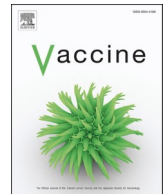


Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Human Papillomavirus (HPV) vaccination coverage among French adolescents: A claims data study

G. de Pourville^a, E. Guyot^{b,*}, G. Farge^c, M. Belhassen^b, M. Bérard^b, F. Jacoud^b, L. Bensimon^c, J.J. Baldauf^d

^a ESSEC Business School, 3 avenue Bernard Hirsch, CS 50105 Cergy, 95021 Cergy-Pontoise Cedex, France

^b PELyon, 210 avenue Jean Jaurès, 69007 Lyon, France

^c MSD France, 10-12 Cr Michelet, 92800 Puteaux, France

^d University Hospital of Strasbourg, Avenue Molière, 67200 Strasbourg, France

ARTICLE INFO

Keywords:

Human papillomavirus
Vaccination coverage rate
Claims database
Full vaccination
Partial vaccination

ABSTRACT

Background: The French cancer control strategy 2021–2030 aims to achieve 80 % human papillomavirus (HPV) vaccination coverage. Since 2021, HPV vaccination is also recommended for boys aged 11–14 years, with a catch-up vaccination recommended for unvaccinated adolescents aged ≤ 19 years. The PAPILLON study used claims data to monitor the evolution of HPV Vaccination Coverage Rate (VCR) in the French population.

Methods: The annual HPV VCR was described from 2017 to 2022. Partial vaccination was defined as the dispensing of at least one dose of HPV vaccination. Full scheme vaccination was defined according to the current French recommendations as two or three doses of HPV vaccine over an 18-month period. Annual HPV vaccine initiation rates were estimated on 11–14 and 15–19-year-olds adolescents. Cumulative VCR were estimated on adolescents aged between 11 and 19 years at the time of first vaccination.

Results: Overall, 1,773,900 females and 592,167 males initiated HPV vaccination between 2017 and 2022. Initiations occurred between 11 and 14 years for 67.3 % of females and 62.4 % of males with a median time between the first two doses of 195 days and 190 days, respectively. In girls, the cumulative vaccination rate for the partial scheme vaccination at 15 y.o. increased from 28.1 % in 2017 to 50.9 % in 2022. Similarly, the cumulative vaccination rate for the full scheme vaccination at 16 y.o. increased from 15.5 % in 2017 to 33.8 % in 2022. In 2022, the initiation rates for males were 12.6 % at age 14 and 1.9 % at age 19.

Conclusions: HPV vaccination coverage increased between 2017 and 2022 among girls targeted by the recommendation but remains insufficient. The results of this study show a tentative but promising start to vaccination in boys. This study will monitor the effects of actions taken to improve vaccination, including the extension of vaccination competencies to community pharmacists since end of 2022.

1. Background

Human papillomavirus (HPV) is highly prevalent in both women and men [1,2]. Some of the infections caused by HPV can persist and progress to pre-cancerous lesions and cancers. HPV is a well-established cause of cervical cancer, other anogenital cancers (vulva, vagina, anus, penis) and some head and neck cancers such as oropharyngeal cancer [2]. It can also cause anogenital warts and recurrent respiratory

papillomatosis in men and women [2]. Overall, HPV causes more than 6300 cancers per year in French women and men and cervical cancer is attributable to HPV in almost 100 % of cases [3,4]. HPV 16 and 18 alone are responsible for approximately 80 % of cervical cancer cases in France [5].

HPV vaccines have been developed to prevent persistent infections caused by high- and low-risk HPV types. In France, vaccination against HPV infections has been first introduced in July 2007 in girls only. In

Abbreviations: CMU-C, Couverture Médicale Universelle Complémentaire – free-access-to-care status; HAS, French National Health Authority; HPV, Human Papillomavirus; INSEE, Institut National de la Statistique et des Etudes Economiques - National Institute of Statistics and Economic Studies; NHS, National Health System; SNDS, Système National des Données de Santé - French administrative health care database; SNIIRAM, French National health insurance information system; SpF, Santé Publique France; VCR, vaccination coverage rate.

* Corresponding author at: PELyon (PharmacoEpidémiologie Lyon), 210 avenue Jean Jaurès, 69007 Lyon, France.

E-mail address: erika.guyot@peylon.fr (E. Guyot).

<https://doi.org/10.1016/j.vaccine.2024.06.007>

Received 28 July 2023; Received in revised form 15 May 2024; Accepted 1 June 2024

0264-610X/© 2024 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

January 2021, the recommendation of the French National Health Authority (HAS) to extend the national HPV program to boys was implemented. Thus, vaccination against HPV infections is now recommended for girls and boys aged 11–14 years (2-dose schedule), with a catch-up vaccination recommended for unvaccinated individuals aged ≤ 19 years (3-dose schedule) [6]. HPV vaccination is also recommended for immunocompromised individuals and for men who have sex with men up to the age of 26.

The last ten years of use of these vaccines have demonstrated a reduction in HPV 16 and 18 infections in countries where coverage has been high [7–11]. Only a high Vaccination Coverage Rate (VCR) could have a significant epidemiological effect with a reduction in HPV-related cancers and diseases [12]. Indeed, the French national cancer institute (INCa) in its cancer plan sets a target of 80 % VCR, and the WHO sets a target of 90 %. These VCR thresholds are those recommended to allow the elimination of HPV-induced cancers. [13–15]. Results published in 2021 in the United Kingdom showed an 87 % reduction in cervical cancer incidence due to HPV VCR of 87 % in girls at age 12–13 [16].

