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Image of the new vaccination obligation through the media

Original article

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Image of the new vaccination obligation through the media

Introduction

Vaccination has always been associated with many controversies. In 1994, the extensive hepatitis B vaccination campaign raised suspicions of links with neurological diseases such as multiple sclerosis (1). More recently, the H1N1 vaccination campaign and the management of vaccine stocks have been strongly criticised (2). Currently, parts of the French population have some doubts about the safety of vaccines (3,4). In France in 2016, 46% of parents of 1-15 year-old children were found vaccine hesitant (according to the WHO definition of vaccine hesitancy (5)); among them some especially doubted of the safety of the hepatitis B vaccine.(6) In a study covering 67 countries, France was the one in which distrust of vaccine safety was the most frequent (41%, compared to a global average of 13%). (7) These uncertainties or even doubts may have contributed to insufficient vaccination coverage to ensure a collective protection and prevent epidemic risks. For example, the "2 doses" vaccination coverage was 80.3% against measles in 2017 and 78.6% against meningococcus C at the age of 2 years in 2018. (8). Under the recommendations of the Ministry of Health, eleven vaccines have become mandatory since 1 January 2018 (9.10).

Information about the new vaccination obligation has been widely reported by the media. The opinion of the general French population is influenced by the content of the media. The quality of information is important, as well as the quantity and the manner in which it is transmitted (11). It has been showed that nearly 7 out of 10 French people have already searched the Internet for health information during their life (12). In 2018, 23% of 15-34-year-olds used to consult media about health nearly every day (13). Although television remains the media with the largest audience (14), the written press and radio are the media in which the French have the greatest confidence (15).

The objective of this study was to analyze the information about the new vaccination obligation disseminated by the media and received by the general French population.

Methods

The information received by the French population on the obligation to vaccinate was collected in the traditional media: articles in the written press, radio and television broadcasts. Articles and broadcasts were selected from the 10 media in each category with the highest audience rate (16.17), from January 2016 to May 2018 (Table1). The search for articles and broadcasts was carried out on the media websites, entering the keywords "vaccination obligation" or "compulsory vaccination" in their search engine.

The radio and television programs were listened to, viewed and then transcribed word by word.

Once the articles were selected and broadcasts transcribed, they were analyzed by inductive coding according to the grounded theory with the help of NVIVO 12 software.

Articles and broadcasts were included until the data saturation. The double coding was done to

increase the validity of the study.

Results

A. Description of analyzed media

The analysis covered 38 written press articles (numbered PE01 to PE38), 18 radio programs (numbered R01 to R18) and 18 television programs (numbered T01 to T18).

B. Description of Stakeholders

In the various media analyzed, several types of speakers could be identified.

Various categories emerge: journalists, doctors or representatives of the medical profession, parents and political representatives. In each of these categories are discourses for or against this new law.

C. Timeline of media coverage (Table 2)

According to the news in media the coverage of the new extension of vaccination in France can be divided into 4 periods:

- Before June 2017: Media activity on vaccines was moderate at this period and media didn't cover vaccination obligation. This period was marked by the "Hurel" report in January 2016 (report on vaccination policy in France) and the French government decision to renew the vaccination policy with the aim of restoring confidence in vaccination and improving vaccination coverage. Debates between multidisciplinary representatives, called "national citizen consultation on vaccination" (18) took place from January 2016, chaired by Professor Alain Fischer. The conclusions were reported in November 2016. In February 2017, an important decision of the state council (the country's highest administrative court) was taken: the combination of the 3 compulsory vaccines in the same injection with other recommended vaccines became illegal. It forced the state to find another solution within 6 months. However, only one article was found during this period which contains the keyword "compulsory vaccination".
- From June 2017 to August 2017: In June 2017, 4 months after the state council decision, the Minister of Health, Agnès Buzyn, announced that the extension of compulsory vaccination should become effective in early 2018. From this date, media began to talk about vaccination obligation, raising numerous debates both on vaccines and on the obligations as such.
- From September 2017 to December 2017: the content of the extension of the compulsory vaccination was proposed in the framework of the Social Security Financing Bill at the National Assembly in September 2017 and was subsequently adopted in October 2017. Media presented a lot of information concerning the content of the new law, including opinions of citizens and doctors about it.
- After January 2018: the law came into force from January 1st. This period contained large number of articles, radio and TV shows, explaining the modalities of application as well as the

sanctions of the law.

D. Themes After Coding

9 main themes emerged from the coding of the analysed media.

I. Is vaccination useful? (Appendix 1)

Some parents described vaccination as unnecessary regardless of the period of the interview. A father interviewed during a visit at a pediatrician in Paris in July 2017 argued that diseases in young children are not serious and that it is better to acquire immunity naturally:

"It is not very serious to get sick and at that age they recover quickly..... And then they can also acquire their defenses naturally" (R18).

Parents interviewed in Caen referred to times when there were fewer vaccines and children were still healthy:

"The more it goes, the more we are told that we need vaccines, we need vaccines for this and before we lived without all this and here it is. It was no worse " (T02).

The media give voice to several doctors in different views.

A homeopathic pediatrician, Martin Hirte, on the set of the TV show "Square des idées, Les vaccins, ça se discute" also shared this idea in January 2018. He talked about unimmunized and healthy children, as well as the ineffectiveness of some vaccines. This doctor claimed that vaccine-preventable diseases are not serious:

"I have seen and treated a lot of measles cases. I've been practicing since 1994. I have never seen any complications" (T13).

On the other hand, another pediatrician interviewed in his doctor's office highlighted the usefulness of the vaccines in July 2017:

"The benefit is not even debatable." (T03)

Fabienne Cancelem, pediatrician member of AFPA (French Association of Ambulatory Pediatrics) on the radio show "RTL grand soir" in April 2018 recalled that :

"the vaccine is the act that has saved the most human lives in the recent 20th century. "(R12).

Overall, the physicians recalled the importance of the collective protection allowed by vaccination (R12) while parents seemed to be more concerned about individual protection of their child (T04).

A journalist of "Le Monde" (the most read newspaper in France), has entitled his editorial of December 2017: "Vaccines: a sanitary duty of common sense" and took a stand for the obligation of vaccination:

"It must help to combat the reemergence of infectious diseases such as measles" (PE14).

In July 2017, the same journal cited scientific studies:

" A German study of 2000 shows that, on the contrary, vaccinated children have better defenses than unvaccinated children" (PE32).

In June 2017, the journal "Le Parisien" commented on the French public health:

"it is necessary to protect children as soon as possible because these diseases can be deadly in under 2 years" (PE23).

The same journal "Le Parisien" recalled examples of eradication of old diseases:

"This technique that has suspended or even eradicated from the planet, many pathologies such as smallpox" (PE25).

Agnès Buzyn, the Minister of Health, was interviewed on September 2017 and compared France with foreign countries:

"Latin America has managed to eradicate diseases. Eradicate measles! We had 4,000 cases" (T06).

II. Can we have confidence in vaccines? (Appendix 2)

Media reported the lack of public confidence in vaccines through interviews with parents who were afraid of vaccines. Notably, parents thought children were too fragile for vaccination:

"It's being injected directly into small children with an immune system that is still weak" (T04).

They also feared that the intervals between vaccines were too close together (T03) and questioned the safety of vaccines and their composition (R06, T16). A mother testified about her premature daughter, reproaching doses not adapted to the weight and the young age of her child. She proposed:

"micro-vaccination" (R07).

Some diseases described as related to vaccines were mentioned in patient's interviews (R06, T12).

Some doctors talked about link between vaccines and some disease, like Dr. Martin Hirte, on a TV show in January 2018 who incriminated vaccination in the occurrence of sudden infant deaths:

"in the days following vaccination, sudden infant death is statistically more common than any time. There is indeed enough to remain suspicious" (T13).

The Nobel Prize laureate in Medicine, Prof. Luc Montagnier cited scientific studies validating the existence of these diseases as the result of vaccination:

"the risks of sudden infant death. Unfortunately, there are scientific facts..." (T14).

A journalist at Le Monde recalled that Professor Henri Joyeux, affirmed in an open letter to the President of the Republic and the Minister of Health that

"the harmfulness of the aluminum salt adjuvant is demonstrated".

But the journalist described him as *"a longtime opponent of certain vaccines"* and also recalled that he has been expelled from the principal authority of medical profession - a professional union of doctors (L'Ordre des Medecins) in 2016 (PE32).

On the contrary, other doctors insisted that scientific studies have not found a link between vaccines and these diseases such as sudden infant death (R07), fibromyalgia (T12) and multiple sclerosis (T14). During the events of the European Immunization Week in April 2018, lots of doctors interviewed were promoting the vaccination. Alain Fischer, president of the "national citizen consultation on vaccination", Professor of Pediatric Immunology and Researcher in Biology explained that vaccines have been used for a long time:

"vaccines are not new, some of them are 70-80 years old. The new ones still take 20 to 30 years to reach the users" (R07).

Doctor Bertrand Gagnaire, epidemiologist of the national public health agency "Public Health of France" explained how vaccines are manufactured and improved through scientific advances:

"Finally, the production of vaccines is very restrictive" (R09)

Marc Maisonnny, delegated director of prevention and health protection at regional health agency highlighted that:

"they are created under conditions by researchers, by laboratories.... controls.... are controlled...." (R10).

