Évolution de l'activité de publication des internes de pédiatrie affectés à Marseille sur 20 ans

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Evolution de l'activié de publication des internes de pédiatrie affectés à Marseille sur 20 ans

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ROSSI Dominique (PU-PH)

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À mon Président du Jury,

Monsieur le Professeur Hervé Chambost,

Vous me faites l'honneur de présider ce jury de thèse. Merci de l'intérêt que vous avez porté à mon travail, et de le juger. Veuillez recevoir l'expression de ma sincère reconnaissance et l'assurance de mon profond respect.

À mon Jury de Thèse,

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SYNTHÈSE

Introduction :

Se former à la recherche scientifique fait partie intégrante des études médicales. En France, le diplôme de Docteur en médecine n'est obtenu qu'après soutenance de la thèse, où l'interne mène à bien un projet de recherche. L'aboutissement de la recherche est sa publication. Cette étude porte sur l'évolution du schéma de publication des internes de pédiatrie et sur l'identification des facteurs favorisant la publication scientifique, en s'intéressant aux thèses, à leur publication et aux publications hors thèses.

Matériels et méthodes :

Il s'agissait d'une étude de cohorte rétrospective sur 20 ans (1996 – 2015) chez les internes de pédiatrie diplômés de l'université de médecine de Marseille. À partir du catalogue du Système Universitaire de Documentation (SUDOC), nous avons recueilli la liste des thèses soutenues par les internes de pédiatrie, leurs caractéristiques (titre, taille du manuscrit, directeur de thèse, type d'étude, population) et celles des internes (âge, sexe). Les publications réalisées par chaque interne, et leurs caractéristiques, ont été compilées à partir des bases de données Pubmed et Google Scholar. Nous avons déterminé si l'interne a poursuivi par une thèse de science à partir du catalogue SUDOC. Pour chaque directeur de thèse, nous avons cumulé le nombre total de thèses dirigées sur la période d'étude de 20 ans. Pour chaque article, le nombre de citations obtenues à + 5ans et à +3ans après parution étaient obtenus en utilisant la base de données ISI Web of knowledge. L'Impact Factor du journal de parution de l'article était déterminé grâce au classement de Journal of Citation Reports (JCR) fourni par Clarivate Analytics (groupe Web of science). Le nombre de publications publiées par l'interne à distance de la soutenance était basé sur la même méthode de recherche, à partir d'un an jusqu'à trois ans après la soutenance.

Résultats :

Parmi les 144 internes de pédiatrie diplômés entre 1996 et 2015 à l'université de médecine de Marseille, 122 étaient des femmes, 11 ont poursuivi par une thèse de science. Parmi les 144 internes, 74 (51%) internes ont publié leur thèse médicale. Le délai médian de publication était de 1 (EI=1 ; extrêmes 0-6). Quatre-vingt-sept (60%) des 144 internes ont publié au moins un article non lié à la thèse, édité avant la soutenance et jusqu'à un an après (soit 206 articles), avec une médiane de 2 articles par interne (Écart Interquartile EI=2 ; extrêmes 1-16). Trente-six (25%) des 144 internes n'ont rien publié. Concernant les publications à distance de la

soutenance (de 1 à 3 ans après la soutenance) : 65 (45%) des 144 internes ont publié 205 articles non liés à la thèse, et 94 (65%) ont publié 257 articles liés ou non liés à la thèse.

Tableau 1: Caractéristiques de l'interne, de la thèse et de l'étude concernant les thèses publiées, les thèses non publiées et les publications non liées à la thèse ; les publications non liées à la thèse étaient publiées avant la soutenance et jusqu'à un an après. Comparaison statistique de la publication ou non de la thèse.
Les données sont présentées sous la forme : médiane (EI ; valeurs extrêmes) ou n (%)
n = effectifs de la population (précisés entre parenthèse en cas de données manquantes)

	Thèses publiées n = 74		**Thèses non publiées n = 70**		**Comparaison thèse publiée / non publiée**	**Publications non liées à la thèse n = 206**	
• ***Caractéristiques de l'interne***		(n)		(n)	p		(n)
Âge lors de la soutenance (années)	29 (1 ; 27 - 32)	(71)	30 (1 ; 27 - 35)	(66)	0,35	29 (1 ; 27 - 33)	(198)
Sexe : masculin	12 (16%)		12 (17%)		1,00	16 (11%)	
Thèse de science	3 (4%)		8 (11%)		0,25	10 (7%)	
• ***Caractéristiques de la thèse***							
Taille du manuscrit (pages)	43 (54 ; 9 - 193)		84 (61 ; 19 - 227)	(69)	***< 0,0001******	62 (59 ; 9 - 227)	(143)
Nombre de thèses encadrées par le directeur de thèse de l'interne sur la période d'étude de 20 ans	6 (10 ; 1 - 20)		5 (5 ; 1 - 20)		***0,004 ****	NA	
• ***Caractéristiques de l'étude***							
❖ ***Type d'étude***					1,00		(203)
Étude épidémiologique	73 (99%)		70 (100%)			145 (72%)	
Étude de recherche en laboratoire	1 (1%)		0			11 (5%)	
Revue de la littérature / mise au point	0		0			47 (23%)	
→ Étude épidémiologique (détaillée):					0,22		
- étude observationnelle descriptive	53 (72%)		59 (85%)			128 (89%)	
- étude observationnelle analytique	11 (15%)		8 (11%)			6 (4%)	
- étude expérimentale	8 (11%)		3 (4%)			9 (6%)	
- étude qualitative	1 (1%)		0			1 (1%)	
❖ ***Population de l'étude***							
Type de sujets		(73)		(69)	0,21		(158)
- patient	65 (88%)		66 (96%)			138 (87%)	
- entourage du patient (proches, docteurs, étudiants en médecine…)	8 (11%)		3 (4%)			8 (5%)	
- animaux, tissus, cellules	1 (1 %)		0			12 (8%)	
Nombre de sujets (effectif de la population)	58 (148 ; 1 - 3500)	(73)	56 (72 ; 2 - 1496)	(68)	0,07	2 (31 ; 1 - 650)	(142)

Le tableau 1 résume les caractéristiques des thèses et des publications et analyse les facteurs associés à la publication de la thèse. La publication de la thèse était associée de manière significative à la taille du manuscrit soumis pour la soutenance (43 versus 84 pages (médiane) ; *p = 0,0001****) et au directeur de thèse (*p = 0,004***).

Bien que de meilleures caractéristiques bibliométriques étaient retrouvées pour les publications issues des thèses, cette différence n'était statistiquement significative que pour la position de l'interne en 1er auteur (tableau 2).