In France, the HPV vaccine program performance coverage is among the lowest of high-income countries [17]. However, the vaccination coverage for girls increased in the recent years [18–20], to reach 47.8 % for the partial scheme vaccination at age 15, and 41.5 % for the full scheme vaccination at age 16 in 2022 [21]. For boys, the figures were 12.8 % and 8.5 %, respectively.

The French Ten-Year Cancer Control Strategy 2021–2030 objective is to achieve 80 % of VCR. Since 2021, the political environment is favorable to increase HPV vaccination coverage with the arrival of vaccination in community pharmacies [22,23], and the announcement in February 2023 of a vaccination campaign in schools by the President of the Republic [24]. In this context, it is important to continue monitoring the evolution of vaccination coverage in France.

The PAILLON study aims to describe the evolution of HPV VCR in the French population. It provides detailed results on the target cohort (11–14 years), as well as on the catch-up cohort (15–19 years), and the vaccination procedures, including the time between doses according to age. This publication covers estimated annual age-specific vaccination initiation rates for females and males in France, as well as age-specific cumulative vaccination rates for partial and complete vaccination schemes for the period 2017–2022.

2. Methods

2.1. Study design and data source

This is a retrospective cohort study using the national healthcare claims database in France (French acronym: SNDS) covering around 99 % of the French population. The SNDS contains pseudonymised individual data about primary and secondary care utilization. It includes general patient characteristics and all reimbursed non-hospital healthcare expenditure (e.g., prescription and delivery of drugs, consultations, biological tests, etc.) and hospital discharge summaries [25].

2.2. Study population

The study population consisted of females and males who were dispensed their first HPV vaccine between 1 July 2007 and 31 December 2022. The date of inclusion was defined as the date of the first dispensing by a pharmacy for one of the HPV vaccines (Cervarix® [the bivalent HPV vaccine (2vHPV vaccine)], Gardasil® [the 4-valent HPV vaccine (4vHPV vaccine)], or Gardasil® 9 [the 9-valent HPV vaccine (9vHPV vaccine)]). Each dose dispensed was studied. As the SNDS database does not contain information on the actual inject of the vaccine, we are using the date the vaccine was dispensed by the pharmacy as a proxy. Adolescents who were dispensed two different HPV vaccines on the same day were excluded from the cumulative full vaccination analysis

because it was not possible to determine whether they were fully vaccinated.

3. Definitions and outcomes

3.1. Vaccination scheme

An individual has been considered to have initiated the HPV vaccination if at least one dose of the vaccine has been dispensed. Adolescents who were dispensed at least one dose of HPV vaccine were considered partially vaccinated. According to the French recommendations, the completion of the vaccination schedule was defined according to the vaccine dispensed. Adolescents were considered fully vaccinated with the 4vHPV vaccine if they were aged 11–13 years at initiation and were dispensed two doses within 18 months, or if they were aged 14–19 years and were dispensed three doses within 18 months. Adolescents were considered fully vaccinated with the 9vHPV vaccine and the 2vHPV vaccine if they were aged 11–14 years and were dispensed two doses within 18 months, or if they were aged 15–19 years and were dispensed three doses within 18 months. The results of the full 18-month vaccination schedule are not presented for males, as the recommendation to vaccinate males aged 11 to 19 years was introduced in January 2021 in France, which therefore does not allow to have 18 months of follow-up for this population.

3.2. Annual HPV vaccination initiation rate

The annual HPV vaccination initiation rate was defined as the number of females or males aged 11–19 years who initiate HPV vaccination in the studied year divided by the total number of females or males aged 11–19 years in the studied year who had not initiated HPV vaccination in previous years. The annual HPV vaccination initiation rate by year (from 2017 to 2022) and by age was defined as the number of females or males of a given age who initiated HPV vaccination in the studied year divided by the number of females or males of the same given age who had not initiated HPV vaccination in previous years. For example, the 2017 annual HPV vaccination initiation rate for girls at age 15 was the number of 15-year-old girls age (born in 2002) still alive at the end of 2017 who initiated HPV vaccination in 2017 divided by the number of 15-year-old girls who did not initiate HPV vaccination in previous years. The denominator was obtained by subtracting the total number of girls born in 2002 from the national census population data, i. e. INSEE (National Institute of Statistics and Economic Studies in France) dataset as of 31 December of the studied year and the number of girls still alive who initiated HPV vaccination in previous years.

3.3. Cumulative HPV vaccination rates for partial scheme vaccination

The cumulative HPV vaccination rate by year (from 2017 to 2022) and birth cohort for the partial vaccination scheme was defined as the number of females or males alive at the end of year, in a given year of birth who were dispensed at least one dose of HPV vaccine during or before the study year divided by the total number of females or males of the same year of birth, alive in the study year (Supplementary material, Figure S1).