Doctors insisted on the safety of aluminium salts, which have been in use for years (R09).

The juridical recognition of the causal link between vaccines and certain diseases was occasionally controversial within the same article. For example, in response to a mother's question, a doctor responded:

"It has just been recognized by a French court that there is a link between the hepatitis vaccine and multiple sclerosis <...> The court found that the case was dismissed, so it is not true" (T14).

Journalists also reported the concern of the French by citing polls:

"39% of respondents-whether they are for or against the obligation-consider that the risks to immunization are higher than the profits" (PE34).

They analyzed the reasons for the loss of trust in vaccination. They recalled previous health scandals:

"in a climate of suspicion, the increasing mistrust of vaccines is fueled by repeated health scandals (hepatitis B, H1N1 flu...)" (PE29).

They also invoked lack of information in the vaccine confidence crisis in France. For example, in January 2018, Lise Barnéoud, scientific journalist and author of the book "Immune? a new look at vaccines" talked about controversy concerning macrophage myofasciitis and the chronic fatigue syndrome, saying *"we think that the less we talk about it, the less scary it is, but on the contrary" "mistrust is essentially fueled by a lack of transparency"* (R07).

The presence of fake news (T12), which is reportedly spread by anti-vaccination movement, was also deplored by some journalists (T14). A journalist at "Le monde" responded to what he called "false information" in an article in July 2017 where he explained among others things, how adjuvants work and why they are needed (PE32).

Journalists also highlighted the fact that *"It is a Franco-French controversy... Almost all cases of suspected complications related to vaccination involving aluminic adjuvants have been described in France, more than 80-90%"* (R07).

Media interviewed politicians about their confidence in vaccines. The ecologist European deputy Michèle Rivasi speculated about a conspiracy between the State and the pharmaceutical industry :

"the minister of health has always been close to the pharmaceutical industry " (PE10).

She also referred to scientific studies, as for aluminum-based adjuvants:

"it has been many years since these associations are present in the scientific studies, that show they have neurotoxic effects" (R04).

In response, The minister of Health in January 2018 answered parents' questions on the TV show "La Maison des Maternelles" to reassure:

"these vaccines have been shown to be very effective and safe at the ages recommended by the vaccination schedule" (T12).

She answered about the aluminum-based adjuvants arguing in an interview entitled *"More aluminium is ingested every day than we get in a dose of vaccine"* (T12).

III. Does the vaccination coverage rate justify the obligation? (Appendix 3)

Some patients introduced the idea that there is no health problem or increase in diseases, especially measles. The journal Le Monde covered the event that took place in Paris in September 2017 in front of the Ministry of Health to denounce the government's plan. Protesters were stating:

"There is no epidemic or public health emergency to increase the number of mandatory vaccines to eleven" (PE33).

On the contrary, doctors described the obligation as essential since insufficient vaccination coverage is responsible for the resurgence of diseases, particularly measles (R9, R11). It is therefore necessary to have at least 95% vaccination coverage to protect the population (T6). Patrick Zylberman (health historian in the Steering Committee of the Citizen Consultation on Immunization) explained the problem that the

"distinction between mandatory and recommended vaccines was a source of confusion for parents, and all vaccines had to be on an equal footing <...> We felt that lifting the obligation was too much of the risk. In this case, 15 to 20% of parents may no longer have their children vaccinated at all" (PE26).

An article from the newspaper "La Croix" refers to scientists from INSERM institute who commented the report of the European project Asset published in 2016. It raised:

"there does not seem to be a strict correlation between obligation and increase in immunization coverage" (PE09).

Another article reported the opinion of the CNGE (National College of General Practitioners Teachers) *"there is no scientific evidence that this measure results in better protection, particularly for children"* (PE27).

IV. The link between obligation and confidence in vaccination (appendix 4)

The conclusions of the "citizen consultation on vaccination" were reported by ecologist politicians in an article of the journal "Libération" in October 2017.

"The vaccination obligation should be removed for the benefit of the population's adherence to the Vaccination Act. The principle of obligation does not instill confidence, worse, it is counterproductive. Breaking the obligation would allow greater accountability of parents, citizens and adolescents. For half of us, lifting the obligatory character would facilitate the use of vaccination. People would feel less constrained, which would avoid strong resistance to the very notion of obligation " (PE29).

The CNGE also argued that :

"It is to be feared that its authoritarian nature reinforces the mistrust and suspicion of a growing part of the population" (PE 27).

On the other hand, a doctor spoke in a radio emission in January 2018:

"It is difficult to understand public health reasoning and that's why I appreciate that vaccines become obligatory" (R7).

According to Prof Zylberman:

"The immunization obligation may be an opportunity to do pedagogy and restore confidence" (PE26).

The Health Minister recalls that:

"the goal of this measure is not to sanction but to create confidence in vaccines" (PE20).

V. The cost of vaccinal obligation (appendix 5)

The obligation was sometimes represented as a benefit to laboratories. The ecologist European deputy Michele Rivasi argued that :

"we never know when we advise vaccination whether it is not the laboratories behind that pushes for vaccination because for them it is really a jackpot if you can vaccinate, especially when it comes to 11 vaccines for 750,000 children born each year" (R03).

On the contrary, some doctors noted that it is an inexpensive measure, with little benefit for laboratories:

"Originally vaccines have been made mandatory to allow access to all <...> It was a social measure." (R9).

Prof. Monneret, Honorary President of the National Academy of Pharmacy, stressed out that:

"It is certainly not for commercial purposes that laboratories produce vaccines. The industry would do more profits by delivering drugs for the diseases resulting from the lack of vaccination." (PE34)

A journalist for "Libération journal" mentioned the cost for the State:

"As for vaccines that are already mandatory, National Insurance Fund covers 65%, mutuels are obliged to pay the remaining 35%. This represents an additional cost of 12 million euros for the state" (PE15).

VI. Ethical concerns about the notion of obligation (Appendix 6)

Some parents thought that:

"It's their freedom to decide what is right for their children" (PE27).

Michele Rivasi stated:

"It's an authoritarian position. This is a position that infantilize parents" (R04),

A medical law student also considered that:

"the vaccination obligation is a rare and exceptional infringement of the fundamental freedom of free and informed consent" (PE12).

The homeopath doctor M. Hirte claimed:

"citizens are becoming victims of the politicization of a preventive medical measure" (T13).

Yet, according to several doctors, the law for the sake of everyone.

"our fellow citizens are calling for a political measure that will put the common good above selfishness and protect the weakest." (PE35).

They also reported that the major patient associations, particularly associations of immunocompromised or transplanted patients, approve the measure (PE35).

VII. Would the obligation achieve a change in practice? (Appendix 7)

Doctors found the differentiation between recommended and mandatory vaccines misleading. Indeed, the eight new mandatory vaccines were already recommended and very widely prescribed, *"more than 90% for most of them"* (PE15, PE21).

There will be no change in practice, as one pediatrician explains:

"It doesn't change anything because these are the 11 vaccines we have almost always made. These vaccines were recommended in the French vaccination calendar" (R17).

It was also noted that for parents who are reluctant to vaccinate, the obligation will not change their position of refusal. Some will not comply with the law, while others hope to obtain a certificate of contraindication (PE33).

VIII. The image of anti-vaccination advocates carried by the media (Appendix 8)

These arguments were mainly presented by doctors. The image of anti-vaccination advocates was particularly negative. They were described as spoiled children representative of an individualistic society (PE18, PE34), playing on the fear of parents who doubt the safety of vaccines (PE36) and endangering the population in the name of freedom (R7). Doctors interviewed in the programs see anti-vaccination advocates as a small group but able to efficiently mobilize through social networks and the Internet.

According to the media analysed, anti-vaccination advocates use these channels to disseminate inaccurate content and question scientific facts (PE21, PE15, PE25).

IX. The law explained in the media (Appendix 9)

Journalists reported on the path that led to the outline of this law. They mentioned the 2016 citizen inquiry that served as the basis for the discussion concerning this law (R07). For some journalists, it was mainly a question of solving an administrative problem encountered by the Council of State (PE37). Journalists also pointed out that the purpose of this law was to protect the children (T05, T06)

In a majority of the articles or programs, journalists and doctors described the application of the law. They specified the details of the vaccination schedule, the number of injections or vaccines (R04, T08, T10). Some journalists reminded that

"According to the Minister, this obligation would only be temporary: four to five years, the time to convince the parents" (T02).

The sanctions anticipated in the event of non-compliance with the law were also covered in the media. In the summer 2017, media talk about

" six months in prison and 3 750 euros in fine, as defined in article L 3116-4 of the public health Code" (PE22).

But in September 2017, The Minister of Health announced that

"there will be no incriminations, penalties or fines for people who will not be vaccinated" (PE30).

Finally, the sanctions would be of social character:

"the eleven compulsory vaccinations will be essential for the child to be admitted in community (nursery, school, stay of vacation...)" (PE30).

On the other hand, a child who would be disabled due to a lack of vaccine would have the

"right to criminalize his parents" (punishable up to two years imprisonment and 30,000 euros fine)" (PE20).

The idea of a religious or philosophical exemption clause for parents opposed to vaccination was rejected.

"If it is a public health imperative, it cannot be waived for reasons of conscience alone," argued the ministry (PE30).