Tableau 2: Caractéristiques bibliométriques des publications issues de la thèse (publiées depuis la soutenance jusqu'au recueil des données) et des publications non liées à la thèse (publiées avant la soutenance et jusqu'à un an après). Comparaison statistique des publications issues de la thèse (classe de référence) et non liées à la thèse.
Les données sont présentées sous la forme : médiane (EI ; valeurs extrêmes) ou n (%)
n = effectifs de la population (précisés entre parenthèse en cas de données manquantes)

	Publications issues de la thèse; n=74 (n)		Publications non liées à la thèse; n=206 (n)		p OR [IC 95%]
Nombre de publications en 1er auteur	59 (80%)		91 (44%)		***< 0,0001*** *** 4,97 [2,65-9,33]
Nombre de publications indexées dans Medline	70 (95%)		198 (96%)		0,52
Nombre de publications en anglais	41 (55%)		91 (44%)		0,13
Impact Factor du journal de parution	1,221 (1,996; 0,119 - 28,409)	(72)	0,495 (1,821; 0,188 - 18,316)	(183)	0,68
Nombre de citations obtenues à + 5ans après parution	5 (9 ; 0 - 25)	(50)	2 (4 ; 0 - 68)	(171)	0,10
Nombre de citations obtenues à + 3 ans après parution	4 (5,5 ; 0 - 24)	(59)	1 (4 ; 0 - 35)	(188)	0,10

Le taux de publication des thèses a augmenté de façon significative sur 20 ans (*p=0,003***) jusqu'à tripler (de 21% à 65%) (figure 1), mais non le taux de publication globale, alors que la taille du manuscrit soumis pour la soutenance a diminué de façon significative sur 20 ans (pente = - 4,19 pages/an ; *p<0,0001****) (figure 2).

Figure 1: Évolution de la taille du manuscrit (nombre de pages) sur la période 1996 - 2015

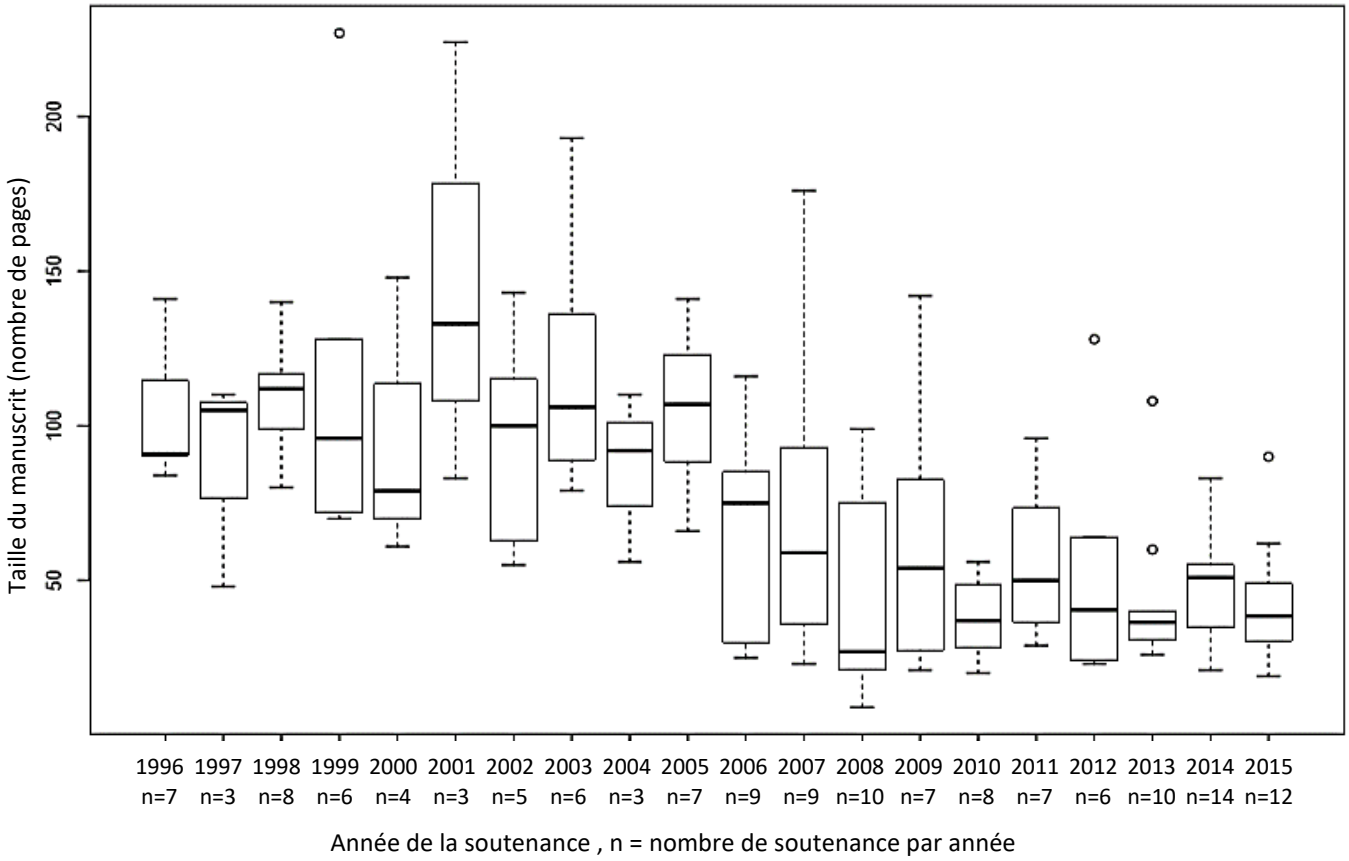
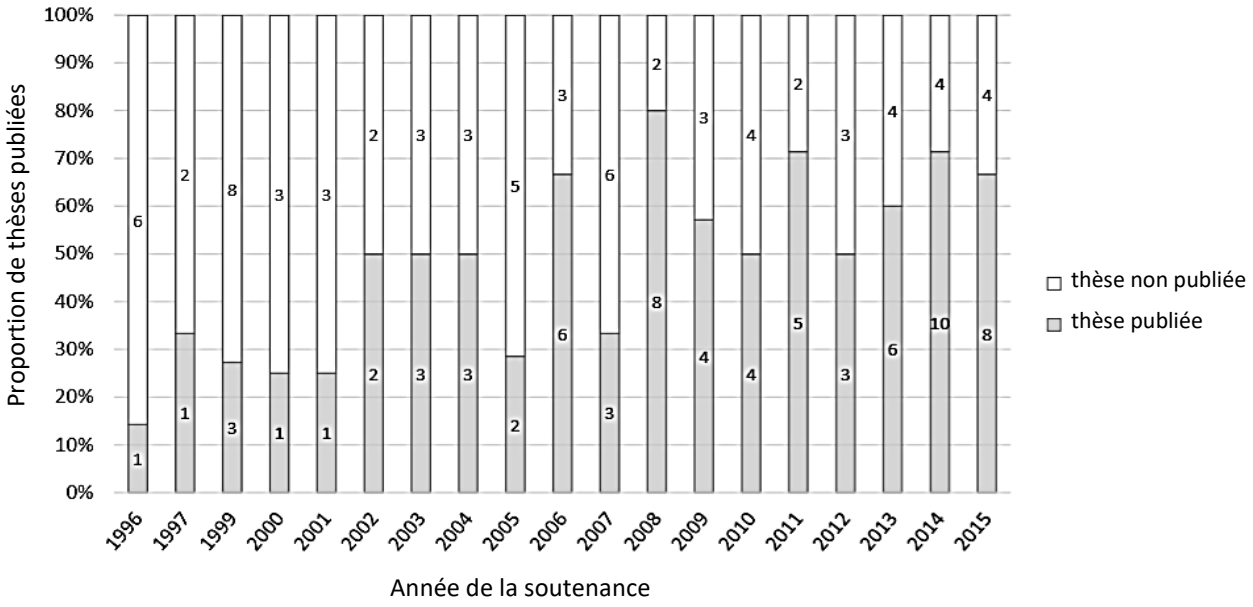