3.4. Cumulative HPV vaccination rates for full scheme vaccination

The cumulative HPV vaccination rate by year and by birth cohort for the full vaccination scheme was defined as the number of females or males alive at the end of year of a given year of birth who had been dispensed the full HPV vaccination scheme during the studied year divided by the total number of females or males of the same year of birth, alive in the studied year. For example, the cumulative HPV vaccination rate for the full scheme vaccination in 2017 among the 2002 birth cohort is the number of girls still alive with a full scheme

vaccination in 2017 or earlier and born in 2002 divided by the number of girls born in 2002 alive in 2017 (Supplementary material, Figure S2).

3.5. Variables

The annual overall and age-specific vaccination initiation rates from 2017 to 2022 were described to assess vaccination program performance over the years studied. The cumulative vaccination rates by calendar year (from 2017 to 2022) and birth cohort for the partial and for the full vaccination scheme were described to assess the level of protection in the French population by birth cohort. The distributions of the age at initiation, median time between doses, and number of doses dispensed were also described.

3.6. Statistical analyses

All analyses were stratified by gender. Descriptive analyses (age distribution, number of doses, and time between doses) are presented for adolescents aged 11–19 years who initiated HPV vaccination since 2017. The estimate of cumulative vaccination coverage for adolescents aged 11–19 years is based on data from the entire study period (July 1, 2007, to December 31, 2022). Quantitative variables were described using sample size, mean, standard deviation (STD), median and interquartile range (IQR). Qualitative variables were described using sample size, and percentages.

Annual HPV vaccination initiation rates were described between 11 and 19 years of age by specific age in years. Cumulative HPV vaccination rates in a calendar year for the partial vaccination scheme and for the full vaccination scheme at 18 months were described by birth cohort. The statistical analysis was performed with SAS Enterprise Guide® (SAS Institute, North Carolina), version 7.13.

3.7. Ethics

This observational study was conducted using anonymized data after approval by the French Institute for Health Data, approval n° TPS 31281, on 20 February 2018 and the French Data Protection Authority (CNIL), approval n° DR-2018-953, on 4 October 2018. Written informed consent was not required for participation in this study, in accordance with national legislation and institutional requirements.

4. Results

4.1. Study population

In our study, 1,773,900 females aged between 11 and 19 and 592,167 males aged between 11 and 19 were included (Fig. 1). A total of 1,071,894 (60.4%) females had a full scheme vaccination at 18 months. The mean age at inclusion was similar for females and males aged 11 to 14 years (12.4 ± 1.1 and 12.5 ± 1.1 y.o., respectively), as it was for those aged 15 to 19 years (16.4 ± 1.3 and 16.3 ± 1.2 y.o., respectively).

4.2. HPV vaccination in girls

Among girls who initiated HPV vaccination between 11 and 14 years old, 60.4 % had a two-dose vaccination schedule (Table 1). The median (IQR) time between the two first doses was 195.0 (119) days (6.5 mo) (Table 2). Among the girls who initiated HPV vaccination between 15 and 19 years old, 47.8 % had a three-dose schedule. The median (IQR) time between the first two doses was 75.0 (88) days (2.5 mo) while it was 126.0 (72) days (4.1 mo) between the second and third doses.

The initiation rate for the overall female population aged 11–19 increased between 2017 and 2022 (except for the year 2020 impacted by COVID-19 pandemic). This increase is more marked for the primary cohort [11–14] than for the catch-up cohort, with a slowdown among 15–19-year-olds in 2022 (Supplementary material, Table S1; Fig. 2).

4.3. VCR by year

The cumulative vaccination rate for the partial scheme vaccination at 15 y.o. increased from 28.1 % in 2017 to 50.9 % in 2022 (+22.8

Table 1

Number of doses of an HPV vaccine between 2017 and 2020 for females (N = 1,055,874) aged 11–19 years at initiation.

Number of doses according to age	Females 11–14 years old (2 doses)	Females 15–19 years old (3 doses)
1	130,518 (20.9%)	74,730 (20.2%)
2	436,306 (69.9%)	76,229 (20.6%)
3	53,072 (8.5%)	205,933 (55.7%)
≥4	4,015 (0.6%)	13,097 (3.5%)

