43% (Figure 3 y Table 2), sufficient to observe the absolute difference for 2013 was 2,026 (Figure 4 y Table 2) children under one year of the PAI recorded in your system and not EEVV

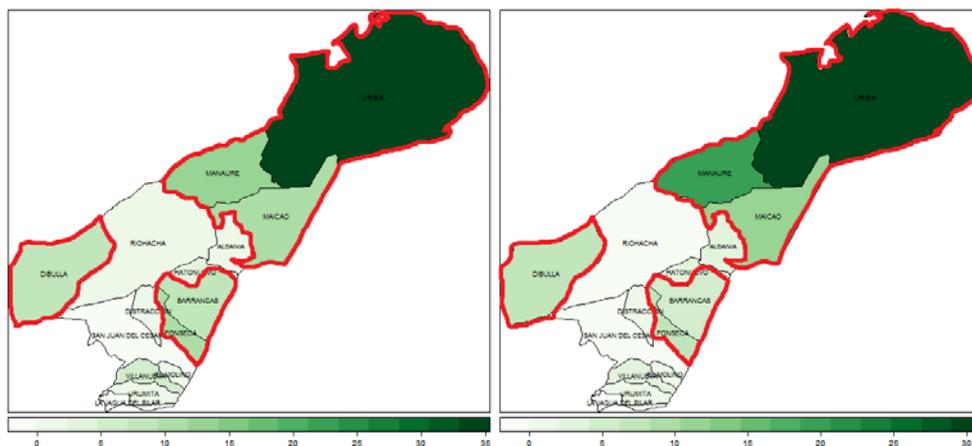
Figure 4. Choropleth map of absolute differences (PAI-EEVV) for the department of La Guaiira



Source: DANE and MSPS – Expanded Program on Immunization (PAI). Own calculations

36. Through the following representation is able to locate the municipalities where should strengthen the capture of the information collected by the team EEVV DANE; ie percentage distribution of departmental undercoverage. Thus, for the 6 municipalities highlighted in Figure 4 of the 15 in the department, 82% and 83% of under-coverage focuses on the department in 2013 and 2014 respectively

Figure 5. Choropleth map of percentage distribution of departmental undercoverage at the municipal level



Source: DANE and MSPS – Expanded Program on Immunization (PAI). Own calculations

D. Estimation of Fertility in Colombia through a coverage adjustment births from immunization record

37. As a result of the exercise of adjustment on EEVV, direct estimation of age-specific fertility rates was developed and subsequently the total fertility rate was calculated; resulting in Table 3 presented below:

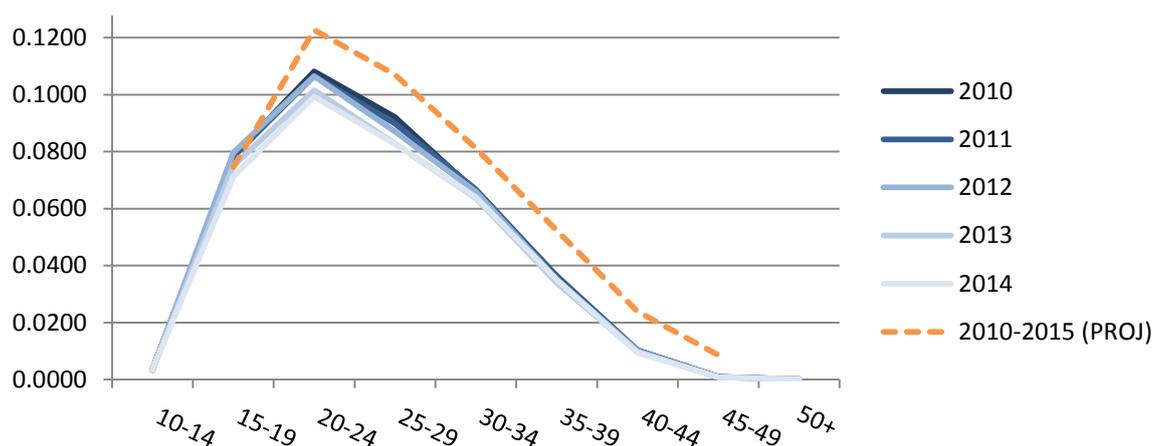
Table 3. Age-Specific Fertility Rate and Total Fertility Rate of adjusted EEVV