It was suggested to give families time to vaccinate their children:

"the first verifications will only take place on June 1, 2018" (PE20).

The production of false certificates of contraindication to vaccination was criticised by some journalists and doctors (R08). Some parents found strategies to circumvent the law: *"Find excuses to postpone the deadline, until, luckily, the manager ends up forgetting them"* (PE08). The media also gave the voice to some nursery directors who saw this law difficult to apply (R07).

Discussion

This qualitative study highlights the information received by the French population through the main media.

It is important to note that the articles and broadcasts published by the media on the new vaccination obligation date only from June 2017, while the committee of "the citizen consultation" presented its report in November 2016 (19). The media therefore had a latency period of 7 months on this subject.

The law (20) and the vaccination calendar (21) were correctly described by journalists, except for some errors in some media.

Vaccination was supported by a majority of doctors in the media. A study of DREES in 2015 showed that 97% of general practitioners (GP) were in favor to vaccination in general. (22). They described vaccines as safe and effective drugs. Numerous scientific studies corroborated their statements (23,24).

Nevertheless, some representatives of the medical profession have expressed doubts about vaccination. This finding is supported by a study conducted in 2014 in France showing that 33% of general practitioners (GP) believed in a link between adjuvanted vaccines and long-term complications.

(25) The vaccination hesitation therefore exists to varying degrees among GPs :18% of GPs were not vaccine-hesitant, 68% slightly hesitant, 11% moderately hesitant and 3% highly hesitant or opposed to vaccination.

The media highlights a controversy about the existence of a decline in immunization coverage. They published false information from doctors and patients about the absence of a decrease in vaccination coverage and epidemics. Indeed, the latest epidemiological data clearly show the decrease in vaccination coverage as well as the resurgence of epidemics, particularly measles (26).

This study shows that the traditional French media provide divergent information on the correlation between vaccination requirements and rates. This difference was also found in the literature. A study of the different types of vaccination policies (27) suggested that vaccination obligation is effective in increasing coverage rates. An American review of literature (28) concluded that an exemption from vaccination obligation is associated with a decrease in coverage. However, the report of the European Asset project (29) concluded that it is impossible to confirm a relationship between the obligation and the vaccination coverage rates of children in Europe, suggesting that factors other than vaccination policies and parental hesitation could come into play (charges, ease of access to the vaccination act, etc.). In 2019, there is an improvement in vaccination coverage against hepatitis B. 98.6% of children born between January 1, 2018 and May 31, 2018, received their first vaccination using hexavalent vaccines including hepatitis B, compared to 93.1% for those born between January 1 and May 31, 2017 (30). Concerning the measles immunization coverage, 87.2% of children of 12 months in 2018 received their first dose, which represents a gain of 2.2 % compared to 2017. However, this coverage gain cannot be attributed directly to the vaccination obligation since it only applies to newborns from January 2018. On the other hand, this gain can be linked to the communication made around this obligation and vaccination in general. This increase may also be related to the media coverage on current outbreak of measles. (30.31).

This obligation is associated with a perception of the State's commitment. This association between the obligation and responsibility of health authorities seems to generate confidence among the French, as indicated by the results of another qualitative study on the population's knowledge and perceptions of vaccination obligations (32).

In addition, the media give a voice to parents who expressed their fears about the infringement of their freedoms and the right to decide for their children. Other studies entitled this concept as "*being an expert of his own child*" (33). In a study about antivaccination misinformation on the internet in 2010 (34) 75% of websites mentioned parental rights that were seen as being offended by not letting parents make choices on the care for their children.

The media escalated the mistrust of the population towards vaccines. In the Baromètre Santé France 2016, 75,1% of those surveyed said they were in favor of vaccination in general. On the contrary,

41.5% said they are unfavorable to one or more vaccinations in particular. This percentage is higher among those who said they are unfavorable to vaccination in general (71.7%), however it still reached as much as 31.6% among those declaring to adhere to it (35).

A number of recurrent motives of vaccine hesitancy could be detected in the analysed media that are also present in the literature. Mottos such as “*vaccines are unnatural*”, “*Multiple vaccines at once increase adverse events*”, “*Dangers of vaccine-preventable diseases are exaggerated to frighten parents*” are well-known tropes from the anti-vaccine movement (33, 34).

Some interviewees cited studies that demonstrate a causal link between vaccines and the occurrence of diseases secondary to vaccines (like multiple sclerosis, autism or macrophage myofasciitis). However, none of the original studies could be found. On the contrary, available scientific studies prove that there is no causal link between vaccines and the mentioned diseases (9,11). The characteristics of the antivaccination movement are skewing the science by endorsing the poorly-conducted studies that promote anti-vaccine statements. (33)

The age of vaccination is also in question, even though scientific studies show that make the vaccines early reduces the rate of infant morbidity and mortality (36). The loss of confidence is probably due to previous health scandals such as the management of H1N1 vaccine stocks (2).

Fear of adverse reactions due to the use of aluminum salts as an adjuvant in vaccines is highlighted by the media. However, for the moment, scientific studies do not prove a link between vaccines and pathologies (multiple sclerosis (37.38), sudden infant death (36.39)). Concerning aluminium salts, scientific studies showed that it is both an effective and safe product (40). A communication on the scientific data published on this subject (41) could be a communication lever to restore the confidence. Despite being able to legally recognize the adverse reactions, the courts have repeatedly condemned the National Office for the Compensation of Medical Accidents, Iatrogenic Conditions and Nosocomial Infections (ONIAM) to compensate patients (42,43).

The financial costs of the measures of mandatory vaccination was also a matter of disagreement in the media According to the French Court of Auditors, the vaccination obligation represents only a modest cost for health insurance (€ 12 million for 2018 according to estimates). Moreover, the amount reimbursed by health insurance for vaccines represented € 310 million in 2016, which equals to about 1% of the spendings for the consumption of drugs (44). The data in the literature are more in favour of compulsory vaccination. A U.S. study (45) published in 2017 estimated a \$350 billion savings on the health costs if immunization was extended to 73 countries (low and middle income) between 2001 and 2020.

The image of anti-vaccination activists or “anti-vaxxers” in the traditional media is negative and the idea that they endanger the population is highlighted (46). Other studies also mentioned the danger of the expression of anti-vaccination ideas via the Internet (47.48). There is much more alarming vaccination criticism on the websites and blogs than there are recommendations in favour of vaccines (according to the study called “Antidox”) (11). Social networks help spreading the misinformation (11).

It would therefore be interesting to conduct further studies covering these data.

The major strength of the present study is the selection of the media with the highest audience rates which makes it possible to analyse the information received by a large proportion of the French population. To gain maximum information the articles and broadcasts were included until the analysis reached data saturation. In addition, we have used large number of articles and major programs (74 articles and programs were analyzed) as well as the double coding with two investigators to increase the internal validity of this study. Triangulation of the data with the literature has led to consistent results, reinforcing external validity.

The main limitation of the study remains to be the analysis that comprise only the traditional media, excluding data from internet forums, social media, and journals with low audience rates limiting external validity.

Conclusions

This study shows that between June 2017 and May 2018, the French received a wealth of information in the traditional media about vaccination and the obligation to vaccinate. This information has sometimes been contradictory, respecting the freedom of expression of doctors and patients but also contributing in part to the loss of confidence of the French in vaccination and the emergence of controversies around this new law. The media gave equal voice to physicians, patients and politicians.

The analysis provided in this study could be completed by incorporating the information on the French vaccination obligations disseminated via the Internet.

Our results provide useful insights to guide public health policy, particularly in the field of information. We recommend the public authorities to set up a clearer information campaign on the vaccination obligation in order to ensure better transparency and thus better acceptance of this new law by the population.

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Tables

Table 1

Media with the highest audience rate in 2017		
Print (40) (number of readers)	Radio (13) (audience in percentage)	Television (12) (audience in percentage)
- Le Monde (2 720 000)	- RTL (12,1%)	- TF1 (20,2%)
- Le Parisien (2 263 000)	- France Inter (11,3%)	- France 2 (13,5%)
- Le Figaro (1 943 000)	- NRJ (10,5%)	- M6 (9,5%)
- Liberation (1 132 000)	- France Info (8,5%)	- France 3 (9,1%)
- Les Echos (693 000)	- France Bleu (7%)	- France 5 (3,6%)

- La Croix (548 000)	- Europe 1 (6,6%)	- C8 (3,3%)
- L'Humanité (363 000)		- TMC (3,2%)
		- BFM TV (2,7%)
		- ARTE (2,2%)

Table 2 : Number of media by period

Period	Number of media	Number by kind of media
Before june 2017	1	1 print article
June 2017 – August 2017	21	12 print article 7 radio emission 2 TV emission
September 2017 – december 2017	26	15 print article 3 radio emission 8 TV emission
After january 2018	26	10 print article 8 Radio emission 8 TV emission