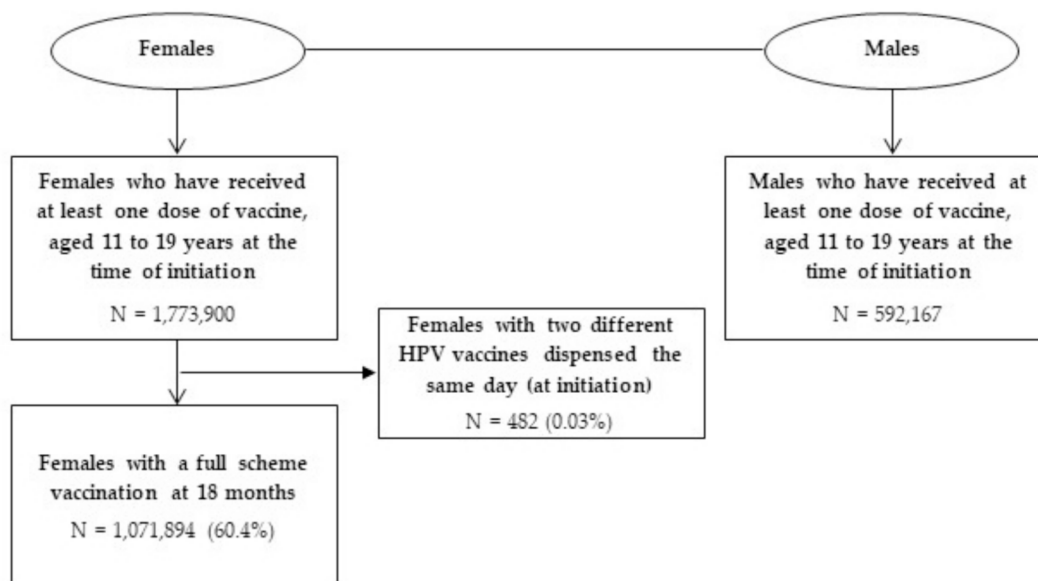


Fig. 1. Flowchart of the population. HPV: Human papillomavirus.

Table 2

Median time (in days) between doses for females (N = 1,773,900) and males (N = 592,167) aged between 11 and 19 years at initiation.

	Females				Males			
	N	%	Median	IQR	N	%	Median	IQR
Initiation between 11 and 14 years old								
Time between 1st and 2nd doses	858,697	71.9 %	195.0	119	181,254	49.0 %	190.0	104
Time between 2nd and 3rd doses	143,765	12.0 %	156.0	159	13,189	3.6 %	133.0	133
Initiation between 15 and 19 years old								
Time between 1st and 2nd doses	444,354	76.6 %	75.0	88	145,974	65.6 %	74.0	84
Time between 2nd and 3rd doses	308,159	53.1 %	126.0	72	76,592	34.4 %	125.0	63

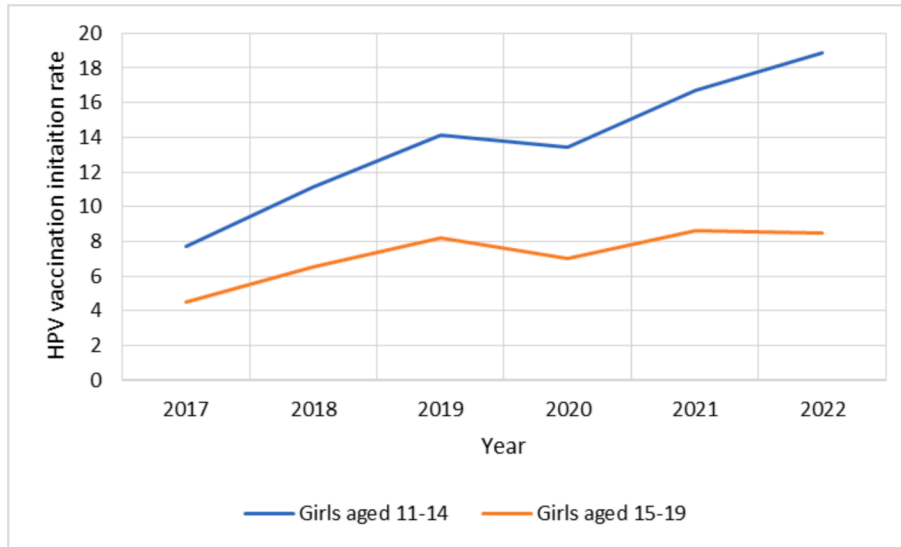


Fig. 2. Annual HPV vaccination initiation rates among girls aged 11–14 and 15–19. HPV: Human papillomavirus.

percentage points). The cumulative vaccination rate for the full scheme vaccination at 18 months among girls increased more rapidly among the youngest adolescent girls (born between 2004 and 2009) than for the

oldest (born between 2001 and 2003) (Fig. 3). The cumulative vaccination rate for the full scheme vaccination at age 16 increased from 15.5 % in 2017 to 33.8 % in 2022 (+18.3 percentage points).

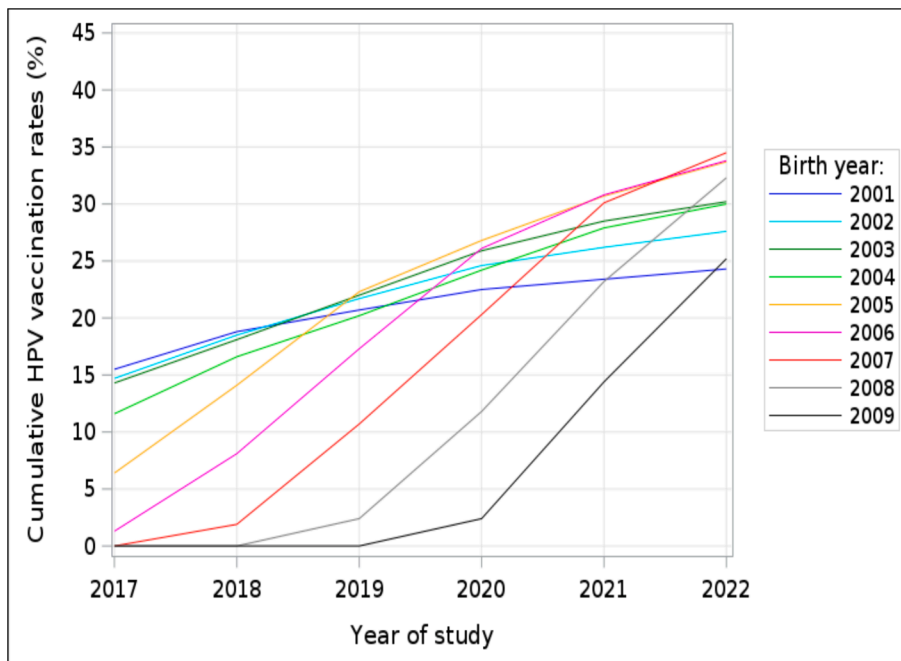


Fig. 3. Annual cumulative HPV vaccination rates for the full scheme at 18 mo by birth cohort among girls. HPV: Human papillomavirus.