Figure 2: Évolution de la proportion de thèses publiées sur la période 1996 - 2015



Le nombre total de publications augmentait si l'interne avait poursuivi par une thèse de science (Odd Ratio ajusté=1,51 ; *p=0,006***), s'il avait plus publié en post-internat (OR ajusté=0,47 ; *p<0,0001****) et s'il était plus âgé au moment de la soutenance de thèse (OR ajusté=0,31 ; *p=0,005***). Le sexe de l'interne (féminin ou masculin) n'était pas associé à la publication de la thèse mais était associé à l'activité globale de publication de manière significative en analyse univariée (OR=1,18 ; *p=0,01**) mais non en analyse multivariée.

Tableau 3: Analyses univariée et multivariée des facteurs associés à la publication de la thèse et des facteurs associés au nombre total de publications par interne (liées et non liées à la thèse, publiées avant la soutenance et jusqu'à un an après).

	Analyse univariée OR [IC 95%]	*p*	Analyse multivariée OR ajusté [IC 95%]	*p*
• ***Publication de la thèse (classe de référence) (modèle de régression logistique)***				
Sexe : masculin (référence)	0,94 [0,39 ; 2,25]	1,00		0,84
Année de soutenance	1,12 [1,05 ; 1,19]	***0,0003*** ***		0,20
Nombre de thèses encadrées par le directeur de thèse de l'interne sur la période d'étude de 20 ans	1,09 [1,03 ; 1,15]	***0,004*** **	1,09 [1,02 ; 1,17]	***0,01*** *
Taille du manuscrit (pages)	0,98 [0,97 ; 0,99]	***<0,0001*** ***	0,98 [0,97 ; 0,99]	***0,005*** **
Nombre total de publications non liées à la thèse	1,23]1,00 ; 1,51]	***0,04*** *		0,19
• ***Nombre total de publications par interne publiées avant la soutenance et jusqu'à un an après (modèle de régression linéaire)***				
Sexe : masculin (référence)	1,18 [0,28 ; 2,07]	***0,01*** *		0,80
Âge lors de la soutenance (années)	0,33 [0,06 ; 0,60]	***0,02****	0,31 [0,10 ; 0,56]	***0,005****
Thèse de science	2,59 [1,37 ; 3,80]	***<0,0001*** ***	1,51 [0,45 ; 2,57]	***0,006*** **
Nombre total de publications publiées entre 1 et 3 ans après la soutenance (liées et non liées à la thèse)	0,50 [0,39 ; 0,62]	***<0,0001*** ***	0,47 [0,35 ; 0,59]	***<0,0001*** ***

Conclusion : La publication des thèses de pédiatrie s'est améliorée en 20 ans, mais les efforts doivent se poursuivre pour améliorer également l'activité globale de publication des internes. Il serait intéressant d'étendre cette étude à l'ensemble du pays mais aussi de la reproduire dans le futur, suite à la réforme de 2017 du Troisième cycle des Études Médicales.

Les données complètes et détaillées concernant cette étude sont présentées dans l'article en cours de soumission aux Archives de Pédiatrie et sont reportées en page 7 de ce manuscrit.

ABSTRACT

Background: Health research training is an essential component of medical education. In many countries, as in France, medical training is not complete until the defense of a thesis, based on a research project. Research is incomplete until reported, and publishing research work is critical to the progress of science. This study investigated the evolution of the publication pattern of pediatric residents and identified the possible factors associated with an increased productivity, by investigating at thesis, thesis publications and publications non-based on the thesis.

Materials and methods: We conducted a retrospective cohort study over a 20-year period (1996-2015) about pediatric residents graduated at the medical university of Marseille in France. The list of the pediatrician residents' thesis was retrieved from the French database of university theses (SUDOC), along with residents and thesis' characteristics. Resident publications' features were collected by scanning the Pubmed and Google Scholar database.

Results: Of the 144 graduated residents, 74 (51%) published their medical thesis and 87 (60%) published at least one paper, during pre-graduation up to one -year post-graduation, with a median of 2 papers per resident (InterQuartile Range IQR = 2). Publishing the thesis was significantly associated with dissertation length (43 versus 84 pages (median); *p=0,0001***) and thesis supervisor (*p=0,004**), but not with residents' characteristics or studies' features. The thesis publication rate increased significantly over the years (*p=0,003***) as it has tripled, but not the overall publication rate, and dissertation length significantly decreased over the years (linear slove = - 4,19 pages/year; *p<0,0001****). The number of publications per resident were significantly increased when the resident has pursued with a scientific thesis (adjusted OR=1,51; *p=0,006****), when he has published more papers during post-residency (adjusted OR=0,47 ; *p<0,0001****) and when he graduated older (adjusted Odds Ratio=0,31 ; *p=0,005***). Publishing the thesis was not influenced by resident sex whereas overall publication activity was significantly associated with resident sex in univariate analysis (OR=1,18 ; *p=0,01**) but not in multivariate analysis.

Conclusion: Thesis publication rate of pediatric interns has improved over 20 years, however efforts must be continued to improve also the overall academic productivity. It would be of interest to extend this study to the whole country and to reproduce it in the future as residency program in France has undergone major changes since 2017.

INTRODUCTION

Current medical practice is ruled by the principle of evidence-based medicine (EBM). EBM aims to apply evidence obtained through scientific research to strengthen medical decision in the daily practice [1]. Research is incomplete until reported [2] : publishing manuscripts is the major way by which scientists communicate with each other. Hence, the science does not exist until it is published [3].