		AGE-SPECIFIC FERTILITY RATES PER YEAR											
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Age of Mother	10-14	0,003	0,004	0,004	0,004	0,004	0,004	0,004	0,003	0,003	0,003	0,003	0,003
	15-19	0,093	0,093	0,091	0,090	0,089	0,089	0,085	0,079	0,078	0,080	0,075	0,071
	20-24	0,142	0,141	0,137	0,132	0,127	0,123	0,118	0,108	0,107	0,106	0,101	0,099
	25-29	0,115	0,114	0,112	0,110	0,107	0,106	0,101	0,092	0,090	0,087	0,083	0,083
	30-34	0,083	0,082	0,079	0,076	0,073	0,072	0,070	0,066	0,067	0,066	0,064	0,064
	35-39	0,045	0,045	0,045	0,043	0,042	0,041	0,039	0,036	0,036	0,035	0,034	0,035
	40-44	0,014	0,014	0,013	0,013	0,012	0,012	0,011	0,010	0,010	0,010	0,010	0,009
	45-49	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001	0,001
	50+	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
	TFR	2,49	2,47	2,41	2,34	2,27	2,24	2,14	1,98	1,96	1,94	1,85	1,83

Source: DANE and MSPS – Expanded Program on Immunization (PAI). Own calculations

38. In general, the trend downward slope fertility between 2003 and 2014 (Figure 6). It should also add the difference between the cusps of the projected fertility and births observed by tight; where a national total of the dilated¹⁵ cusps are presented in the two sources.

Figure 6. Age-specific fertility rates projected for quinquennial (2010-2015), compared with adjusted EEVV for the same period



Source: DANE and MSPS – Expanded Program on Immunization (PAI). Own calculations

¹⁵ Higher fertility in women aged in 20 to 29 years old.

39. Differences in fertility levels observed: of which we can say that the projections of fertility rates overestimate the actual behavior of fertility in the country for the quinquennial 2010-2014.

40. Briefly, from the findings presented above, conducting a census, is necessary for the country projections can be updates and reconcile the inter-census information and validate the estimated data from the information recorded by vaccination

IV. CONCLUSIONS

41. According to the analysis in this paper, the overestimation that presents the projections of births in the country is evident. Therefore, it is important to have access to an updated census information, also to verify the quality of immunization records.

42. The estimation exercise developed from the PAI represents a way to investigate and describe the dynamic future of fertility, ensuring timely and quality estimates. Thus, with access to vaccines information given to pregnant women of childbearing age and, it will get feature a complete source for estimating fertility in the future for the country.

43. Likewise, since the exercises are carried out currently by DANE for integration and generation of statistics from administrative records, PAI information is useful to complete data for the experimental statistical register of population, and be able subsequently develop exercises reconstruction of family structures, among others studies.

44. This allows us to approach DANE with the institution responsible for registration of vaccines, which is essential in order to show the importance of registration for future population statistics in Colombia.

45. Another important point in this exercise is the growing global interest in analyzing information related to adolescent fertility, as a tool for understanding the development in the country. Colombia currently has information of 2005 census for the count of fertility in women aged 12 and older. Hence, the need to work with information vital statistics, to reconstruct and analyze live births for all age ranges mothers, in complementarity way with census information.

46. The conditions of undercoverage in departments such as La Guajira, hinder their statistical monitoring for understanding the demographic and epidemiological dynamics to identify and analyze important factors in the life conditions of this population.

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