4.4. VCR by birth cohort

In the cohort born in 2003, the cumulative HPV vaccination rate for the partial scheme vaccination was 25.0 % at age 15 in 2017 and 49.3 % at age 19 in 2022 (Supplementary material, Table S2). In the cohort born in 2002, the cumulative vaccination rate for the full scheme vaccination was 18.5 % at age 16 in 2018 and 27.6 % at age 20 in 2022. Comparatively, in the cohort born in 2006, the cumulative vaccination rate for the full scheme vaccination was 33.8 % at age 16 in 2022 (Supplementary material, Table S3).

4.5. HPV vaccination in boys

Most of the males (51.0 %), who initiated HPV vaccination between 11 and 14 years old were dispensed only one dose of vaccine, while 45.5 % had a two-dose vaccination schedule (Table 1). Among the latest, the median (IQR) time between the two first doses was 190.0 (104) days (6.3 mo) (Table 2). Among men who started HPV vaccination between the ages of 15 and 19, 34.4 % were dispensed one dose of HPV vaccine, 31.2 % were dispensed two doses, and 32.9 % were dispensed three doses. The median (IQR) time between the two first doses was 74.0 (84) days (2.8 mo), while it was 125.0 (63) days (4.0 mo) between the second and third doses.

The initiation rates for the overall male population between 11 and 19 years old was 0.2 % in 2019, 1.1 % in 2020, 6.4 % in 2021 and 9.0 % in 2022 (Table 3). In 2022, initiation rates were the lowest among 18- and 19-year-old males (3.5 % and 1.9 %, respectively), while they were the highest among 12 and 13-year-olds (13.7 % and 12.9 %, respectively).

In 2022, the cumulative HPV vaccination rate for partial vaccination scheme was 19.7 % among boys born in 2007 (at 15 y.o.) and 2.9 % among boys born in 2002 (at 20 y.o.) (Supplementary material, Table S4).

5. Discussion

The PAPILLON study used the SNDS database, which covers 99 % of the French population, providing a comprehensive, recent and reliable estimate of HPV VCR among girls and boys.

5.1. HPV vaccination in French girls

Our results indicate that the initiation rate among 11–19-year-old girls increased from 6.1 % in 2017 to 14.2 % in 2022. We found that the cumulative vaccination rate for the partial scheme vaccination increased from 28.1 % in 2017 to 45.8 % in 2022 among 15-year-old girls. The same trend was observed for the cumulative vaccination rate for the full schedule at age 16, which increased from 15.5 % in 2017 to 33.8 % in 2022.

Our results regarding cumulative HPV vaccination rate for the partial scheme are consistent with those published by SpF, which found a rate of 47.8 % at age 15 in 2022 [26]. Similarly, a study based on the Baromètre santé 2021 survey showed that HPV vaccination coverage for the partial scheme vaccination was 43.6 % among 15- to 18-year-olds girls in metropolitan France using data reported by parents through random telephone calls [27].

However, a difference of 7.7 percentage points was observed

between the results of the present study and those of SpF in terms of cumulative HPV vaccination rate for the full scheme. Indeed, according to SpF, 41.5 % of girls born in 2006 had a complete HPV vaccination regimen when they reached age 16. Potential discrepancies might be due to different methodology and definition used. SpF also used the SNDS, but the definitions and conventions used may differ from those applied in this study, which may explain some of the discrepancies observed. We have defined the maximum time required to obtain the full scheme vaccination as 18 months from initiation. This time frame is not mentioned in the SpF reports and therefore could be different. In addition, we considered women who initiated HPV vaccination between 2007 and March 2014 to be fully vaccinated with 3 doses of vaccine within 18 months, whereas we considered women who initiated vaccination from April 2014 to be fully vaccinated with 2 or 3 doses of vaccine depending on their age at initiation and the vaccine delivered, to be in line with the recommendations of the French health authorities. SpF considered women born before 2000 to have a complete vaccination schedule if they were dispensed 3 doses of vaccine and those born after 2000 to have a complete regimen if they were dispensed 2 doses of vaccine. Finally, a difference in the reference population used to calculate vaccination coverage could also explain the observed inconsistency. While we use INSEE data to estimate the total number of French adolescents in each age group, the reference population is not specified in the SpF study.

It should be noted that, we observed a decline in HPV vaccination in 2020. This is coherent with the decrease of 30.1 % between observed vs. expected dispensing of HPV vaccine reported in the EPI-PHARE report between March 2020 (beginning of the first lockdown in France) and the end of 2020 [28,29]. Overall, these findings suggest that the COVID-19 pandemic has had a negative impact on HPV vaccination. This phenomenon and any possible catch-up in the post-COVID-19 years should be further investigated.