Health research training is an essential exercise to help develop physician research skills: it is considered by many to be an important component of residency training. In many countries, and also in France, medical training is not complete before the defense of a thesis. The thesis is based on a research project and may be, for physicians who will be practicing outside the hospital, their first and only research experience. For scientific, economic and ethical reasons, thesis must be made publicly accessible. Furthermore, publication in a peer reviewed journal indicates that the content of the thesis is acceptable to the international scientific community [4]. However, many thesis remain unpublished [5].

Interest has grown about resident research publications and factors influencing academic productivity during residency [6–8]. However, little is known about pediatric trainees' scholarly activity in France: only one previous study in France looked at pediatric residents, based on a cross-sectional study and focusing on thesis publication [9]. The purpose of this study was to investigate the evolution of the publication pattern of pediatric residents and to identify the possible factors associated with an increased productivity, by looking at thesis, publication of the thesis and publications non-related to the thesis. The studied population was the pediatric residents graduated at the medical university of Marseille in France over a 20-year period (1996-2015).

MATERIALS AND METHODS

We conducted a single-center retrospective cohort study in a French university over a 20-year period. All residents who defended their medical thesis to graduate in pediatrics at the medical university of Marseille between 1996 and 2015 were included. Data collection were carried on October 2019. The SUDOC catalogue (www.sudoc.abes.fr) provides an exhaustive and detailed referencing of all French doctoral thesis, and also their respective abstract. In this database, we used the search terms "pediatrics AND Marseille" (in french "pédiatrie AND Marseille"): then, we collected the list of the pediatric residents having defended their thesis at the medical university of Marseille between 1996 and 2015, along with resident's characteristics (age at graduation, sex) and with thesis' characteristics (title, dissertation length, thesis supervisor's name, study design and study participants' characteristics). We determined if the resident has pursued with a scientific thesis by using the resident's name as search term in SUDOC database, and then by selecting only scientific thesis. Concerning thesis supervisor, we have counted the number of thesis supervised by each supervisor over the 20-year period study.

To identify resident's publications, we conducted a comprehensive search in Pubmed and Google Scholar databases : in Pubmed database (www.ncbi.nlm.nih.gov/pubmed) to identify resident's publications in Medline-indexed journals and in Google Scholar database (https://scholar.google.com) to identify residents publications in non-indexed journals.

First, we investigated for published thesis in order to collect thesis' publication characteristics. In both databases, search queries were the last name and the initial letter of the first name of the residents, without any time limit, adding the affiliation city (Marseille) if too many results were returned. For women, the married name was also used when known. Publications from thesis were identified by comparing titles and abstracts of the articles with the theses. If no results were returned, we extended the search using the thesis supervisor's name.

Secondly, we investigated for all papers published during residency other than thesis' publication in order to collect publication characteristics of papers non-based on the thesis. Similarly, in both databases, search queries were the last name and the initial letter of the first name of the residents, but this time, the included articles had to be published within a certain time limit: only publications issued before the thesis defense and up to one year after the thesis defense were included. Residents defend their thesis predominantly during the last year of residency; thus, such time limit allowed to cover publications made during the residency. The

one-year limit after graduation was in order to pick up articles submitted during residency and awaiting publication, given that one-year delay is sufficient [10]. To avoid confusion, publications issued before the thesis defense and up to one year after the thesis defense were called “publications during residency”. For women, the married name was also used as search query when known. If too many results were returned, we added the affiliation city (Marseille) to the search criteria.

The paper’s number of citations was determined by using ISI Web of Knowledge database (www.webofknowledge.com): ISI Web of Knowledge database provides the number of citations per year so we reported the number of citations over five years and over three years from publication for each paper. Journal impact factor for the year of issue of each paper was retrieved using the Journal of Citation Reports (JCR) released by Clarivate Analytics, Web of science group (https://jcr.clarivate.com).

In order to know how the scholastic productivity non-related to the thesis evolved after the graduation, we used the same investigation method from one year post-graduation up to three years post-graduation, collecting only the number of papers per resident.

Study design classification was based on the current classification used in epidemiology [11,12]. Studies were categorized into 3 types: clinical original study, laboratory study, and literature review/state of the art. Clinical original studies were sub-categorized into 4 types : observational descriptive study (related to case report, case series, observational cohort study, observational cross-sectional study) , observational analytical study (related to analytical cohort study exposed/unexposed, case-control study, analytical cross sectional study), experimental study, and qualitative study.

All data collected were publicly available on internet.

Statistical Analysis

Statistical analysis was carried on November 2019. Values were expressed as medians - interquartile ranges – extreme ranges, or as numbers - percentages, as appropriate. In univariate analysis, Chi2 or Fisher exact test, Student’s t-test or simple linear regression were used, as appropriate. In multivariate analysis, multiple linear regression or multiple logistic regression models were used, as appropriate. Simple linear regression was used in longitudinal analysis. The Chow test was used to determine structural change between two periods in our

time series and to identify breakpoint. The population we were studying was sufficiently large, so we approximated the normality in all our analysis. A *p*-value <0.05 was considered to be significant. The analyses were performed with the R software (3.6.1 version for Windows) and RStudio (1.2.1335 version).

RESULTS

One hundred and forty-four pediatric residents defended their medical thesis between 1996 and 2015 at the medical university of Marseille. The median number of graduating residents per year was 7 (InterQuartile Range IQR = 3; range: 3-14 residents). One hundred and twenty pediatric residents were female (83%). Eleven (8%) pursued with a scientific thesis. Seventy-four (51%) published their medical thesis, from their thesis defense until data collection. Median publishing delay was 1 year (IQR = 1; range: 0-6 years).

About scholarly productivity non-related to the thesis during residency, 87 (60%) of the 144 residents published at least one paper during pre-graduation period and up to one-year post-graduation, with a total of 206 publications non-related to the thesis. The median number of papers during residency non-related to the thesis was 2 per resident (IQR = 2; range: 1-16). Of the 74 residents who published their medical thesis, 21 (15%) didn't publish any other paper than the thesis. Of the 144 graduated residents, 36 (25%) didn't published anything at all. The overall publication (thesis publications and publications non-related to the thesis during residency) was 280 articles, from 108 (75%) of the 144 residents; the median number of all publications during residency was 2 per resident (IQR = 2; range: 1-16).

In order to know how the scholastic productivity evolved after the graduation, we used the same investigation method between one year up to three years post-graduation : the number of papers post-residency and non-related to the thesis was 205, published by 65 (45%) of the 144 graduated residents. The number of overall publications (related and non-related to the thesis) issued one year up to three years post-graduation was 257, from 94 (65%) of the 144 residents.

Among thesis dissertations, top three sub-specialities most presented to the thesis jury were respectively neonatology / intensive care (30; 21%), hemato-oncology (20; 14%) and infectious disease (19; 13%). Among thesis-based papers, top three sub-specialities most published were respectively neonatology / intensive care (16; 22%), pneumology (13; 18%) and hemato-oncology (9; 12%). Among publications non-related to the thesis during residency, top three sub-specialities most published were respectively pneumology (34; 17%), infectious disease (30; 15%) and neonatology / intensive care (28; 14%).