Appendix 1

Is vaccination useful?		
Vaccination is unnecessary	<p>Defenses naturally acquire</p> <p>Healthy child without vaccines</p> <p>Measles is not serious</p>	<p>R18: <i>It is not very serious to get sick and at that age they recover quickly..... And then they can also acquire their defenses naturally. »</i></p> <p>T12 <i>"Breastfeeding will protect, will pass a number of protective antibodies effectively to the child"</i></p> <p>T02 <i>"The more it goes, the more we are told that we need vaccines, we need vaccines, we need vaccines for this and before we lived without all this and here it is. It was no worse "</i></p> <p>T13 <i>In my office I take care of a hundred unvaccinated children. And what I observe is that these children are very seldom ill "</i></p> <p>T13 <i>I have seen and treated a lot of measles cases. I've been practicing since 1994. I have never seen any complications»</i></p>
Vaccination is useful	<p>Vaccines save lives</p> <p>Fight against deadly diseases</p> <p>Disease eradication</p> <p>Healthier vaccinated children</p>	<p>R12 <i>« The vaccine is the act that has saved more human lives in recent times in the twentieth century. »</i></p> <p>PE14 <i>« It must help to combat the reemergence of infectious diseases such as measles '</i></p> <p>PE23 <i>« According to public health France, it is necessary to protect children as soon as possible because these diseases can be deadly in under 2 years '</i></p> <p>PE25 <i>« This technique that has brought back, or even disappear from the planet, many pathologies such as smallpox»</i></p> <p>T06 <i>Latin America has managed to eradicate diseases. Eradicate measles! »</i></p> <p>PE32 <i>"... A German study of 2000 (https://www.ncbi.nlm.nih.gov/pubmed/11023764) shows, on the contrary, that vaccinated children have better defenses than unvaccinated children"</i></p>
Protection	<p>Collective</p> <p>Individual</p>	<p>R12 <i>"Getting vaccinated is protecting yourself and protecting others." It's a citizen act. »</i></p> <p>T11 <i>« I think it is necessary and indispensable for the population to be healthy '</i></p> <p>T04 <i>"Of course, I want to protect my children, that they do not catch all these diseases, for which we have made enormous progress</i></p>

Appendix 2

Can we trust vaccines?		
Absence Confidence in vaccines	<p>Children too fragile</p> <p>Vaccination interval Too close</p> <p>Solution to adapt doses</p> <p>Dangerous vaccines</p> <p>French concerns</p>	<p>T04 « <i>It's still injecting directly on small children with an immune system that is still weaker '</i></p> <p>T03 <i>"I, what is problematic is more vaccines.... not being able to space them"</i></p> <p>R07 <i>"It might be good to think for some children about micro-vaccination"</i></p> <p>R06 <i>"I think the vaccine is potentially dangerous and children who are handicapped with... because of vaccinations"</i></p> <p>T13 <i>"in the days following vaccination, sudden infant death is statistically more common than the rest of the time. There is indeed enough to remain suspicious"</i></p> <p>PE34 <i>"The survey shows that 39% of respondents-whether they are for or against the obligation-consider that the risks to immunization are higher than the profits"</i></p>
The reasons for the loss of confidence	<p>Previous scandals</p> <p>Lack of transparency</p> <p>false information</p> <p>Spread by anti- vaccines</p>	<p>PE29 <i>"The transition to 11 compulsory vaccinations is in a climate of suspicion, even of increasing mistrust of vaccines, fueled by repeated health scandals (hepatitis B, H1N1 flu...) »</i></p> <p>PE 34 <i>"the level of institutional mistrust that prevails in France, particularly because of health scandals such as the Mediator"</i></p> <p>R07 <i>"I think the example of aluminum shows how much we really need To open the controversy in France in a transparent way ' "mistrust is essentially fueled by a lack of transparency"</i></p> <p>T12 <i>"There are a lot of fake-news Unfortunately, we know, on the subject of vaccination."</i></p> <p>T14 <i>On the side of the anti that also goes has contributed to.... to propagate fake-news and erroneous ideas about vaccines»</i></p>

	Conspiracy between state and pharmaceutical industry	PE10 <i>"In a statement, she points out that the minister" has always been close to the pharmaceutical industry "</i>
Reassurance on Vaccination	History of vaccination How Vaccines work Production and improvement of vaccines	R07 <i>"vaccines are not new, some of them have 70-80 years of age. The newer ones still have 20 to 30 years at least »</i> T13 <i>In Africa, inoculation was conceived several centuries ago. After the English Jenner, the French pastor finds the principle of vaccination according to the work of the German Koch, which had put in link disease and microbes»</i> R05 <i>"Each vaccine defends, protects against a specific disease." So the 11 vaccines protect against 11 diseases..... There are several types of vaccines. There are live vaccines, inactivated vaccines, vaccines in pieces</i> R09 <i>"After it is true that there the manufacture of vaccines Finally, it is very restrictive. This is Between 6 and 24 months, versus 1 and 6 months for a drug "</i> R10 <i>« L.... vaccines are... are... prepared and.... created under conditions by researchers, by laboratories.... controls.... are controlled.... and besides, compared to the years 60..... In fact, we injected 3000 antigens to stimulate the children's immune system and today..... we inject more than 50 in fact because we realized that the children's immune system was very high performance.</i>
Secondary diseases to vaccines		T12 <i>The young woman then starts studying to become a nurse and needs to be vaccinated against hepatitis B..... The evil that Laetitia suffers is fibromyalgia»</i> R06 <i>My son had plaques with eczema and he had hemolytic anemia "</i>
Recognition by the medical body	Doctor Acknowledging the link	T13 <i>We looked at who had asthma during childhood and when these people were vaccinated. And it was established that postponing the first 3-month vaccination, divided by 2 the risk of having asthma in school age.</i> PE23 <i>" A few cases of multiple sclerosis have emerged. Some patients have made the connection. The doubt has intruded</i>

	<p>Link proven by scientific studies</p> <p>Links not proven by scientific studies</p>	<p>T12 <i>It can be recalled that in France a study was conducted by a researcher, Prof. Gherardi and this study tends to show that these aluminum salts can promote a very handicapping disease called Myofasciitis to Macrophage "</i></p> <p>T14 <i>I would like to first alert you to the risks of sudden infant death. Unfortunately, there are scientific facts, facts observed by parents, that this death occurred after vaccination "</i></p> <p>R07 <i>This is absolutely inaccurate, has been demonstrated by a large number of published, corroborated scientific studies. Sudden infant death is not caused by vaccination "</i></p> <p>T12 <i>I would like to remind you that there is no proven link between fibromyalgia and hepatitis B vaccine, but between fibromyalgia and vaccine. That is to say that scientifically, today, this link has never been demonstrated "</i></p> <p>T14 <i>"The studies that have been done for a long time conclude that he There is no link between vaccination and multiple sclerosis»</i></p>
<p>Legal recognition of adverse reactions</p>		<p>T14 <i>"The link between hepatitis vaccine and multiple sclerosis has just been recognized by a French court."</i></p> <p><i>"The court found a dismissal so it is wrong"</i></p>
<p>Aluminum salt</p>	<p>Diseases caused by his injection</p> <p>Scientific studies</p> <p>Operation and need of aluminum salts</p>	<p>R07 <i>"This is called Myofasciitis to macrophages, because it's in the muscle and aluminum inclusions are in macrophages, immune cells"</i></p> <p>R04 <i>"In addition there are aluminum-based adjuvants, it has been many years since the associations, through scientific studies, show that it has neurotoxic effects"</i></p> <p>T12 <i>It can be recalled that in France a study was conducted by a researcher, Prof. Gherardi and this study tends to show that these aluminum salts can promote a very handicapping disease called Myofasciitis to Macrophage "</i></p> <p>R04 <i>"In addition there are aluminum-based adjuvants, it has been many years since the associations, through scientific studies, show that it has neurotoxic effects"</i></p> <p>PE32 <i>"Aluminum hydroxide is used as an adjuvant in many vaccines, to stimulate the body's immune response"</i></p>

	<p>Safety</p>	<p>R09 <i>"Today in any case there is no doubt a report to a general effect of aluminium, knowing that since 1920 you can imagine that there are millions and millions of vaccines that have been injected."</i></p> <p>T12 <i>"We ingest daily more aluminum every day than we do in a dose of vaccine"</i></p>
	<p>French problem</p>	<p>R07 <i>It is a French controversy..... Almost all of the cases of suspected complications related to vaccination including aluminum adjuvants have been described in France, more than 80-90%. »</i></p>

Appendix 3

Do the vaccination coverage rate justifies the obligation?		
Vaccination coverage	No better coverage in case of obligation	<p>PE29 <i>"Most of the vaccines today recommended, tomorrow mandatory, are the target of the 95% set by WHO for optimal immunization coverage."</i></p> <p>PE09 <i>"There does not seem to be a strict correlation between obligation and increase in immunization coverage"</i></p> <p>PE27 <i>The vaccination obligation is a simplistic and inappropriate response. There is no scientific evidence that this measure leads to better protection especially for children.</i></p>
	Insufficient vaccination coverage, responsible for resurgence of disease	<p>R9 <i>"apart from DTP vaccines with a vaccination coverage of almost 95% of the French population, the others do not have the same coastline. Coverage at 2 years of age against measles mumps rubella is 80%, for meningococcal C, it is 73%»</i></p> <p>R11 <i>"It is the state that takes the responsibility of ... to impose this vaccination on everyone, including those who have doubts about being able to so that everyone can benefit from the positive effects of vaccination and especially to eradicate certain diseases"</i></p> <p>T6 <i>"The public health objective is to achieve a vaccination coverage rate of at least 95% for real efficacy."</i></p>
	Lower coverage in the absence of an obligation	<p>PE26 <i>"distinction between mandatory and recommended vaccines was a source of confusion for parents, and all vaccines had to be on an equal footing." Either we removed the obligation for DT-polio and then the 11 vaccines became only recommended. Either we made all vaccines mandatory. "We felt that lifting the obligation was too much risk. In this case, 15 to 20% of parents may no longer have their children vaccinated at all. "</i></p> <p>R03 <i>« We would have liked the population to join the vaccination. In fact, unfortunately we are forced to see that today we are in France faced with a very important mistrust vis-à-vis vaccines. And the studies that have been done, show that if we eliminate the obligations, since we can not remain with this kind of mandatory and recommended vaccines, we will see a drop in immunization coverage, probably in the order of roughly nearly 20%. And 20% that means we will see again cases of measles »</i></p>

