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The French National Cochlear Implant Registry (EPIIC): results, quality of life, questionnaires, academic and professional life

Auteurs:

F Artières-Sterkers (1),

M Mondain (1),

Karine Aubry (2)

Philippe Bordure (3)

Alexis Bozorg-Grayeli (4)

Olivier Deguine (5)

Carine Eyermann (6)

Valérie Franco-Vidal (7)

Benoit Godey (8)

Nicolas Guevara (9)

Alexandre Karkas (10)

Nathalie Klopp (11)

Marc Labrousse (12)

Jean- Pascal Lebreton (13)

Yannick Lerosey (14)

Emmanuel Lescanne (15)

Natalie Loundon (16)

Rémy Marianowski (17)

Fanny Merklen (1)

Kheira Mezouaghi (18)

Thierry Mom (19)

Sylvain Moreau (20)

Isabelle Mosnier (21)

Nathalie Noël-Petroff (22)

Christine Poncet (23)

Emilien Radafy (24)

Stéphane Roman (25)

Samantha Roux-Vaillard (26)

Sébastien Schmerber (27)

Laurent Tavernier (28)

Eric Truy (29)

Christophe Vincent (30)

A Uziel (1)*

Affiliations :

(1) Service ORL- CHU de Montpellier, Montpellier, France

(2) CHU de Limoges, Limoges, France

(3) CHU de Nantes, Nantes, France

(4) CHU de Dijon, Dijon, France

(5) CHU de Toulouse, Toulouse, France

(6) CHU de Strasbourg, Strasbourg, France

(7) CHU de Bordeaux, Bordeaux, France

(8) CHU de Rennes, Rennes, France

(9) CHU de Nice, Nice, France

(10) CHU de St Etienne, Saint-Etienne, France

(11) CHU d'Amiens, Amiens, France

(12) CHU de Reims, Reims, France

(13) CHU de Poitiers, Poitiers, France

(14) CHU de Rouen, Rouen, France

(15) CHU de Tours, Tours, France

(16) Hôpital Necker, Paris, France

(17) CHU de Brest, Brest, France

(18) CH de La Réunion, La Réunion, France

(19) CHU de Clermont-Ferrand, Clermont-Ferrand, France

(20) CHU de Caen, Caen, France

(21) Hôpital Pitié-Salpêtrière, Paris, France

(22) Hôpital Robert Debré, Paris, France

(23) Hôpital Rothschild, Paris, France

(24) CH du Lamentin, Martinique, France

(25) CHU de Marseille, Marseille, France

(26) CHU d'Angers, Angers, France

(27) CHU de Grenoble, La Tronche, France

(28) CHU de Besançon, Besançon, France

(29) CHU de Lyon, Lyon, France

(30) CHU de Lille, Lille, France

* Corresponding author.

E mail address : alain.uziel@free.fr (A. Uziel)

Service ORL- CHU de Montpellier, Montpellier, France

Abstract

This study concerns the results of cochlear implantation in children and adults from French cochlear implantation centers, monitored at one, two and three years by the Cochlear Implant French Registry EPIIC.

This multicenter study enrolled 2603 subjects (1667 adults and 936 children) implanted in one ear.

The following parameters were studied: hearing overall performances, monosyllabic or disyllabic word perception, speech intelligibility, self-assessment questionnaire of Cochlear Implant (CI) benefits (Abbreviated profile of Hearing aid Benefit); professional activity and schooling.

This study confirms the ceiling effect in adults' performances after the 1st year and the progressive growth in children's performances. It also shows that the contralateral hearing aid enhances performances compared to the CI alone condition, in all follow-up sessions.

The French register of CIs is the only worldwide register of systematic follow-up on a period of three years and more of all adults and children implanted in a country.

Key words: cochlear implant, registry, academic, questionnaires, quality of life

Introduction

This study concerns the results of cochlear implantation in children and adults from French cochlear implantation centers, monitored at one, two and three years post CI by the Cochlear Implant French Register.