Resident, thesis and study characteristics of published and unpublished thesis are described and statistically compared in table 1. A description of papers unrelated to the thesis published during residency is also provided in table 1.

Table 1: Resident, thesis and study characteristics of published thesis, non-published thesis and publications non-related to the thesis; the publications non-related to the thesis were published during pre-graduation period until one -ear post-graduation. Statistical comparison between published thesis and non-published thesis.
Data are shown as: median (IQR ; range) or n (%)
n = population size (specified in brackets only in case of missing values)

	Published thesis n = 74		**Unpublished thesis n = 70**		**Comparison published / unpublished thesis**	**Publication non-related to the thesis n = 206**	
• ***Resident characteristics***		(n)		(n)	p-value		(n)
Age at graduation (years)	29 (1 ; 27 - 32)	(71)	30 (1 ; 27 - 35)	(66)	0,35	29 (1 ; 27 - 33)	(198)
Male sex	12 (16%)		12 (17%)		1,00	16 (11%)	
Scientific thesis	3 (4%)		8 (11%)		0,25	10 (7%)	
• ***Thesis characteristics***							
Dissertation length (pages)	43 (54 ; 9 - 193)		84 (61 ; 19 - 227)	(69)	***< 0,0001****	62 (59 ; 9 - 227)	(143)
Number of thesis supervised during the 20-year study period by the resident thesis supervisor	6 (10 ; 1 - 20)		5 (5 ; 1 - 20)		***0,004 *****	NA	
• ***Study characteristics***							
❖ ***Study design***					1,00		(203)
Clinical original study	73 (99%)		70 (100%)			145 (72%)	
Laboratory study	1 (1%)		0			11 (5%)	
Literature review / state of the art	0		0			47 (23%)	
→ Clinical original study (detailed):					0,22		
- observational descriptive study	53 (72%)		59 (85%)			128 (89%)	
- observational analytical study	11 (15%)		8 (11%)			6 (4%)	
- experimental study	8 (11%)		3 (4%)			9 (6%)	
- qualitative study	1 (1%)		0			1 (1%)	
❖ ***Study participants***							
Type of study participants		(73)		(69)	0,21		(158)
- patient	65 (88%)		66 (96%)			138 (87%)	
- patient environment (relatives, doctors, medical students…)	8 (11%)		3 (4%)			8 (5%)	
- animals, cells, tissues	1 (1 %)		0			12 (8%)	
Number of study participants (population size)	58 (148 ; 1 - 3500)	(73)	56 (72 ; 2 - 1496)	(68)	0,07	2 (31 ; 1 - 650)	(142)

There was a significant association between publishing the thesis and thesis characteristics, that is dissertation length and thesis supervisor. Short format of dissertation increased the chances of publishing thesis (Odds Ratio OR = 0,98; 95%IC [0,97 ; 0,99]; p< *0,0001****). A thesis supervisor who has supervised more thesis during the 20-year study period enhanced the thesis publication (OR = 1,09; 95%IC [1,03 ; 1,15]; p=*0,004***). Publication of the thesis was not associated with residents' characteristics or studies' features (table 1).

Although bibliometric characteristics of publications were better in published thesis compared to papers non-based on the thesis, there was a statistically significant association only between publications from the thesis and first-author publications. Publishing in indexed journals, in English journals, in high impact factor journals or having many citations were not significantly associated with publications related to the thesis or publications non-related to the thesis. In both, proportion of publications in Medline-indexed journals reached 95% (table 2).

Table 2: Bibliometric characteristics of publications from the thesis (published since the thesis defense until data collection) and publications non-related to the thesis (published during pre-graduation period until one year post-graduation). Statistical comparison between publications from the thesis (reference) and publications non-related to the thesis.
Data are shown as median (IQR ; range) or n(%)
n = population size (specified in brackets only in case of missing values)

	Publications from the thesis; n=74	(n)	Publications non-related to the thesis; n=206	(n)	p-value OR [95%CI]
Number of first-author publications	59 (80%)		91 (44%)		***< 0,0001*** *** 4,97 [2,65-9,33]
Number of publications in Medline-indexed journals	70 (95%)		198 (96%)		0,52
Number of publications in english journals	41 (55%)		91 (44%)		0,13
Impact factor of the journal 's publication	1,221 (1,996; 0,119 - 28,409)	(72)	0,495 (1,821; 0,188 - 18,316)	(183)	0,68
Number of citations over 5 years	5 (9 ; 0 - 25)	(50)	2 (4 ; 0 - 68)	(171)	0,10
Number of citations over 3 years	4 (5,5 ; 0 - 24)	(59)	1 (4 ; 0 - 35)	(188)	0,10

Longitudinal analysis of thesis characteristics pointed out a significant decrease of the dissertation length over time, in regards to the number of pages (linear slope = - 4,19 pages/year ; 95%CI [-5,18 ; -3,20] ; *p<0,0001* ***) (figure 1). This evolution can be broken down into 2 periods with a breakpoint in the year 2006 (Chow test, *p=0,01* **) : before 2006, there was no

significant evolution of the dissertation length ; on the contrary, from 2006, dissertation length significantly lowered (OR = -2,18 ; 95%CI [-4,29 ; -0,08] ; *p=0,04* *).

The thesis publication rate increased significantly over the years (linear slope = 0,03 published thesis/year ; 95%CI [0,01 ; 0,04]; *p=0,003* **) : comparing 1996-2000 period and 2011-2015 period, thesis publication rate has tripled from 21% to 65% (figure 2). Considering all scholarly productivity (related and non-related to the thesis), longitudinal analysis indicated a significant increase in first-author publication produced by residents over time, while also taking account of the increase of published thesis over time by a multivariate analysis, as thesis are more often first-author publications (linear slope = 0,08 first-author publication/year ; 95%CI [0,03 ; 0,12] ; *p=0,001* **). Other characteristics of overall academic productivity (related and non-related to the thesis) were not significantly changed over the years, that is, the impact factor of the journal 's publication, the number of publications per resident, the number of publications in english journals and the number of citations over 5 and 3 years.