5.2. HPV vaccination in French boys

We found that 592,167 boys aged 11 to 19 years were dispensed at least one dose of HPV vaccine between January 1, 2017, and December 31, 2022. Initiation rates were 0.2 % in 2019, 1.1 % in 2020, 6.4 % in 2021, up to 9.0 % in 2022 which might be related to the expansion of HPV vaccination recommendations to boys since January 2021 in France. Vaccination of boys is still in its early stage and its progress will need to be monitored in the coming years. A study conducted in the USA showed that the vaccination coverage of boys reached that of girls in only 6 years [30].

5.3. Importance of HPV vaccination

Overall, this study highlights that the HPV vaccination coverage is progressing in France, but remains insufficient with respect to the objectives set by the national cancer control plan, which envisaged reaching vaccination coverage of 80 % in 2030 [31]. French vaccination coverage is among the lowest of high-income countries [17].

Only a high VCR could have a significant epidemiological effect with a reduction in HPV-related cancers and diseases [12]. One of the reasons for the low vaccination coverage in France is the complexity of the HPV vaccination process [23,32]. Until recently, the main actors in this

Table 3

Annual HPV vaccination initiation rates (%) among males aged between 11 and 19 years each year studied.

Year of vaccination	Overall (%)	Age in year of vaccination								
		11	12	13	14	15	16	17	18	19
2019	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1
2020	1.1	1.3	1.4	1.5	1.6	1.3	1.0	0.7	0.4	0.3
2021	6.4	7.8	8.7	8.9	9.3	7.7	6.1	4.4	2.6	1.4
2022	9.0	12.0	13.7	12.9	12.6	10.1	8.0	6.0	3.5	1.9

vaccine pathway were general practitioners. In 2022, the HAS recommended involving new vaccinators (including community pharmacists, nurses and midwives) to facilitate the vaccination process [22,23]. Since 2022 and 2023, pharmacists can prescribe and administer HPV vaccines [33]. In addition to this measure, a generalized free HPV vaccination campaign at school for all 7th graders has been launched in September 2023 [24], as well as a general public communication campaign by the French national cancer institute in 2023 and renewed in 2024. To achieve the French Ten-Year Cancer Control Strategy 2021 – 2030 vaccination coverage objective, these efforts must be continued and reinforced by additional information such as campaigns for health professionals and the general public, an invitation letter for HPV vaccination by the health insurance, communication on the extension of vaccination competencies, and an extension of the cohort for catch-up.

5.4. Strengths and limitations

The main strength of this study is the use of SNDS database, which covers 99 % of the French population. In this context, the calculation of the annual vaccination initiation rates and the annual cumulative vaccination rate for full scheme at 18 months gives an accurate estimate of the vaccination coverage of French adolescents. Another strength of the present study is the provision of comprehensive data on the 15–19-year-old-cohort. In France, the only other estimates for this age group come from a telephone survey conducted in 2021 among parents of girls aged 15 to 18 [27]. Furthermore, the PAPILLON study brings details on vaccination procedures, including the time between doses according to the age of the adolescents, which can be related to the vaccine recommendations. The stratification of the results by gender is also an important added value of the present study, because it allows us to put into perspective the vaccination dynamics of girls and boys.

Some limitations should be acknowledged. Since the study uses claims data, we considered the dispensing of vaccines as a proxy of vaccination, but we do not have any information reported about the actual vaccine injection. Some vaccines may be dispensed by community pharmacists but not injected to adolescents, leading to an over-estimation of HPV vaccine coverage. On the other hand, it should be noted that SNDS only contains information on care reimbursed by the French NHS, which means that the vaccines which were dispensed for free are not recorded in this database. Vaccinations against HPV can be performed during a medical follow-up consultation for children and adolescents (one between 11 and 13 years and one between 15 and 16 years). The vaccines dispensed and injected as part of these free visits are not recorded in the SNDS, so as those performed in family planning clinics (Centres de Planification ou d'Education Familiale), therefore vaccination rates may be underestimated. The SNDS data are also limited in that the reasons (or determinants) of poor vaccination uptake are unfortunately unknown. However, we tried to identify these determinants in our previous publication, both for factors associated with initiation, and for factors associated with schema completion [20]. In France, the GEOVAX study identified new potential explanations for HPV VCR geographical disparities [34]. Indeed, in urban areas, a low rate of HPV VCR is preferentially associated with unfavorable socioeconomic factors (poverty, unemployment, immigration). In rural areas, HPV VCR is preferentially associated with sociocultural factors (socio-professional categories, education level, interest in alternative medicines the anti-vaccine movement). According to a study published by *Santé Publique France*, aimed at exploring the socioeconomic factors associated with vaccination against HPV infections, strong territorial inequalities in vaccination were highlighted at the national level, with vaccination coverage four times lower among the most disadvantaged. In another study published by *Santé Publique France*, women with a disadvantaged socio-economic situation participate less in screening. Young women from disadvantaged backgrounds thus combine the risk of not benefiting from either of the two cervical cancer prevention measures during their lifetime [27,35].