Subjects and Methods

This multicenter study enrolled 2603 subjects (1667 adults and 936 children with prelingual deafness) implanted in one ear. Results on bilateral implantation will be studied in another article. Table 1 shows the patients' demographics at year one, two and three post CI. Subjects were divided into 3 groups: adults, children over 2 years old, and children under 2.

Fig.1 shows the histogram of ages at implantation. In children, the median age is 3.37. Figures 2 a and b show boxplots on ages at implantation for children between 0 and 18 months and for the overall panel.

The following parameters were studied: hearing overall performances, monosyllabic or disyllabic words perception, speech intelligibility, self-assessment questionnaire of CI benefits (Abbreviated profile of Hearing aid Benefit); professional activity and schooling.

Overall hearing performances were assessed using the "Categories of Auditory Performance" (CAP) on a scale ranging from 1 to 9 [1].

A speech perception test was run at 65 dB with French monosyllabic (PBK) or disyllabic word lists (Fournier). Overall, disyllabic word lists were used in 62% of cases and the monosyllabic ones in 38%.

Speech intelligibility was assessed by the Speech Intelligibility Rating (SIR) on a scale ranging from 1 to 5 [2].

The benefit from hearing aid amplification was measured with the APHAB questionnaire (Abbreviated Profile of Hearing Aid Benefit). It uses 4 categories: ease of communication, background noise, reverberation, sound aversion [3]. This questionnaire calculates the percentage of difficulty in each category for 2 conditions (before and after cochlear implantation).

Finally, the registry listed the type of children's schooling: inclusion (enrolled without institutional support), integration (enrolled with institutional support) or specialized school. For the adults, the registry listed the professional activity such as: working, student, retired, looking for work, invalidity, unemployed.

Table 2 shows the percentage of data correctly completed for each parameter. We noticed that there is a big variability depending on the parameter and the date of follow-up session.

Results

Fig.3 shows CAP scores evolution in terms of follow-up. In adults and children over 2, the Student test shows a significant increase in performances at the 1 year and 2 years intervals. There is no significant difference between the tests at 2 and 3 years after CI in children above 2. In children under 2, there is a significant improvement of CAP scores during the 3-years of follow-up ($p < 0.0001$).

Fig.4 and 5 show the evolution of speech recognition of dissyllabic and monosyllabic words in terms of follow-up duration in the three categories studied. With dissyllabic word lists (Fig.4), in adults, there is a ceiling effect on performances at one-year post-implantation with a mean value of 60%. The use of the contralateral hearing aid results in a mean performance improvement of 11% at year 1 and 18 % at year 2. For children above 2, there is also a rapid improvement in dissyllabic words recognition at one-year post CI compared to pre-implantation. The Student test results show that performances do not increase significantly after one year. The use of contralateral hearing aid gives a significant improvement of

performances ($p < 0.0001$). For children under 2 with no language at pre-implantation, we observe a gradual increase of the performances at 1, 2 and 3 years post CI; however, there is no significant improvement with a contralateral hearing aid. ($p = 0.346$).

The performance growth is slower and more limited with monosyllabic word lists (Fig.5). In adults, there is a ceiling effect at 50% after one year. In children over 2, there is small improvement of performances at 1, 2 and 3 years post CI. Statistical analysis could not be run on the group of children under 2 because of the lack of data.

Fig. 6 shows the evolution of speech intelligibility (SIR) in terms of follow-up duration. For the children implanted after 2, there is a progressive improvement in performances between 1 and 3 years. In children implanted before 2, speech intelligibility increases slowly with a significant improvement after the age of 2 compared to the mean pre-implanted value.

Fig.7 shows the evolution of the APHAB questionnaire for the adults' follow-up. There is a significant difference ($p < 0.0001$) between scores at 1 and 2 years compared to the pre-implantation level, except for sound aversion. These results show that benefits of cochlear implant are quantitatively higher than those of hearing aid.