Appendix 4

The link between obligation and confidence in vaccination	
<p>Adherence to vaccination would have been preferable to make confidence and facilitate the use of vaccines</p>	<p>PE27 <i>"It is to be feared that its authoritarian nature reinforces the mistrust and suspicion of a growing part of the population"</i></p> <p>PE29 <i>The vaccination obligation should be removed for the benefit of the population's adherence to the Vaccination Act. For half of us, lifting the obligatory character would facilitate the use of vaccination "concluded the citizen jury of the consultation on vaccination. »</i></p> <p>R19 <i>"It is incongruous to claim to restore confidence by the obligation using a form of injunction against patients."</i></p>
<p>The obligation will give confidence to the French</p>	<p>PE20 <i>"Because the goal of this measure is not to sanction but to make confidence in vaccines" announces a minister.</i></p> <p>R7 <i>"It is difficult to understand public health reasoning." And that's why I appreciate that vaccines become obligatory '</i></p> <p>PE26 <i>"The immunization obligation may be an opportunity to do pedagogy and restore confidence"</i></p>

Appendix 5

The cost of the obligation	
Gifts to Laboratories	<p>R03 <i>"Because for them it's really the jackpot if you can vaccinate, especially on 11 vaccines, 750 000 children born every year"</i></p> <p>T14 <i>"We can clearly see that there are interests that are absolutely gigantic financial interests"</i></p>
Over cost for Social Security	<p>PE15 <i>"Medicare covers 65%, mutuels are obliged to pay the remaining 35%, as for vaccines already mandatory. This represents an additional cost to the state of 12 million euros"</i></p>
Social measure, inexpensive	<p>R9 <i>"Originally vaccines have been made mandatory to allow access to all." It was a social measure. »</i></p> <p>PE34 <i>"It is certainly not for commercial purposes that laboratories produce vaccines." The industry would do more profits by delivering drugs for diseases contracted because of the lack of vaccination. »</i></p> <p>T13 <i>"The vaccine remains the most cost-effective intervention in public health."</i></p>

Appendix 6

Ethical questioning about the notion of obligation	
Infantilization political measure, Violation of freedom.	<p>T13 <i>"Citizens are becoming victims of the politicization of preventive medical measures"</i></p> <p>R04 <i>"It's an authoritarian position. This is a position that infantilize parents "</i></p> <p>PE12 <i>"It is that the vaccination obligation is a rare and exceptional infringement of the fundamental freedom of free and informed consent"</i></p> <p>PE27 <i>"It's a Their freedom to decide what is right for their children"</i></p>
The law is intended by all	<p>PE35 <i>"Yes, our citizens call for their wish a political measure that will put the common good above selfishness and will protect the weakest."</i></p> <p>PE35 <i>"The main associations representing the patients also welcomed it, in particular the associations of immunocompromised or grafted patients, who cannot be vaccinated and whose protection is therefore dependent on collective vaccination"</i></p>

Appendix 7

Would the obligation bring about a change in practices?	
No difference between mandatory and recommended vaccines	<p>PE15 <i>"The change is mostly symbolic because the eight new vaccines were so far recommended and already very widely prescribed (to more than 90% for most of them)."</i></p> <p>PE21 <i>"It's not eleven new vaccines, it's the recommended vaccines that become mandatory"</i></p>
No change of practice	<p>R17 <i>"It doesn't change anything because it's the 11 vaccines that we've almost always done. These vaccines were recommended in the French vaccination schedule. Explains a pediatrician.</i></p> <p>PE33 <i>"On January 1, it will not change anything for me except that I will be even more outlaw than I am now."</i></p>

Appendix 8

The image of anti-vaccines carried by the media		
<p>Negative Image</p>	<p>Spoiled children representative of an individualistic society</p> <p>They play on the fear of the parents</p> <p>Endangering the population</p>	<p>PE18 <i>From this point of view, the rejection of vaccination appears as a selfish attitude. It is the fact of spoiled children of the technique»</i></p> <p>PE34 <i>In an increasingly individualized society, the constraint of vaccination is less accepted. Because the latter is mainly thought as an individual act, which only concerns the choice of the individual</i> "</p> <p>PE36 <i>"They are surfing the fear of parents who are questioning the safety of vaccines and their interest in their children and society."</i></p> <p>R7 <i>"There are enough obscurantist groups that take the pretext of freedom but endanger the health or life of others"</i></p>
<p>They are few but able to do a strong mobilization through social networks</p>		<p>PE21 <i>"In Fact, in reality it is necessary to know that there is a very small percentage of antivaccine in France. »</i></p> <p>PE15 <i>"As a bonus, the Antivaccines spoke loudly, imposing their voices on social networks, neglected by the health authorities."</i></p> <p>PE25 <i>«In the multitudes of the sites, blogs... 70% disseminate content that questions scientific facts. It plays when you are undecided.</i></p>

Appendix 9

The law explained in the media		
Origin of the law	<p>Citizen Consultation</p> <p>Administrative problem</p> <p>Protection of children and people</p>	<p>R07 <i>Citizen consultation It was juries and consultation if I may say so, a panel discussion with a committee and there was an extremely interesting debate between the members of the jury and the steering committee, which almost unanimously with the juries at concluded that the obligation was the lesser evil. »</i></p> <p>PE37 <i>" Some lend the Minister the intention of extending the vaccination obligation for the sole purpose of escaping the wrath of the Council of State and relying precisely on its injunction to justify a global obligation "</i></p> <p>T05 <i>There is a general measure concerning the production... protection of children, so that is the law, in general parents are supposed to protect their children»</i></p> <p>T06 <i>The law says that overall parents have to protect their children "</i></p>
Description of the Act	<p>Vaccination Schedule</p> <p>Number of vaccines and injections</p> <p>Temporary law</p> <p>Difficult to apply</p>	<p>T10 <i>In concrete terms between 2 and 18 months, the child receives 10 injections. 6 Appointments are enough thanks to the use of combined vaccines»</i></p> <p>R04 <i>We're going to go from 3 to 11 mandatory vaccines "</i></p> <p>T08 <i>All children born after 1rst January will have to submit to this vaccination... They will have until June 2018 to be able to do so. "</i></p> <p>T02 <i>According to the minister, this obligation would only be temporary: four to five years, the time to convince the parents "</i></p> <p>R07 <i>I still believe that there will be a big difficulty there in the coming months for the directors of Cribs and kindergarten directors who will be them in.. Uh.. In the obligation to do this sorting and I already had returns from manager who wonders how well they will realize this... this selection in fact»</i></p>
Law enforcement	Criminal Sanction before 2018, and its deletion	PE22 <i>"In theory, recalcitrant have up six months in prison and 3 750 euros in fine, as provided for in article L 3116-4 of the public health Code"</i>