6. Conclusion

The PAPILLON study provides recent, robust and reliable estimates of HPV vaccination coverage among French adolescents, using data from the national health care claims database, SNDS. The results of this study show an increase in vaccination coverage between 2017 and 2021 among girls targeted by the recommendation, and a tentative but promising start to vaccination among boys. This study will monitor the effects of recent measures taken to improve vaccination, including the extension of vaccination competencies to community pharmacists since 2022. It seems plausible that further actions will be necessary to reach the 80 % HPV vaccination coverage target set by the French cancer control strategy in 10 years (2021–2030). As an example, the recent announcement from the French President (February 2023) to implement HPV vaccination in school should have a positive impact on VCR. Moreover, support from healthcare authorities is key to inform health professionals and parents of the public health benefits of HPV prevention.

CRedit authorship contribution statement

G. de Pourville: Methodology, Supervision, Writing – review & editing. **E. Guyot:** Methodology, Validation, Writing – original draft. **G. Farge:** Methodology, Validation, Writing – review & editing. **M. Belhassen:** Methodology, Supervision, Writing – review & editing. **M. Bérard:** Formal analysis, Writing – review & editing. **F. Jacoud:** Formal analysis, Writing – review & editing. **L. Bensimon:** Funding acquisition, Writing – review & editing. **J.J. Baldauf:** Methodology, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Gerard de Pourville reports financial support was provided by MSD France. Jean-Jacques Baldauf reports financial support was provided by MSD France. M. Belhassen, M. Bérard, E. Guyot and F. Jacoud are full-time employees of PELyon. L. Bensimon and G. Farge are full-time employees of MSD France.

Data availability

The authors do not have permission to share data.

Acknowledgments

The authors thank the French NHS (Caisse Nationale de l'Assurance Maladie) for providing access to its claims data. This study was funded by MSD France.

All authors attest they meet the ICMJE criteria for authorship.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.vaccine.2024.06.007>.

References

- [1] Dunne EF, Nielson CM, Stone KM, Markowitz LE, Giuliano AR. Prevalence of HPV infection among men: a systematic review of the literature. *J Infect Dis* 2006;194 (8):1044–57.
- [2] Forman D, de Martel C, Lacey CJ, Soerjomataram I, Lortet-Tieulent J, Bruni L, et al. Global burden of human papillomavirus and related diseases. *Vaccine* 2012;30 (Suppl 5):F12–23.
- [3] Shield KD, Marant Micallef C, de Martel C, Heard I, Megraud F, Plummer M, et al. New cancer cases in France in 2015 attributable to infectious agents: a systematic review and meta-analysis. *Eur J Epidemiol* 2018;33(3):263–74.

- [4] Hartwig S, St Guily JL, Dominiak-Felden G, Alemany L, de Sanjose S. Estimation of the overall burden of cancers, precancerous lesions, and genital warts attributable to 9-valent HPV vaccine types in women and men in Europe. *Infectious Agents Cancer* 2017;12:19.
- [5] Pretet JL, Jacquard AC, Saunier M, Clavel C, Dachez R, Gondry J, et al. Human papillomavirus genotype distribution in low-grade squamous intraepithelial lesions in France and comparison with CIN2/3 and invasive cervical cancer: the EDiTH III study. *Gynecol Oncol* 2008;110(2):179–84.
- [6] Institut de Veille Sanitaire. Calendrier des vaccinations et recommandations vaccinales 2016. *Hors Série Avril*; 2016.
- [7] Harper DM, DeMars LR. HPV vaccines - a review of the first decade. *Gynecol Oncol* 2017;146(1):196–204.
- [8] Lei J, Ploner A, Elfstrom KM, Wang J, Roth A, Fang F, et al. HPV vaccination and the risk of invasive cervical cancer. *N Engl J Med* 2020;383(14):1340–8.
- [9] Kjaer SK, Dehlendorff C, Belmonte F, Baandrup L. Real-world effectiveness of human papillomavirus vaccination against cervical cancer. *J Natl Cancer Inst* 2021; 113(10):1329–35.
- [10] Wang WV, Kothari S, Skufca J, Giuliano AR, Sundstrom K, Nygard M, et al. Real-world impact and effectiveness of the quadrivalent HPV vaccine: an updated systematic literature review. *Expert Rev Vaccines* 2022;21(12):1799–817.
- [11] Meites E, Stone L, Amiling R, Singh V, Unger ER, Derkay CS, et al. Significant declines in juvenile-onset recurrent respiratory papillomatosis following human papillomavirus (HPV) vaccine introduction in the United States. *Clin Infect Dis* 2021;73(5):885–90.
- [12] Schiffman M, Wacholder S. Success of HPV vaccination is now a matter of coverage. *Lancet Oncol* 2012;13(1):10–2.
- [13] Europe's Beating Cancer Plan. Communication from the commission to the European Parliament and the Council; 2021.
- [14] Spinner C, Ding L, Bernstein DI, Brown DR, Franco EL, Covert C, et al. Human papillomavirus vaccine effectiveness and herd protection in young women. *Pediatrics* 2019;143(2).
- [15] Brisson M, Benard E, Drolet M, Bogaards JA, Baussano I, Vanska S, et al. Population-level impact, herd immunity, and elimination after human papillomavirus vaccination: a systematic review and meta-analysis of predictions from transmission-dynamic models. *Lancet Public Health* 2016;1(1):e8–17.
- [16] Falcato M, Castanon A, Ndlela B, Checchi M, Soldan K, Lopez-Bernal J, et al. The effects of the national HPV vaccination programme in England, UK, on cervical cancer and grade 3 cervical intraepithelial neoplasia incidence: a register-based observational study. *Lancet (London, England)* 2021;398(10316):2084–92.
- [17] Bruni L, Saura-Lazaro A, Montoliu A, Brotons M, Alemany L, Diallo MS, et al. HPV vaccination introduction worldwide and WHO and UNICEF estimates of national HPV immunization coverage 2010–2019. *Prev Med* 2021;144:106399.
- [18] Fonteneau L, Barret AS, Lévy-Bruhl D. Évolution de la couverture vaccinale du vaccin contre le papillomavirus en France - 2008-20BEH. 2019(22-23).
- [19] Fonteneau L, Vaux S, Parent Du Châtelet I. Bulletin de santé publique vaccination. Saint-Maurice: Santé publique France; 2022, 9 p.
- [20] Dalon F, Majed L, Belhassen M, Jacoud F, Berard M, Levy-Bachelot L, et al. Human papillomavirus (HPV) vaccine coverage rates (VCRs) in France: a French claims data study. *Vaccine* 2021;39(36):5129–37.
- [21] Santé Publique France. Données de couverture vaccinale papillomavirus humains (HPV) par groupe d'âge 2023 [updated 25/04/2023. Available from: <https://www.santepubliquefrance.fr/determinants-de-sante/vaccination/articles/donnees-de-couverture-vaccinale-papillomavirus-humains-hpv-par-groupe-d-age>.
- [22] Haute Autorité de Santé. Elargissement des compétences en matière de vaccination des infirmiers, des pharmaciens et des sages-femmes. Premier volet, personnes de plus de 16 ans; 2022.
- [23] Haute Autorité de Santé. Élargissement des compétences en matière de vaccination des infirmiers, des pharmaciens et des sages-femmes. Second volet, enfants et adolescents de moins de 16 ans; 2022.
- [24] Direction de l'information légale et administrative (Première ministre). Papillomavirus : vaccination généralisée à la rentrée 2023 pour les élèves de 5e 2023 [updated 07 March 2023. Available from: <https://www.service-public.fr/particuliers/actualites/A16438#:~:text=%C3%80%20partir%20de%20la%20rentr%C3%A9e,vaccination%20ne%20sera%20pas%20obligatoire>.
- [25] Tuppin P, Rudant J, Constantinou P, Gastaldi-Menager C, Rachas A, de Roquefeuil L, et al. Value of a national administrative database to guide public decisions: From the systeme national d'information interregimes de l'Assurance Maladie (SNIIRAM) to the systeme national des donnees de sante (SNDS) in France. *Rev Epidemiol Sante Publique* 2017;65(Suppl 4):S149–67.
- [26] Santé Publique France. Données infra-nationales de couverture vaccinale papillomavirus humains (HPV) 2022 [Available from: <https://www.santepubliquefrance.fr/determinants-de-sante/vaccination/articles/donnees-infra-nationales-de-couverture-vaccinale-papillomavirus-humains-hpv>.
- [27] Hanguard R, Gautier A, Soullier N, Barret A, Parent du Châtelet I, Vaux S, et al. DREES. *Bull Épidémiol Hebd* 2021;24–25:446–55.
- [28] Assurance Maladie. Rapport au ministre chargé de la Sécurité sociale et au Parlement sur l'évolution des charges et des produits de l'Assurance Maladie au titre de 2023 (loi du 13 août 2004). 2022 Juillet 2022.
- [29] Alain Weill, Jérôme Drouin, David Desplas, Francois Cuenot, Rosemary Dray-Spira, Zureik M. Usage des médicaments de ville en France durant l'épidémie de la Covid-19. Rapport 6. EPI-PHARE 27 mai 2021.
- [30] Prabhu VS, Bansal N, Liu Z, Finalle R, Sénécal M, Kothari S, et al. HPV vaccination uptake and administration from 2006 to 2016 in a commercially insured population of the United States. *BMC Public Health* 2021;21(1):1629.
- [31] Institut National du Cancer. Stratégie décennale de lutte contre les cancers 2021-2030.
- [32] Vaux S, Gautier A, Nassany O, Bonmarin I. Vaccination acceptability in the French general population and related determinants, 2000–2021. *Vaccine* 2023;41(42): 6281–90.
- [33] Décret n° 2022-610 du 21 avril 2022 relatif aux compétences vaccinales des infirmiers et des pharmaciens d'officine; 2022.
- [34] Ribassin-Majed L, Pereira M, Magneron C, Levy-Bachelot L, Fagherazzi G, Baldauf JJ, et al. Interest of a geostatistical approach to analyze the geographical disparities in human papillomavirus vaccine coverage in France. *Rev Epidemiol Sante Publique* 2021;69(6):321–8.
- [35] Blondel C. Influence des facteurs socioéconomiques sur la vaccination contre les infections à papillomavirus humain chez les adolescentes en France. *BEH* 2019.