Fig. 8 shows the evolution of the type of schooling integration. We notice a decrease in percentage of children out-of-school for the benefit of an enrolment in integration or specialized school. After 3 years, 48.53% of the children were integrated in school, 19.61% were in ordinary school and 29.41% in a specialized school.

Fig. 9 shows the evolution of professional activity for adults. After 2 years of follow-up, 46.5% were retired, 35% were working, 4.39% were unemployed, 5% were looking for a job, 1.94% were students and 7.1% were incapacitated. After implantation, no important changes were observed in the adults' panel.

Discussion

The French registry of CIs is the only worldwide register of systematic follow-up over a period of three years and more for all adults and children implanted in a country.

Although the results of cochlear implantation in adults and children have already been the topic of several international papers, this work is innovative in the methodological way of studying multicentric follow-up results in every implantation center of a country, and the great number of population followed-up (1667 adults and 936 children).

First of all, we notice that the exhaustivity of data is not perfect with values ranging from 19% to 92%. Data exhaustivity is good for hearing performances, the results of professional activity or the educational experience, but weak for other parameters such as SIR score or APHAB questionnaire. We also observe a clear tendency to a defect of data input for the third year. It is unfortunate that this multicentric study has not benefited from a more exhaustive control of data input for some topics by clinical researcher associates.

The implantation age in children seems to be high compared to the HAS recommendations and compared to other countries. The children population can be split up in three groups: children implanted before 2, children implanted between 2 and 10 and a teenager population between 10 and 18 years old.

In the first group, the number of children implanted before their 1st year is low (13%). This low level should alert French teams, considering the international literature data [4-5] that show that implantation before 2 years old gives better performances especially for speech intelligibility and language development.

The analysis of the second group of implanted children is even more surprising since this group represents 59% of the entire panel. The median age at implantation of this group is 2.86. One must wonder about the reasons of such a late implantation: lack in neonatal screening, delay in hearing loss diagnosis, late implantation because of difficult access to

MRI, or resilience to cochlear implantation by some associations? In this panel, children who have a progressive hearing loss and who became late candidates for cochlear implantation have to be taken into account. The structure of the French registry cannot yet give the answer to these issues.

The long-term evolution of performances of CI in adults and children is the topic of several publications [6-8]. This multicentric study limited to 3 years of follow-up does not offer innovative data. It confirms the ceiling effect in the adults' performances at the end of the first year of follow-up, and the progressive increase in children's performances. It also shows that speech comprehension is more difficult with monosyllabic than disyllabic word lists. French teams should focus on using monosyllabic word lists in order to assess word perception. The performances evolution (CAP, SIR, word perception) and the APHAB questionnaire show that cochlear implants offer a quantitatively higher benefit than hearing aids. The main goal of this study is to show that the use of the contralateral hearing aid could lead to a significant benefit in terms of performances compared to the cochlear implant only condition, during all follow-up sessions.

There are only few data in the literature that focus on the schooling mode or the working activity in implanted adults [6-10].

Regarding the schooling experience, French teams favored the integration in ordinary school with or without support, but there is still 20% of children that are enrolled in specialized schools.

Finally, the study of the work activity in adults shows they are mainly retired. The rate of active population with a cochlear implant is close to 35 % and 7 % among them are declared handicapped.

To conclude, there are several biases in this study. Therefore, it did not enable to assess the benefits of cochlear implantation in terms of language development. The register has included the EVIP test, but the data collected were not sufficient to have a statistical analysis. Data from the international literature show the interest of language tests in implanted children, specially the benefits of early cochlear implantation [4-5].