Bibliography

1. Moyroud L, Hustache S, Goirand L, Hauzanneau M, Epaulard O. Negative perceptions of hepatitis B vaccination among attendees of an urban free testing center for sexually transmitted infections in France. *Hum Vaccin Immunother.* mai 2017;13(5):998-1004.
2. Peretti-Watel P, barometre P, Raude J, Constant A, Gautier A, Jestin C, et al. Dramatic change in public attitudes towards vaccination during the 2009 influenza A(H1N1) pandemic in France. *Euro Surveill.* 31 oct 2013;18(44).
3. Karafillakis E, Larson HJ. The benefit of the doubt or doubts over benefits? A systematic literature review of perceived risks of vaccines in European populations. *Vaccine.* 5 sept 2017;35(37):4840-50.
4. Andre F. Vaccinology: past achievements, present roadblocks and future promises. *Vaccine.* janv 2003;21(7-8):593-5.
5. MacDonald; SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: Definition, scope and determinants. *Vaccine.* 2015 Aug 14;33(34):4161-4. doi: 10.1016/j.vaccine.2015.04.036. Epub 2015 Apr 17.
6. Rey D, et al. Vaccine hesitancy in the French population in 2016, and its association with vaccine uptake and perceived vaccine risk-benefit balance. *Eurosurveillance*, 2018, vol 23, April 26.
7. Larson HJ, de Figueiredo A, Xiaohong Z, Schulz WS, Verger P, Johnston IG, et al. The State of Vaccine Confidence 2016: Global Insights Through a 67-Country Survey. *EBioMedicine.* oct 2016;12:295-301.
8. Bulletin de santé publique vaccination. Avril 2019. / Tous les numéros / Bulletin de veille sanitaire / Publications et outils / Accueil [Internet]. [cité 25 juin 2019]. Disponible sur: <http://invs.santepubliquefrance.fr/Publications-et-outils/Bulletin-de-veille-sanitaire/Tous-les-numeros/Bulletin-de-sante-publique-vaccination.-Avril-2019>
9. Hurel - Rapport sur la politique vaccinale.pdf [Internet]. [cité 19 sept 2018]. Disponible sur: https://solidarites-sante.gouv.fr/IMG/pdf/rapport_sur_la_politique_vaccinale_janvier_2016_.pdf
10. Décret n° 2018-42 du 25 janvier 2018 relatif à la vaccination obligatoire | Legifrance [Internet]. [cité 13 oct 2018]. Disponible sur: <https://www.legifrance.gouv.fr/eli/decret/2018/1/25/SSAP1732098D/jo/texte>
11. Etude-Vaccination-Printemps-de-la-Prévention-2.pdf [Internet]. [cité 18 oct 2018]. Disponible sur: <https://www.antidox.fr/wp-content/uploads/2018/04/Etude-Vaccination-Printemps-de-la-Pr%C3%A9vention-2.pdf>
12. Rapport IPSOS, Usages et attentes des Français à l'égard du digital en matière d'information sur leur santé, Mai 2016
13. Etude médiamétrie « les jeunes et l'information » juillet 2018
14. Newman N, Fletcher R, Kalogeropoulos A, Levy DAL, Nielsen RK. Digital News Report 2018. 2018;144.
15. 31e Baromètre de confiance dans les médias, réalisé par Kantar/Sofres. Disponible sur: [/Economie/Medias/confiance-Francais-medias-traditionnels-progresse-2018-01-23-1200908029](#)
16. 2018 01 29 Médiamat mensuel janvier 2018.pdf.

17. CP 126 000 Radio_Novembre-Décembre 2017.pdf.
18. Jeremy K.Ward, JamesColgrove, PierreVerger. Why France is making eight new vaccines mandatory. *Vaccine*. Volume 36, Issue 14, 27 March 2018, Pages 1801-1803
19. Rapport-de-la-concertation-citoyenne-sur-la-vaccination.pdf [Internet]. [cité 15 oct 2018]. Disponible sur: <http://concertation-vaccination.fr/wp-content/uploads/2016/11/Rapport-de-la-concertation-citoyenne-sur-la-vaccination.pdf>
20. LOI n° 2017-1836 du 30 décembre 2017 de financement de la sécurité sociale pour 2018 - Article 49. 2017-1836 déc 30, 2017.
21. calendrier_vaccinations_2018.pdf [Internet]. [cité 13 oct 2018]. Disponible sur: https://solidarites-sante.gouv.fr/IMG/pdf/calendrier_vaccinations_2018.pdf
22. Vaccinations : attitudes et pratiques des médecins généralistes. DREES. 2015. <https://drees.solidarites-sante.gouv.fr/etudes-et-statistiques/publications/etudes-et-resultats/article/>
23. Hansen JS, Thyssen SM, Rodrigues A, Martins C, Fisker AB. Is early measles vaccination associated with stronger survival benefits than later measles vaccination? *BMC Public Health* [Internet]. déc 2018 [cité 7 oct 2018];18(1). Disponible sur: <https://bmcpublihealth.biomedcentral.com/articles/10.1186/s12889-018-5866-y>
24. Lorton F, Chalumeau M, Assathiany R, Martinot A, Bucchia M, Roué J-M, et al. Vaccine-preventable severe morbidity and mortality caused by meningococcus and pneumococcus: A population-based study in France. *Paediatric and Perinatal Epidemiology* [Internet]. [cité 7 oct 2018];0(0). Disponible sur: <http://onlinelibrary.wiley.com/doi/abs/10.1111/ppe.12500>
25. Pierre Verger, Lisa Fressard, Fanny Collange, Arnaud Gautiere, Christine Jestine, Odile Launay, Jocelyn Raudeg, Céline Pulcini, Patrick Peretti-Watel. Vaccine Hesitancy Among General Practitioners and Its Determinants During Controversies : A National Cross-sectional Survey in France. *EbioMedicine*. August 2015 Volume 2, Issue 8, Pages 891–897
26. Bulletin épidémiologique rougeole. Données de surveillance au 1er août 2018. / Points d'actualités / Rougeole / Maladies à prévention vaccinale / Maladies infectieuses / Dossiers thématiques / Accueil [Internet]. [cité 15 oct 2018]. Disponible sur: <http://invs.santepubliquefrance.fr/Dossiers-thematiques/Maladies-infectieuses/Maladies-a-prevention-vaccinale/Rougeole/Points-d-actualites/Bulletin-epidemiologique-rougeole.-Donnees-de-surveillance-au-1er-aout-2018>
27. Briss PA, Rodewald LE, Hinman AR, Shefer AM, Strikas RA, Bernier RR, et al. Reviews of Evidence Regarding Interventions to Improve Vaccination Coverage in Children, Adolescents, and Adults. *Am J Prev Med*. :44.
28. Wang E, Clymer J, Davis-Hayes C, Bутtenheim A. Nonmedical Exemptions From School Immunization Requirements: A Systematic Review. *American Journal of Public Health*. nov 2014;104(11):e62-84.
29. Compulsory Vaccination and Rates of Coverage Immunization in Europe [Internet]. [cité 18 oct 2018]. Disponible sur: <http://www.asset-scienceinsociety.eu/reports/page1.html>
30. Bulletin-de-sante-publique-vaccination.-avril 2019 Disponible sur <https://www.santepubliquefrance.fr>
31. Daniel Lévy-Bruhl, Laure Fonteneau, Sophie Vaux, Anne-Sophie Barret, Denise Antona, Isabelle Bonmarin, Didier Che, Sylvie Quelet, and Bruno Coignard. Assessment of the impact of the extension of vaccination mandates on vaccine coverage after 1 year, France, 2019. *Euro Surveill*. 2019 Jun 27; 24(26): 1900301.

32. Humez M, Le Lay E, Jestin C, Perrey C. Obligation vaccinale : résultats d'une étude qualitative sur les connaissances et perceptions de la population générale en France. *Bull Epidémiol Hebd.* 2017;(Hors-série Vaccination):12-20.
33. Kata.A /Anti-vaccine activists, Web 2.0, and the postmodern paradigm--an overview of tactics and tropes used online by the anti-vaccination movement. *Vaccine.* 2012 May 28;30(25):3778-89. doi: 10.1016/j.vaccine.2011.11.112. Epub 2011 Dec 13.
34. Kata. A / A postmodern Pandora's box: Anti-vaccination misinformation on the Internet. *Vaccine.* Volume 28, Issue 7, 17 February 2010, Pages 1709-1716
35. GAUTIER A, JESTIN C, CHEMLAL K, Groupe Baromètre santé 2016. FRA. Adhésion à la vaccination en France : résultats du Baromètre santé 2016. Vaccination des jeunes enfants : des données pour mieux comprendre l'action publique. *BULLETIN EPIDEMIOLOGIQUE HEBDOMADAIRE.* 19 oct 2017;21-7.
36. Müller-Nordhorn J, Hettler-Chen C-M, Keil T, Muckelbauer R. Association between sudden infant death syndrome and diphtheria-tetanus-pertussis immunisation: an ecological study. *BMC Pediatrics* [Internet]. déc 2015 [cité 8 oct 2018];15(1). Disponible sur: <http://bmcpediatr.biomedcentral.com/articles/10.1186/s12887-015-0318-7>
37. Mouchet J, Salvo F, Raschi E, Poluzzi E, Antonazzo IC, De Ponti F, et al. Hepatitis B vaccination and the putative risk of central demyelinating diseases – A systematic review and meta-analysis. *Vaccine.* mars 2018;36(12):1548-55.
38. Frederiksen JL, Mailand MT. Vaccines and multiple sclerosis. *Acta Neurologica Scandinavica.* 136(S201):49-51.
39. Yang YT, Shaw J. Sudden infant death syndrome, attention-deficit/hyperactivity disorder and vaccines: Longitudinal population analyses. *Vaccine.* janv 2018;36(5):595-8.
40. Gołoś A, Lutyńska A. ALUMINIUM-ADJUVANTED VACCINES – A REVIEW OF THE CURRENT STATE OF KNOWLEDGE. (4):4.
41. WER9329-30.pdf [Internet]. [cité 9 oct 2018]. Disponible sur: <http://apps.who.int/iris/bitstream/handle/10665/273010/WER9329-30.pdf?ua=1>
42. CAA de BORDEAUX, 2ème chambre - formation à 3, 26/06/2018, 13BX00304, Inédit au recueil Lebon [Internet]. [cité 15 oct 2018]. Disponible sur: <https://www.legifrance.gouv.fr/affichJuriAdmin.do?oldAction=rechJuriAdmin&idTexte=CETATEX T000037113345&fastReqId=562652749&fastPos=3>
43. Conseil d'État, 5ème et 6ème chambres réunies, 30/03/2018, 408199, Inédit au recueil Lebon [Internet]. Inédit au recueil Lebon. 2018 [cité 15 oct 2018]. Disponible sur: <https://www.legifrance.gouv.fr/affichJuriAdmin.do?oldAction=rechJuriAdmin&idTexte=CETATEX T000036757740&fastReqId=562652749&fastPos=7>
44. Ozawa S, Clark S, Portnoy A, Grewal S, Stack ML, Sinha A, et al. Estimated economic impact of vaccinations in 73 low- and middle-income countries, 2001–2020. *Bulletin of the World Health Organization.* 1 sept 2017;95(9):629-38.
45. Le rapport public annuel 2018 de la Cour des Comptes. Disponible sur : <https://www.ccomptes.fr/sites/default/files/2018-01/06-politique-vaccinale-Tome-1.pdf>
46. L'origine du refus des vaccinations - Afis - Association française pour l'information scientifique [Internet]. [cité 18 oct 2018]. Disponible sur: <https://www.pseudo-sciences.org/spip.php?article2037>

47. Ward JK, Peretti-Watel P, Larson HJ, Raude J, Verger P. Vaccine-criticism on the internet: New insights based on French-speaking websites. *Vaccine*. févr 2015;33(8):1063-70.
48. Aquino F, Donzelli G, De Franco E, Privitera G, Lopalco PL, Carducci A. The web and public confidence in MMR vaccination in Italy. *Vaccine*. août 2017;35(35):4494-8.