Figure 1: Evolution of dissertation length (number of pages) over the period 1996 - 2015

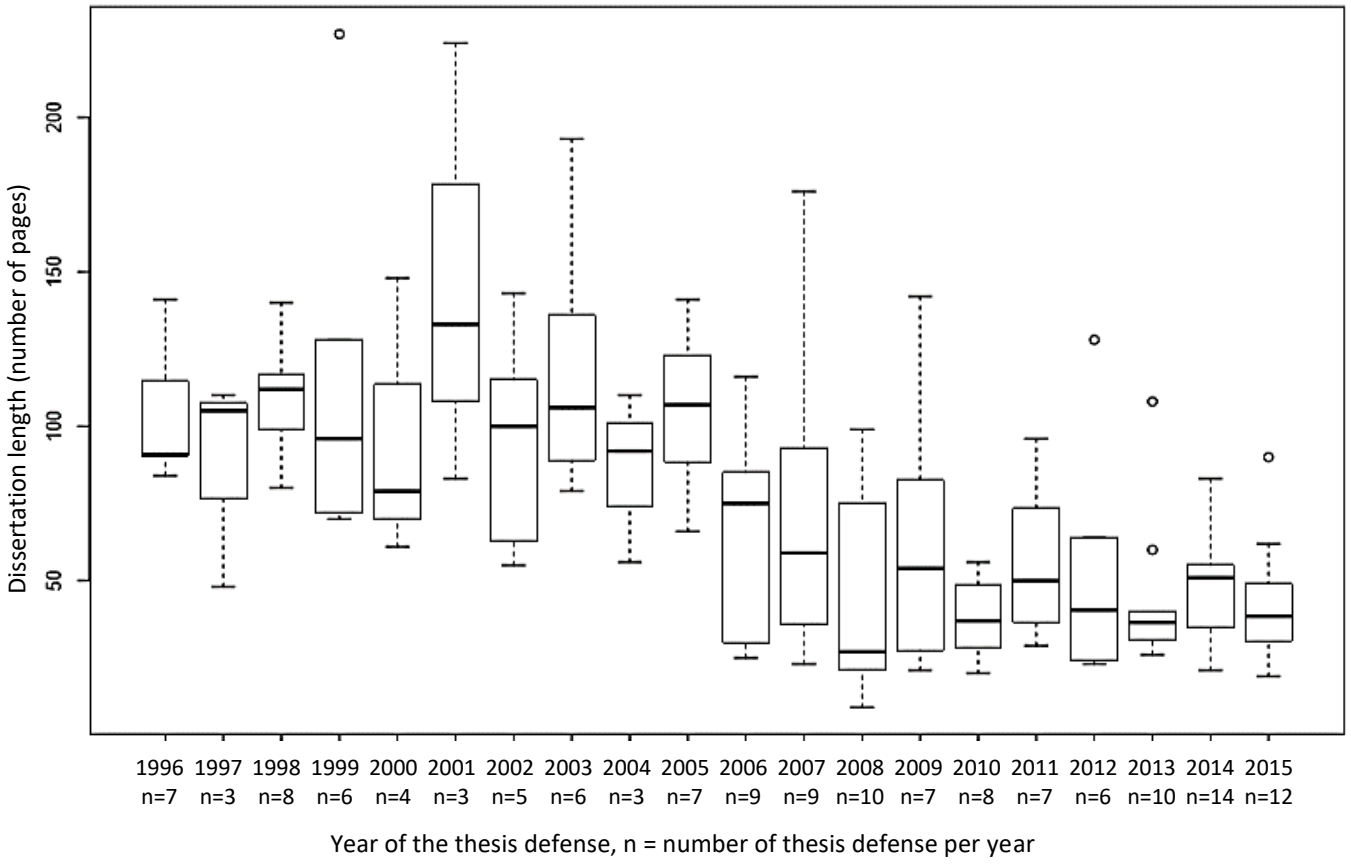
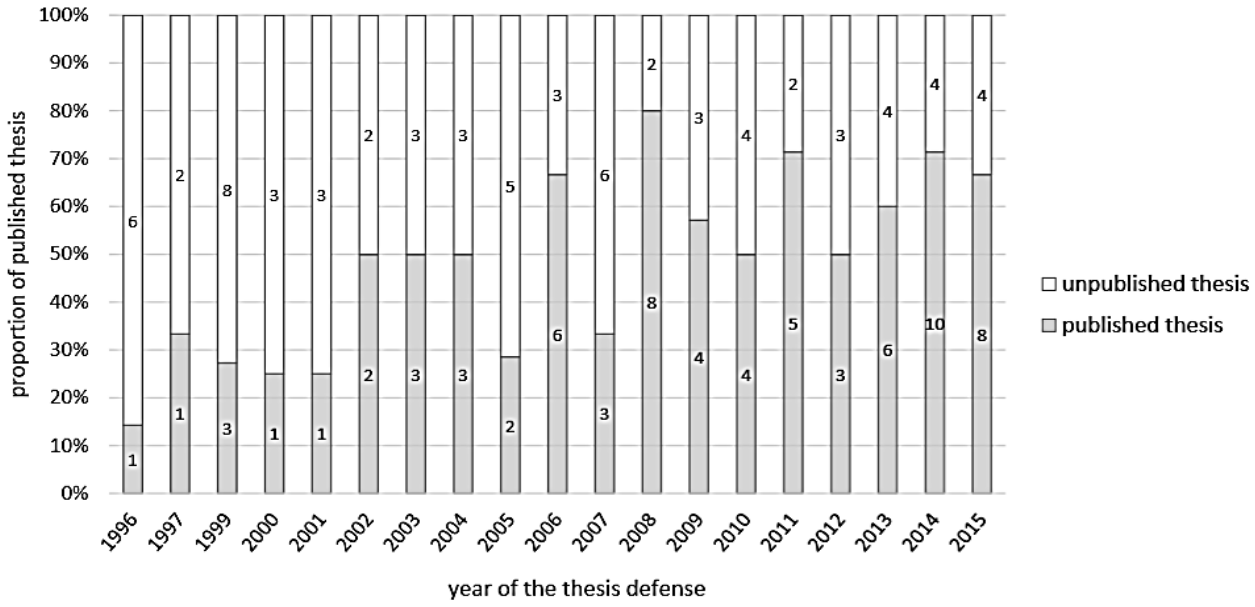


Figure 2: Evolution of the proportion of published thesis over the period 1996 – 2015



In univariate analysis, to get the thesis published was significantly associated with a supervisor who has supervised more thesis during the 20-year study period, a graduation in more recent years, a shorter dissertation length and a higher number of publications non-related to the thesis (table 3). In multivariate analysis, when controlling for the effects of the other variables in the model, publishing the thesis was significantly associated with dissertation length and thesis supervisor; the year of the graduation and the tota l number of publications non-related to the thesis were not anymore significant. We ran a subgroup analysis focusing on prolific thesis supervisors, who are those who have supervised more than 10 thesis. Of the 53 thesis supervisors of this study, three supervisors were included and supervised 20, 12 and 11 thesis. Unlike the previous analyses related to supervisor thesis where the variable used was the total sum of supervised theses over 20 years for each supervisor, we used for this subgroup analysis only the cumulation of supervised theses prior to the current supervised thesis. Statistical analysis showed a significant association between the publication of the thesis and the number of thesis supervised prior to the current supervised thesis : the more the thesis director had supervised thesis, the more likely the thesis was to be published (OR = 1,35 ; 95%CI [1,12-1,63] ; p=0,002**).