Conflicts of interest: none

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	Adults	Children > 2 ans	Children < 2 ans	Total
1st year session	1667	695	241	2603
2 nd year session	783	357	114	1254
3rd year session	400	177	49	226

Table 1: Patients demographics at year one, two and three post CI

	CAP	Words	SIR	APHAB	Activity
1st year session	2379 91 %	1617 62%	724 28%	513 20%	2397 92%
2 nd year session	1103 88%	791 63%	344 27%	233 19%	1163 93%
3rd year session	133 59%	62 27%	152 67%		204 90%

Tableau 2: Rate for completing the register data for each parameter.

Fig.1: age distribution at implantation

Fig 2a et b: Boxplot of age at implantation for children between 0 and 18 and for the entire panel.

Fig.3 : Evolution of hearing performance scores (CAP) by age in terms of follow-up.

* $p < 0.05$ (Student test)

** $p < 0.01$

*** $p < 0.001$

Fig.4: Evolution of speech recognition for dissyllabic word lists by age and through the years.

Fig.5: Evolution of speech recognition for monosyllabic word lists by age and through the years

Fig.6: Evolution of the speech intelligibility (SIR) by age and through the years

Fig.7: APHAB results through the years

Fig.8: Evolution of the schooling experience through the years

Fig. 9: Evolution of the professional activity through the years

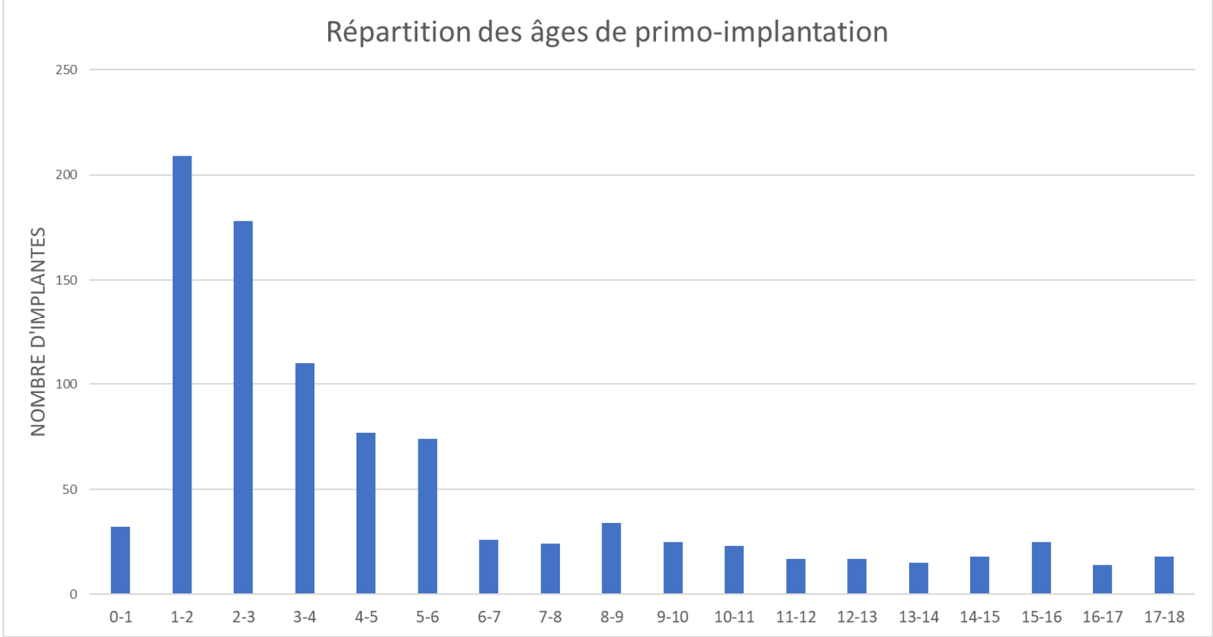
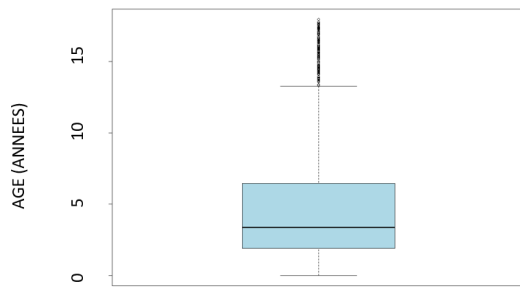


Fig.1: age distribution at implantation

Boxplot des âges à la primo-implantation chez les enfants



Boxplot des âges à la primo-implantation

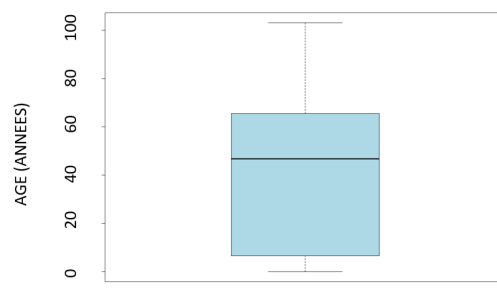


Fig 2a and 2b: Boxplot of age at implantation for children between 0 and 18 and for the entire panel.

Evolution CAP au cours des années par âge

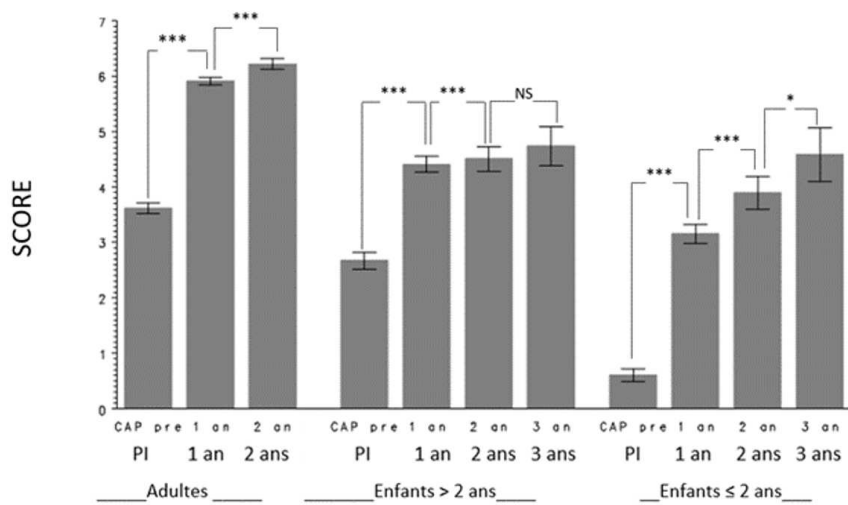


Fig.3 : Evolution of hearing performance scores (CAP) by age in terms of follow-up.

* $p < 0.05$ (Student test)

** $p < 0.01$

*** $p < 0.001$

Evolution de l'audiométrie dissyllabique au cours des années par âge

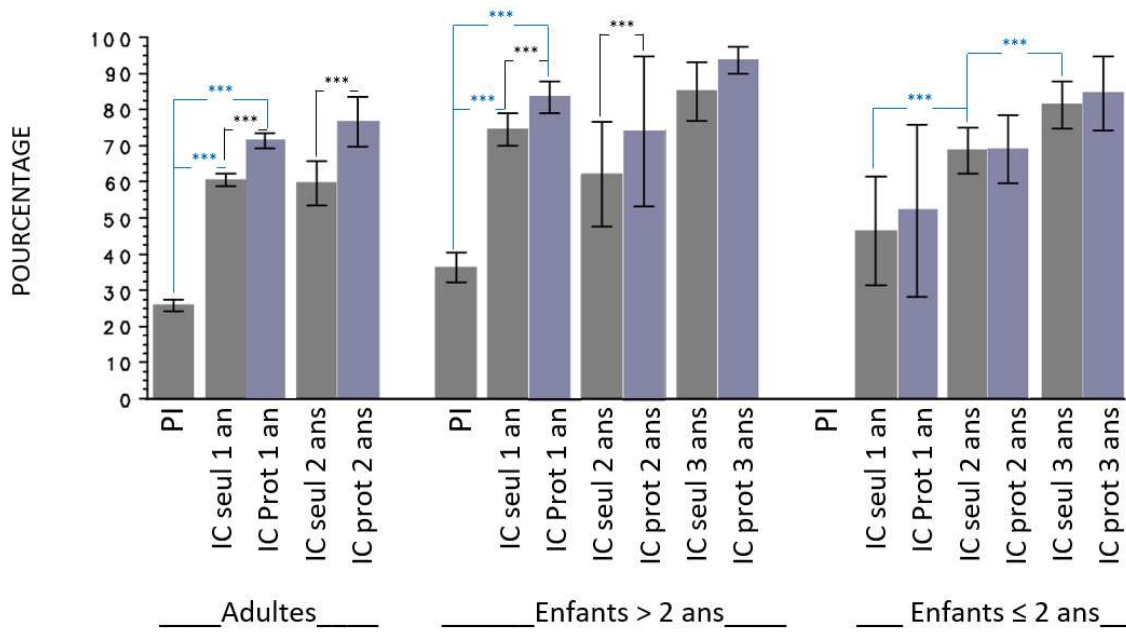


Fig.4: Evolution of speech recognition for dissyllabic word lists by age and through the years.

Evolution de l'audiométrie monosyllabique au cours des années par âge

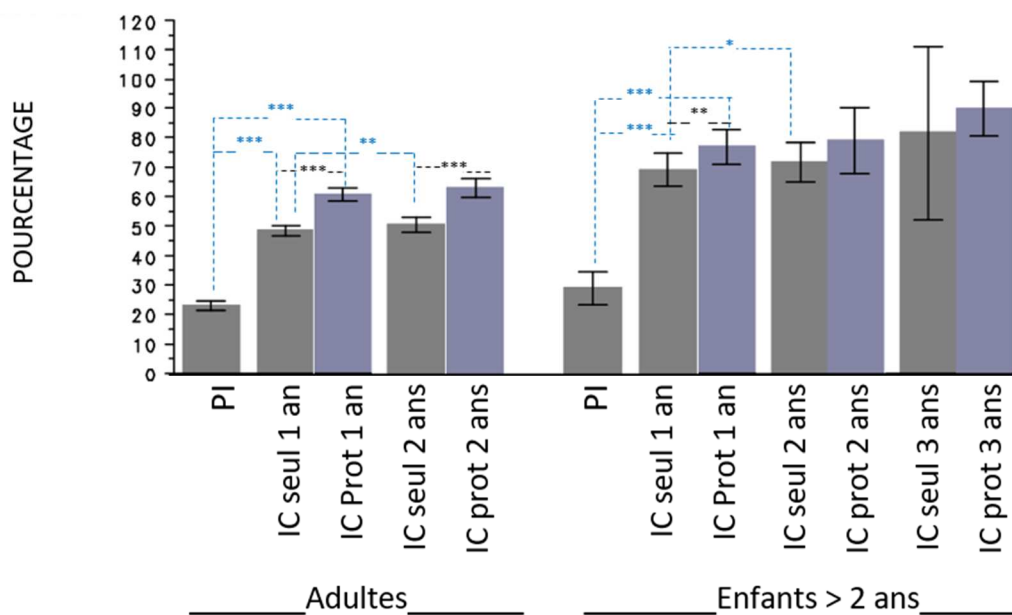


Fig.5: Evolution of speech recognition for monosyllabic word lists by age and through the years

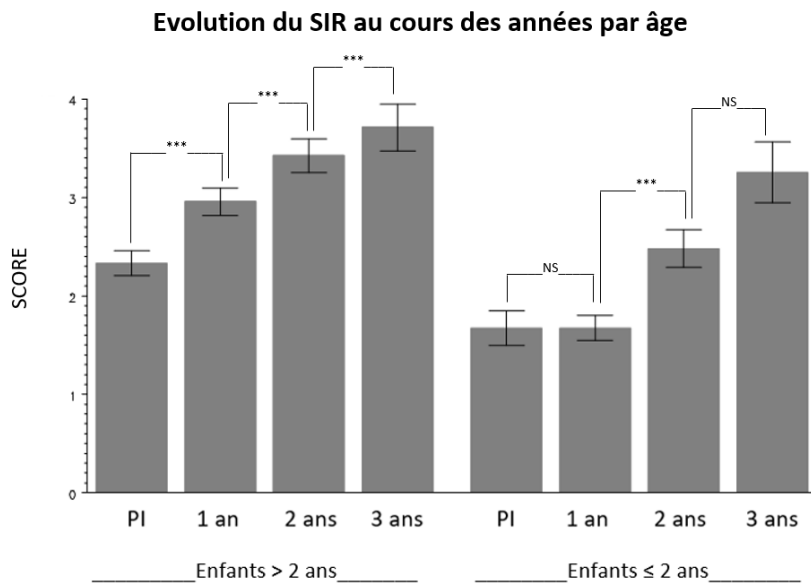


Fig.6: Evolution of the speech intelligibility (SIR) by age and through the years

APHAB au cours du temps

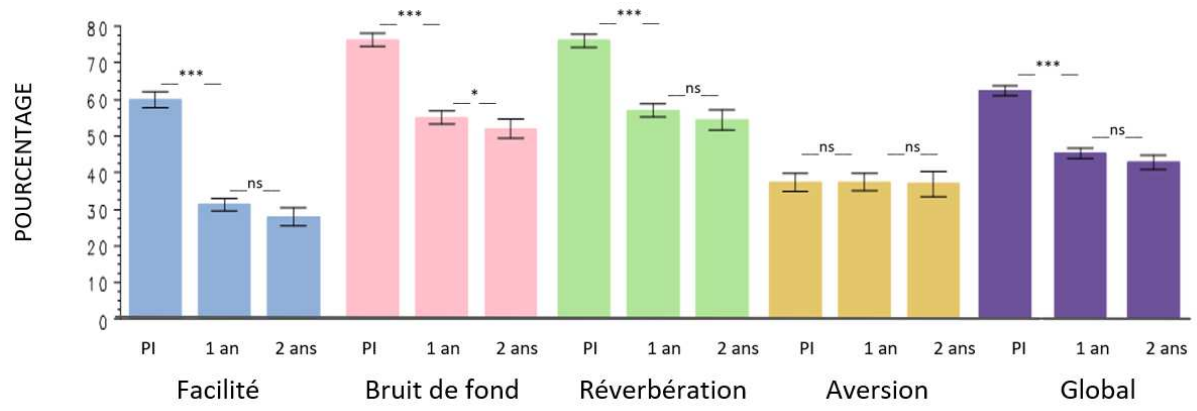


Fig.7: APHAB results through the years

Evolution de la scolarité au cours du temps

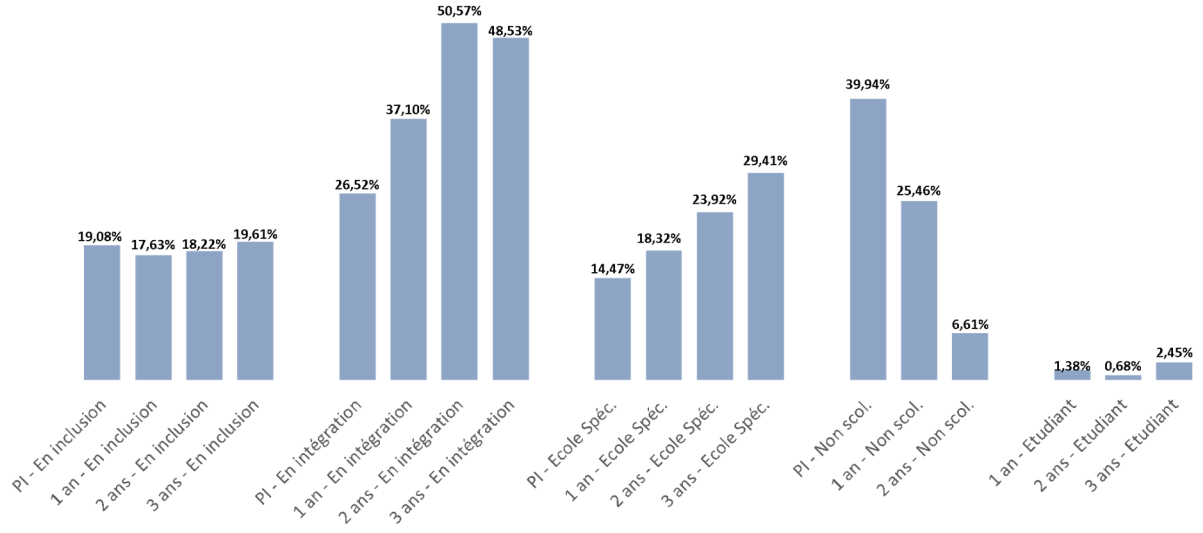


Fig.8: Evolution of the schooling experience through the years

Evolution de l'activité professionnelle au cours du temps

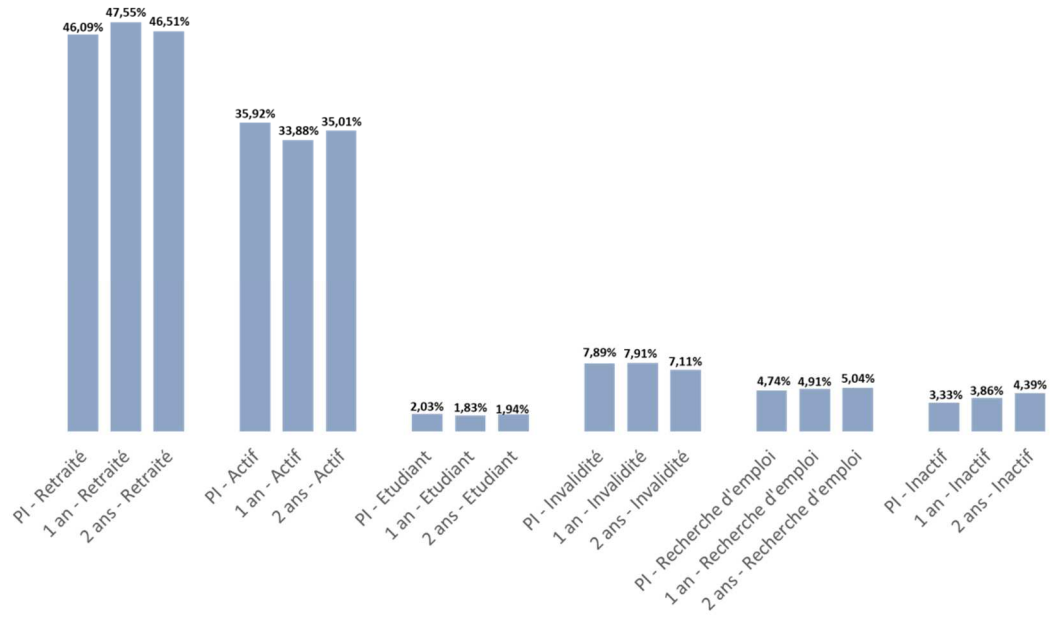


Fig. 9: Evolution of the professional activity through the years