Tables

Table 1

Media with the highest audience rate		
Print (40)	Radio 13	Television 12
<ul style="list-style-type: none">- Le Monde- Le Parisien- Le Figaro- Liberation- Les echos- La croix- L'humanité	<ul style="list-style-type: none">- Rtl- France Inter- Njr- France Info- France Bleue- Europe 1	<ul style="list-style-type: none">- TF1- France 2- M6- France 3- C8- France 5- Tmc- BFM TV- Arte

Table 2

Is vaccination useful?		
Vaccination is unnecessary	<p>Defenses naturally acquire</p> <p>Healthy child without vaccines</p> <p>Measles is not serious</p>	<p>R18: <i>It is not very serious to get sick and at that age they recover quickly..... And then they can also acquire their defenses naturally. »</i></p> <p>T12 <i>"Breastfeeding will protect, will pass a number of protective antibodies effectively to the child"</i></p> <p>T02 <i>"The more it goes, the more we are told that we need vaccines, we need vaccines, we need vaccines for this and before we lived without all this and here it is. It was no worse "</i></p> <p>T13 <i>In my office I take care of a hundred unvaccinated children. And what I observe is that these children are very seldom ill "</i></p> <p>T13 <i>I have seen and treated a lot of measles cases. I've been practicing since 1994. I have never seen any complications»</i></p>
Vaccination is useful	<p>Vaccines save lives</p> <p>Fight against deadly diseases</p> <p>Disease eradication</p> <p>Healthier vaccinated children</p>	<p>R12 <i>« The vaccine is the act that has saved more human lives in recent times in the twentieth century. »</i></p> <p>PE14 <i>« It must help to combat the even marginal reemergence of infectious diseases such as measles '</i></p> <p>PE23 <i>« According to public health France, it is necessary to protect children as soon as possible because these diseases can be deadly in under 2 years '</i></p> <p>PE25 <i>« This technique that has brought back, or even disappear from the planet, many pathologies such as smallpox»</i></p> <p>T06 <i>Latin America has managed to eradicate diseases. Eradicate measles! »</i></p> <p>PE32 <i>"... A German study of 2000 (https://www.ncbi.nlm.nih.gov/pubmed/11023764) shows, on the contrary, that vaccinated children have better defenses than unvaccinated children"</i></p>
Protection	<p>Collective</p> <p>Individual</p>	<p>R12 <i>"Getting vaccinated is protecting yourself and protecting others." It's a citizen act. »</i></p> <p>T11 <i>« I think it is necessary and indispensable for the population to be healthy '</i></p> <p>T04 <i>"Of course, I want to protect my children, that they do not catch all these diseases, for which we have made enormous progress</i></p>

Table 3

Can we trust vaccines?		
Absence Confidence in vaccines	Children too fragile	T04 « <i>It's still injecting directly on small children with an immune system that is still weaker</i> '
	Vaccination interval Too close	T03 <i>"I, what is problematic is more vaccines.... not being able to space them"</i>
	Solution to adapt doses	R07 <i>"It might be good to think for some children about micro-vaccination"</i>
	Dangerous vaccines	R06 <i>"I think the vaccine is potentially dangerous and children who are handicapped with... because of vaccinations"</i>
	French concerns	PE34 <i>"The survey shows that 39% of respondents-whether they are for or against the obligation-consider that the risks to immunization are higher than the profits"</i>
The reasons for the loss of confidence	Previous scandals	PE29 <i>The transition to 11 compulsory vaccinations is in a climate of suspicion, even of increasing mistrust of vaccines, fueled by repeated health scandals (hepatitis B, H1N1 flu...) »</i>
	Lack of transparency	R07 <i>I think the example of aluminum shows how much we really need To open the controversy in France in a transparent way '</i>
	false information	T12 <i>"There are a lot of fake-news Unfortunately, we know, on the subject of vaccination."</i>
	Spread by anti- vaccines	T14 <i>On the side of the anti that also goes has contributed to.... to propagate fake-news and erroneous ideas about vaccines»</i>
	Conspiracy between state and pharmaceutical industry	PE10 <i>"In a statement, she points out that the minister" has always been close to the pharmaceutical industry "</i>
Reassurance on Vaccination	History of vaccination	R07 <i>These vaccines are not new some of them have 70 80 years of age. The newer ones still have 20 to 30 years of honing at last so we have this setback»</i>

	<p>How Vaccines work</p> <p>Production and improvement of vaccines</p>	<p>T13 <i>In Africa, inoculation was conceived several centuries ago. After the English Jenner, the French pastor finds the principle of vaccination according to the work of the German Koch, which had put in link disease and microbes»</i></p> <p>R05 <i>"Each vaccine defends, protects against a specific disease." So the 11 vaccines protect against 11 diseases..... There are several types of vaccines. There are live vaccines, inactivated vaccines, vaccines in pieces</i></p> <p>R09 <i>"After it is true that there the manufacture of vaccines Finally, it is very restrictive. This is Between 6 and 24 months, versus 1 and 6 months for a drug "</i></p> <p>R10 <i>« L.... vaccines are... are... prepared and.... created under conditions by researchers, by laboratories.... controls.... are controlled.... and besides, compared to the years 60..... In fact, we injected 3000 antigens to stimulate the children's immune system and today..... we inject more than 50 in fact because we realized that the children's immune system was very high performance.</i></p>
<p>Secondary diseases to vaccines</p>		<p>T12 <i>The young woman then starts studying to become a nurse and needs to be vaccinated against hepatitis B..... The evil that Laetitia suffers is fibromyalgia»</i></p> <p>R06 <i>My son had plaques with eczema and he had hemolytic anemia "</i></p>
<p>Recognition by the medical body</p>	<p>Doctor Acknowledging the link</p> <p>Link proven by scientific studies</p>	<p>T13 <i>We looked at who had asthma during childhood and when these people were vaccinated. And it was established that postponing the first 3-month vaccination, divided by 2 the risk of having asthma in school age.</i></p> <p>PE23 <i>" A few cases of multiple sclerosis have emerged. Some patients have made the connection. The doubt has intruded</i></p> <p>T12 <i>It can be recalled that in France a study was conducted by a researcher, Prof. Gherardi and this study tends to show that these aluminum salts can promote a very handicapping disease called Myofasciitis to Macrophage "</i></p> <p>T14 <i>I would like to first alert you to the risks of sudden infant death. Unfortunately, there are scientific facts, facts observed by parents, that this death occurred after vaccination "</i></p>

	Links not proven by scientific studies	<p>R07 <i>This is absolutely inaccurate, has been demonstrated by a large number of published, corroborated scientific studies. Sudden infant death is not caused by vaccination "</i></p> <p>T12 <i>I would like to remind you that there is no proven link between fibromyalgia and hepatitis B vaccine, but between fibromyalgia and vaccine. That is to say that scientifically, today, this link has never been demonstrated "</i></p> <p>T14 <i>"The studies that have been done for a long time conclude that he There is no link between vaccination and multiple sclerosis»</i></p>
Legal recognition of adverse reactions		<p>T14 <i>"The link between hepatitis vaccine and multiple sclerosis has just been recognized by a French court. "</i></p> <p><i>"The court found a dismissal so it is wrong"</i></p>
Aluminum salt	<p>Diseases caused by his injection</p> <p>Scientific studies</p> <p>Operation and need of aluminum salts</p> <p>Safety</p>	<p>R07 <i>"This is called Myofasciitis to macrophages, because it's in the muscle and aluminum inclusions are in macrophages, immune cells"</i></p> <p>R04 <i>"In addition there are aluminum-based adjuvants, it has been many years since the associations, through scientific studies, show that it has neurotoxic effects"</i></p> <p>T12 <i>It can be recalled that in France a study was conducted by a researcher, Prof. Gherardi and this study tends to show that these aluminum salts can promote a very handicapping disease called Myofasciitis to Macrophage "</i></p> <p>R04 <i>"In addition there are aluminum-based adjuvants, it has been many years since the associations, through scientific studies, show that it has neurotoxic effects"</i></p> <p>PE32 <i>"Aluminum hydroxide is used as an adjuvant in many vaccines, to stimulate the body's immune response"</i></p> <p>R09 <i>"Today in any case there is no doubt a report to a general effect of aluminium, knowing that since 1920 you can imagine that there are millions and millions of vaccines that have been injected."</i></p> <p>T12 <i>"We ingest daily more aluminum every day than we do in a dose of vaccine"</i></p>