In univariate and multivariate analysis, the total number of publications per resident (related and non-related to the thesis) published during pre-graduation period until one-year post-graduation were significantly increased when the resident has pursued with a scientific thesis, when the total number of publications from one-year up to 3-year post-graduation

(related and non-related to the thesis) was higher, and when the resident were older at the time of graduation .

There was no statistically significant association in both analysis between being a male resident and publishing the thesis. However, being a male resident and being a more prolific writer were significantly associated in univariate analysis but not in multivariate analysis, i.e. when controlling for the effects of the other variables in the model.

Table 3: Univariate and multivariate analysis of factors related to the thesis publication and factors related to the total number of publications per resident (based and non-based on the thesis, published during pre-graduation period until one-year post-graduation).

	Univariate analysis		Multivariate analysis	
	OR [95%CI]	*p-value*	Adjusted OR [95%CI]	*p-value*
• ***Publication of the thesis (reference) (logistic regression model)***				
Resident sex : male (reference)	0,94 [0,39 ; 2,25]	1,00		0,84
Year of the thesis defense	1,12 [1,05 ; 1,19]	***0,0003*** ***		0,20
Number of thesis supervised during the 20-year study period by the resident thesis supervisor	1,09 [1,03 ; 1,15]	***0,004*** **	1,09 [1,02 ; 1,17]	***0,01*** *
Dissertation length (pages)	0,98 [0,97 ; 0,99]	***<0,0001*** ***	0,98 [0,97 ; 0,99]	***0,005*** **
Total number of publications non-related to the thesis	1,23]1,00 ; 1,51]	***0,04*** *		0,19
• ***Total number of publications per resident published during pre-graduation period until one-year post-graduation (linear regression model)***				
Resident sex: male (reference)	1,18 [0,28 ; 2,07]	***0,01*** *		0,80
Age at graduation (years)	0,33 [0,06 ; 0,60]	***0,02****	0,31 [0,10 ; 0,56]	***0,005****
Scientific thesis	2,59 [1,37 ; 3,80]	***<0,0001*** ***	1,51 [0,45 ; 2,57]	***0,006*** **
Total number of publications from one-year up to 3-year post-graduation (related and non-related to the thesis)	0,50 [0,39 ; 0,62]	***<0,0001*** ***	0,47 [0,35 ; 0,59]	***<0,0001*** ***

DISCUSSION

The present retrospective study investigated the evolution of the publication pattern of pediatric residents over 20 years at one French University and identified the possible factors associated with an increased productivity. To the best of our knowledge, this is the first study about publishing activity to focus on pediatric residents in France through a longitudinal investigation. Only one previous study in France looked at pediatric residents, but based on a cross-sectional study and focusing only on thesis publication and not on the overall publication activity [9]. Among the others studies dealing with residents' academic productivity, few gave rare details about the position of pediatrics [5,13,14]. In France, pediatric resident must defend a medical thesis to be graduated as a Medical Doctor. However, it is not mandatory to publish in order to be graduated, whereas an experience in performing research and publishing research findings should be a necessary step in the residency training.

The proportion of published thesis varies widely among countries and medical specialities. Based on literature data, in France, this percentage ranges from 11% (Lille (France), study period 2008-2013) [5] to 28% (Angers (France), study period 2002-2008) [15] relating to all medical specialities , and from 28% (France, study period : 2003-pediatric residents class) [9] to 38% (Brest (France), study period : 2001- 2005) [13] relating to pediatric speciality only. Comparatively, our study reported a high percentage of published thesis with 51% of pediatric thesis leading to a publication at the medical university of Marseille. In his french cross-sectional study about the 2003-pediatric residents promotion, Fabre reported also a high proportion of published thesis at the medical university of Marseille, with 78% of thesis published: but publishing pediatric thesis was varying widely among french universities from 0% to 78%, with 25% (7/27) of french universities not publishing any thesis; however, university of residency wasn't a factor associated with publication.

Publishing thesis showed a significant increase over years in our study, as published thesis' rate has tripled. We found out in the literature four studies similar to our longitudinal study from various specialties, locations and time periods: it referred to Koca *et al.* study, taking place in Turkey during 1974-2014 period for orthopaedic residents [16], to Nour Eldein *et al.* study, taking place in Egypt during 1982-2014 period for general practice/family medicine residents [17], to Prasad *et al.* study, taking place in USA during 2006-2010 period for internal medicine residents [18], and to Balva *et al.* study, taking place in France during 1997-1999 and 2007 – 2009 periods for general practice/family medicine residents [19]. All

these studies indicated a significant increase in publishing activity over the years, and the last study indicated a doubling in thesis publication rate over 10 years. Increased publishing activity is a global trend as worldwide and french publication productivity has demonstrated volumetric expansion over the years [20,21].

We identified two factors positively associated with thesis publication: the thesis length and the thesis supervisor. Thesis length dropped significantly from 2006: even if the OR was close to 1 in univariate and multivariate analysis, it has resulted in a threefold of the thesis publication rate over 20 years. One explanation for this evolution might be that french universities wanted to promote publication and allowed article-based thesis: this might have facilitated the publication process since there was no need to rework the manuscript later. Balva *et al.* obtained the same findings at the faculty of Angers [19]. In the same way, the French Academic College of Radiology decided that submission to a peer-review journal was mandatory to graduate [22]. We do not explain why the breakpoint of thesis length's evolution was 2006.

Our study yielded a positive association between the thesis publication and a thesis supervisor who has supervised more thesis during the 20-year study period: even if the OR was close to 1 in univariate and multivariate analysis, an subgroup analysis focusing on prolific thesis supervisors (> 10 supervised thesis) showed that the more the thesis director has supervised thesis, the more likely the thesis was to be published. This could be explained by a gain of experienced and / or by a gain of motivation and interest. However, this subgroup analysis could be biased by the fact that thesis were significantly more published over the years. The role of the thesis supervisor is disputed in the literature, but studies have focused on the hierarchy or current practice position of the supervisor thesis rather than on his or her involvement in thesis supervision. In one hand, various studies didn't show an association between thesis supervisor and publication, as such in Tunisia, India and New Zealand concerning all medical specialities [23–25], and in France concerning general practice/family medicine residents [19]. In an other hand, being mentored was significantly enhancing the publication activity in various studies in USA [26–28].

The three factors significantly associated with the resident's overall publication activity during residency were : the resident's future involvement in a scientific thesis with an strong odds ratio of 1,51 ; the total number of publications from one-year up to 3-year post-graduation (related and non-related to the thesis) per resident ; and the age at graduation. Concerning the scientific thesis, the literature is not uniform: Chen *et al.* didn't show an association between

PhD degree and publication activity [29], whereas other studies found that resident's choice to pursue a fellowship or an academic career increased the resident's productivity [30,31]. In the same way as having pursued with a scientific thesis, the propensity to publish was already present during the residency when the intern has pursued with numerous post-residency publications. This may be the result of the resident choice for a research career or a fellowship position : the number of publications is one of the tools for selecting applicants and publication is often encouraged during this two positions [18,32]. It could also reflect the constant interest of the resident in scholarly activity. One possible explanation for the fact that residents who graduated older have published more papers could be that they followed a research year, which is a well-known factor in improving publishing activity [33].

Gender disparities in academic productivity is a highly debated issue. Our results were not uniform as publishing the thesis was not influenced by resident sex whereas overall publication activity was significantly associated with resident sex in univariate analysis but not in multivariate analysis. It is to note that the repartition of sex in our population was very unbalanced (only 20 (14%) males). The same findings are noted in the literature: studies have shown that male sex obtained a higher academic productivity [34] based on balanced (42% of males) [35] and unbalanced population (85% of males) [30], however other studies didn't found any disparity [29] based on balanced (40 to 60% of males) [19,24] and unbalanced population (12 to 73% of males) [9,36].

Other factors promoting scholarly productivity are highlighted in the literature. Two systematic reviews identified other factors frequently reported to facilitate publication, in addition to mentoring, such as protected time and research curricula [8,37].

Resident rank as first author in thesis publication was higher in our study compared to the literature data (80% in our study versus mostly 50-60% of published thesis in the literature data) [4,9,17,24]. In our study, when comparing thesis publication to other publications, residents were more likely first author of thesis publication, with a strong odds ratio of 4,97. This result was consistent with Chassagnon *et al.* study [22].

About publication characteristics, english publication was lower in our study compared to the literature data (47% of the overall publication in our study, versus mostly 70% in the literature data from non-english-speaking countries [5,9,22,38–40]). We assume english publication from french pediatricians will be modified in the future: indeed, the journal *Archives*

de pédiatrie has recently shifted from french edition towards english edition, when a third of publications in our study are provided by this journal.

Bibliometric features (journal impact factor and citation) were quasi similar compared to literature data [4,5,9,22,38,40–42] and were not associated with a publication based on the thesis. Nevertheless, journal impact factor and number of citations have limitations. They are imperfect and contested tools for describing the quality of an article, and also for comparing different research fields or time periods [43,44].

There were several limitations to this study. Completeness of data cannot be guaranteed due to the retrospective design of our study: some theses and/or residents might not have been included in the SUDOC databases. Similarly, some publications could have been missed in Pubmed and/or Google Scholar database, if too many results were returned or if the resident's name was wrong (due to a spelling error in SUDOC database or a change of name). We have decided to define the end of residency as the year in which the medical thesis was defended, but in France, medical thesis can also be defended before the end of the residency. This is less common, and we estimated that, by adding one-year post-graduation to the time limit for publications made during residency, we permitted to ensure the completion of the residency and to cover all of it. This is a single-center study, and we cannot generalise these findings to France, even if Fabre'study didn't show an association between the publication and the resident's university: we cannot exclude the possibility that a more powerful study may have shown an association. Our methodology to identify how much a thesis supervisor was involved in thesis supervision can be criticized. We summed the number of thesis supervised by each supervisor from our data: hence, it concerned thesis defended by pediatrician residents at the medical university of Marseille over the 1996-2015 period. But this estimation is incorrect if the supervisor has quickly retired or has recently begun as thesis supervisor; similarly, supervision oftheses defended by non-pediatrician students or students not assigned to the medical university of Marseille were not recorded. Our results were from one city in France and has been compared with cities and countries all around the world, but it should be noted that there is no standardization in medical studies. This makes it more difficult to compare countries: for some universities, having submitted a paper is mandatory in order to graduate [22], whereas for other universities, this is not mandatory [45].

CONCLUSIONS

Of the 144 graduated residents, 74 (51%) published their medical thesis and 87 (60%) published at least one paper, during pre-graduation up to one -year post-graduation, with an average of 2 papers per resident. Publishing the thesis was significantly associated with dissertation length and thesis supervisor, but not with residents' characteristics or studies' features. The thesis publication rate increased significantly over the years, but not the overall publication rate, and dissertation length significantly decreased over the years. These results could show a growing interest about thesis and / or a higher quality of the thesis' studies. The number of publications per resident were significantly increased when the resident has pursued with a scientific thesis, when he graduated older and when he has published more publications in post-residency.

In 2017, residency program in France has undergone major changes, since thesis defense will be mandatory during the third year of residency, that is one to several years before the end of residency. We may wonder if this requirement will improve the rate of published thesis. Furthermore, it would be of interest to extend this study to the whole country.

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SERMENT D'HIPPOCRATE

Au moment d'être admis(e) à exercer la médecine, je promets et je jure d'être fidèle aux lois de l'honneur et de la probité.

Mon premier souci sera de rétablir, de préserver ou de promouvoir la santé dans tous ses éléments, physiques et mentaux, individuels et sociaux.

Je respecterai toutes les personnes, leur autonomie et leur volonté, sans aucune discrimination selon leur état ou leurs convictions. J'interviendrai pour les protéger si elles sont affaiblies, vulnérables ou menacées dans leur intégrité ou leur dignité. Même sous la contrainte, je ne ferai pas usage de mes connaissances contre les lois de l'humanité.

J'informerai les patients des décisions envisagées, de leurs raisons et de leurs conséquences.

Je ne tromperai jamais leur confiance et n'exploiterai pas le pouvoir hérité des circonstances pour forcer les consciences.

Je donnerai mes soins à l'indigent et à quiconque me les demandera. Je ne me laisserai pas influencer par la soif du gain ou la recherche de la gloire.

Admis(e) dans l'intimité des personnes, je tairai les secrets qui me seront confiés. Reçu(e) à l'intérieur des maisons, je respecterai les secrets des foyers et ma conduite ne servira pas à corrompre les moeurs.

Je ferai tout pour soulager les souffrances. Je ne prolongerai pas abusivement les agonies. Je ne provoquerai jamais la mort délibérément.

Je préserverai l'indépendance nécessaire à l'accomplissement de ma mission. Je n'entreprendrai rien qui dépasse mes compétences. Je les entretiendrai et les perfectionnerai pour assurer au mieux les services qui me seront demandés.

J'apporterai mon aide à mes confrères ainsi qu'à leurs familles dans l'adversité.

Que les hommes et mes confrères m'accordent leur estime si je suis fidèle à mes promesses ; que je sois déshonoré(e) et méprisé(e) si j'y manque.

ORDRE NATIONAL DES MÉDECINS
Conseil National de l'Ordre