	French problem	R07 <i>It is a French controversy..... Almost all of the cases of suspected complications related to vaccination including aluminum adjuvants have been described in France, more than 80-90%. »</i>
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Table 4

Do the vaccination coverage rate justifies the obligation?		
Vaccination coverage	<p>No better coverage in case of obligation</p> <p>Insufficient vaccination coverage, responsible for resurgence of disease</p> <p>Lower coverage in the absence of an obligation</p>	<p>PE29 <i>"Most of the vaccines today recommended, tomorrow mandatory, are the target of the 95% set by WHO for optimal immunization coverage."</i></p> <p>PE09 <i>"There does not seem to be a strict correlation between obligation and increase in immunization coverage"</i></p> <p>PE27 <i>The vaccination obligation is a simplistic and inappropriate response. There is no scientific evidence that this measure leads to better protection especially for children.</i></p> <p>R9 <i>apart from DTP vaccines with a vaccination coverage of almost 95% of the French population, the others do not have the same coastline. Coverage at 2 years of age against measles mumps rubella is 80%, for meningococcal C, it is 73%»</i></p> <p>T6 <i>"The public health objective is to achieve a vaccination coverage rate of at least 95% for real efficacy."</i></p> <p>PE26 <i>"Opinion polls showed that, in this case, 15-20% of parents could no longer vaccinate all their children."</i></p>
Outbreak of disease?	<p>No health problems, Or Outbreak of disease</p> <p>Outbreak of disease</p>	<p>T04 <i>"It's not because a few percentages of the population will not be vaccinated tomorrow that we will end up facing a health emergency with hundreds of deaths»</i></p> <p>R03 <i>"When there is a measles epidemic, you have to vaccinate on measles, but to impose a vaccination on measles where there is no epidemic, you can ask the question"</i></p> <p>PE33 <i>"There is no epidemic or public health emergency to move to 11 the number of vaccines required"</i></p> <p>R11 <i>"Measles This is a good example of a disease that we hardly see anymore, and that comes back because we just lack a few people who are not vaccinated."</i></p>

Table 5

The link between obligation and confidence in vaccination	
Adherence to vaccination would have been preferable to make confidence and facilitate the use of vaccines	<p>PE29 <i>The vaccination obligation should be removed for the benefit of the population's adherence to the Vaccination Act. For half of us, lifting the obligatory character would facilitate the use of vaccination "concluded the citizen jury of the consultation on vaccination. »</i></p> <p>R19 <i>"It is incongruous to claim to restore confidence by the obligation using a form of injunction against patients."</i></p>
The obligation will give confidence to the French	<p>PE20 <i>"Because the goal of this measure is not to sanction but to make confidence in vaccines" announces a minister.</i></p> <p>R7 <i>"It is difficult to understand public health reasoning." And that's why I appreciate that vaccines become obligatory '</i></p>

Table 6

The cost of the obligation	
Gifts to Laboratories	<p>R03 <i>"Because for them it's really the jackpot if you can vaccinate, especially on 11 vaccines, 750 000 children born every year"</i></p> <p>T14 <i>"We can clearly see that there are interests that are absolutely gigantic financial interests"</i></p>
Over cost for Social Security	PE15 <i>"This represents an additional cost to the state of 12 million euros"</i>
Social measure, inexpensive	<p>R9 <i>"Originally vaccines have been made mandatory to allow access to all." It was a social measure. »</i></p> <p>PE34 <i>"It is certainly not for commercial purposes that laboratories produce vaccines." The industry would do more profits by delivering drugs for diseases contracted because of the lack of vaccination. »</i></p> <p>T13 <i>"The vaccine remains the most cost-effective intervention in public health."</i></p>

Table 7

Ethical questioning about the notion of obligation	
<p>Infantilization political measure, Violation of freedom.</p>	<p>T13 <i>"Citizens are becoming victims of the politicization of preventive medical measures"</i></p> <p>R04 <i>"It's an authoritarian position. This is a position that infantilize parents "</i></p> <p>PE12 <i>"It is that the vaccination obligation is a rare and exceptional infringement of the fundamental freedom of free and informed consent"</i></p> <p>PE27 <i>"It's a Their freedom to decide what is right for their children"</i></p>
<p>The law is intended by all</p>	<p>PE35 <i>"Yes, our citizens call for their wish a political measure that will put the common good above selfishness and will protect the weakest."</i></p> <p>PE35 <i>"The main associations representing the patients also welcomed it, in particular the associations of immunocompromised or grafted patients, who cannot be vaccinated and whose protection is therefore dependent on collective vaccination"</i></p>

Table 8

Would the obligation bring about a change in practices?	
No difference between mandatory and recommended vaccines	<p>PE15 <i>"The change is mostly symbolic because the eight new vaccines were so far recommended and already very widely prescribed (to more than 90% for most of them)."</i></p> <p>PE21 <i>"It's not eleven new vaccines, it's the recommended vaccines that become mandatory"</i></p>
No change of practice	<p>R17 <i>"It doesn't change anything because it's the 11 vaccines that we've almost always done. These vaccines were recommended in the French vaccination schedule. Explains a pediatrician.</i></p> <p>PE33 <i>"On January 1, it will not change anything for me except that I will be even more outlaw than I am now."</i></p>

Table 9

The image of anti-vaccines carried by the media		
Negative Image	<p>Spoiled children representative of an individualistic society</p> <p>They play on the fear of the parents</p> <p>Endangering the population</p>	<p>PE18 <i>From this point of view, the rejection of vaccination appears as a selfish attitude. It is the fact of spoiled children of the technique»</i></p> <p>PE34 <i>In an increasingly individualized society, the constraint of vaccination is less accepted. Because the latter is mainly thought as an individual act, which only concerns the choice of the individual</i> "</p> <p>PE36 <i>"They are surfing the fear of parents who are questioning the safety of vaccines and their interest in their children and society."</i></p> <p>R7 <i>"There are enough obscurantist groups that take the pretext of freedom but endanger the health or life of others"</i></p>
They are few but able to do a strong mobilization through social networks		<p>PE21 <i>"In Fact, in reality it is necessary to know that there is a very small percentage of antivaccine in France. »</i></p> <p>PE15 <i>"As a bonus, the Antivaccines spoke loudly, imposing their voices on social networks, neglected by the health authorities."</i></p> <p>PE25 <i>«In the multitudes of the sites, blogs... 70% disseminate content that questions scientific facts. It plays when you are undecided.</i></p>

Table 10

The law explained in the media		
Origin of the law	<p>Citizen Consultation</p> <p>Administrative problem</p> <p>Protection of children and people</p>	<p>R07 <i>Citizen consultation It was juries and consultation if I may say so, a panel discussion with a committee and there was an extremely interesting debate between the members of the jury and the steering committee, which almost unanimously with the juries at concluded that the obligation was the lesser evil. »</i></p> <p>PE37 <i>" Some lend the Minister the intention of extending the vaccination obligation for the sole purpose of escaping the wrath of the Council of State and relying precisely on its injunction to justify a global obligation "</i></p> <p>T05 <i>There is a general measure concerning the production... protection of children, so that is the law, in general parents are supposed to protect their children»</i></p> <p>T06 <i>The law says that overall parents have to protect their children "</i></p>
Description of the Act	<p>Vaccination Schedule</p> <p>Number of vaccines and injections</p> <p>Temporary law</p> <p>Difficult to apply</p>	<p>T10 <i>In concrete terms between 2 and 18 months, the child receives 10 injections. 6 Appointments are enough thanks to the use of combined vaccines»</i></p> <p>R04 <i>We're going to go from 3 to 11 mandatory vaccines "</i></p> <p>T08 <i>All children born after 1rst January will have to submit to this vaccination... They will have until June 2018 to be able to do so. "</i></p> <p>T02 <i>According to the minister, this obligation would only be temporary: four to five years, the time to convince the parents "</i></p> <p>R07 <i>I still believe that there will be a big difficulty there in the coming months for the directors of Cribs and kindergarten directors who will be them in.. Uh.. In the obligation to do this sorting and I already had returns from manager who wonders how well they will realize this... this selection in fact»</i></p>
Law enforcement	Criminal Sanction before 2018, and its deletion	<p>PE22 <i>"In theory, recalcitrant have up six months in prison and 3 750 euros in fine, as provided for in article L 3116-4 of the public health Code"</i></p> <p>These sanctions are abolished with the implementation of the law</p>

		PE30 <i>This provision shall be deleted from 1 January 2018»</i>
	Social Sanction	T13 <i>No penalties or fines planned but Inability to benefit from the nursery or daycare</i>
	Misunderstanding of some parents	T16 <i>I got a call from the manger... who told me that if my son was not vaccinated, he could not go back to the crib»</i>
	Sanction in case of false Certificates	R08 <i>An act of defiance which in the absolute could send them behind bars for breach of the obligation to protect children "</i>

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: