1 Title: The population impact of human papillomavirus (HPV) vaccination programmes on

2 infection with nonvaccine HPV genotypes

3 Running Title: Impact of HPV vaccination on nonvaccine HPV types

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### 44 Abstract

We systematically identified and analysed published and unpublished data comparing HPV 45 prevalence in prevaccination and postvaccination time periods, to consider changes in 46 47 nonvaccine HPV types after vaccine introduction. Nine studies provided HPV prevalence data from 13,886 females aged ≤19 years (younger females) and 23,340 females aged 20-24 48 years (older females). Following vaccine introduction, there was some evidence of cross-49 protection for HPV31 among younger females (prevalence ratio (PR) (95%CI)=0.73(0.58-50 0.91)) but little evidence of a reduction in HPV33 and HPV45. There was evidence of a slight 51 increase in two nonvaccine high-risk HPV types: HPV39 and HPV52 (younger females: 52 PR=1.27(1.05-1.54) and 1.34(1.13-1.59) respectively), and in two possible high-risk types 53 54 HPV53 and HPV73 (younger females: PR=1.51(1.10-2.06) and PR=1.36(1.03-1.80)). Given 55 the inconsistency in findings between age groups and the vaccine used, and possible alternative explanations for the increases, there was no clear evidence for type-replacement. 56 57 Continued monitoring of these HPV types is important. 58 Article Summary Line: Following introduction of HPV vaccination, there were some 59 changes in the prevalence of non-vaccine HPV types, but there was no clear evidence for 60

61 type-replacement

### 62 Introduction

63

cause of cervical cancer.(1) Two high-risk types (HPV16 and HPV18) cause approximately 64 70-80% of cervical cancers.(2-4) The HPV vaccines which are currently commercially 65 available have been shown in trial settings to have close to 100% vaccine efficacy against 66 cervical disease caused by vaccine-specific high-risk HPV types: HPV16 and 18 for the 67 bivalent and quadrivalent vaccines; HPV31, 33, 45, 52, and 58 for the new nonavalent 68 vaccine.(5-7) Clinical trial data for the bivalent and quadrivalent vaccines have also shown 69 70 low to moderate protection against some of the other high-risk HPV types which are phylogenetically related to HPV16 and HPV18 (i.e. cross-protection).(8;9) 71 HPV vaccination programmes have now been introduced in many countries.<sup>(10)</sup> A recently 72 73 published systematic review and meta-analysis assessed the population impact of HPV vaccination on the vaccine HPV types, showing strong evidence that HPV vaccination is 74 highly effective against infection with these types.(11) The review also looked at closely 75 related HPV types, but only as a single group, demonstrating some evidence of cross-76 protection overall in a population setting. (11) However, assessment of changes in the 77 prevalence of closely related HPV types combined may not provide full evidence of the 78 impact of vaccination, as it could potentially conceal decreases or increases in the prevalence 79 of individual types. Grouping HPV types together limited the possibility to look at cross-80 protection with specific HPV types and/or changes in other individual nonvaccine types. For 81 82 example, one theoretical concern is that the reductions in the prevalence of HPV16 and HPV18 infection could lead to other high-risk HPV types occupying that niche and becoming 83 a more common cause of disease. Whilst this was not observed in the clinical trials,(12) it is 84 important to monitor this potential for type replacement in population settings following the 85 introduction of national HPV vaccination. Furthermore, since other HPV types are often far 86

Persistent infection with a high-risk human papillomavirus (HPV) genotype is a necessary

less common than the vaccine HPV types, within an individual study there is limited scope to
determine whether type replacement has occurred; combining data from several reports
improves the power to investigate this.

Thus, the aim of this study was to investigate the population level impact of HPV vaccination
programmes, using the bivalent or quadrivalent vaccines, on the type-specific prevalence of
infection of individual nonvaccine high-risk HPV types.

93

### 94 Methods

### 95 **Objectives**

We compared data on HPV prevalence from surveys conducted prior to the introduction of an 96 HPV vaccination programme with surveys after their introduction in similar populations in 97 the same country, to determine the change in HPV prevalence for each nonvaccine high-risk 98 99 HPV type (at the time of this search, any eligible study would have considered changes 100 following vaccination using the bivalent or quadrivalent vaccines, hence high-risk HPV types included in the nonavalent vaccine only were considered nonvaccine HPV types). Each 101 individual type was presented separately. We included HPV types for which some cross-102 protection had been demonstrated in clinical trials (HPV31, HPV33, phylogenetically related 103 to HPV16 and HPV45 phylogenetically related to HPV18), (8;9;13) other high-risk HPV 104 types included in the nonavalent vaccine (HPV52 and HPV58), other high-risk and probable 105 high-risk HPV types (HPV35, HPV39, HPV51, HPV56, HPV59, and HPV68), and other 106 107 possibly high-risk HPV types (HPV26, HPV53, HPV70, HPV73, and HPV82) as defined by the International Agency for Research on Cancer.(14) 108

109 This systematic review and meta-analysis was reported in accordance with PRISMA

110 guidelines.(15)

## 112 Search strategy and selection criteria

Embase, Medline, LILACS and African Index Medicus were searched for eligible 113 publications from 2007 (the date the first HPV vaccination programmes were introduced ) up 114 to 19th February 2016. The search strategy incorporated MeSH terms and relevant free text 115 words in the title/abstract to identify relevant studies which included mention of both 116 vaccination and HPV infection or a related disease (including, but not limited to, HPV-related 117 pre-cancerous lesions and cancers and genital warts; see Supplementary Material for full 118 search terms). There were no language restrictions. 119 Eligible studies were those which assessed population-level impact of HPV vaccination over 120 121 time by comparing the prevalence of HPV infection (defined by the detection of HPV DNA) in a prevaccination period to a postvaccination period. Studies which compared HPV-122 infection in those vaccinated and unvaccinated as part of an individually randomised trial 123 were excluded as they would not measure a population-level effect. Similarly, studies which 124 only compared HPV-infection between unvaccinated and vaccinated individuals in the 125 126 postvaccination period were also excluded. We also excluded studies if a very small proportion (<2%) of the postvaccination study population were vaccinated (i.e. largely 127 unvaccinated populations). Titles and abstracts were initially reviewed for eligibility by DM. 128 Those which were deemed to consider changes in HPV prevalence following the introduction 129 of HPV vaccination programmes were reviewed in full. Search results were also compared to 130 those identified in the related recent review by Drolet and colleagues which compared the 131 132 pre- and postvaccination periods for the high-risk vaccine types (HPV-16/18), cross-protected types (HPV-31/33/45), and all high-risk HPV nonvaccine types combined.(11) 133

134

### 135 Data extraction and data quality

Data were extracted by DM on study design, country of study and then (for both the pre- and postvaccination period) the year(s) of sample collection, study setting and population, sample size, the specimen type, the assay used for HPV-DNA testing, HPV genotypes included in the assay and demographic and sexual behaviour data collected, as well as the measure of effect for each study. Additionally, for the postvaccination period, data were extracted on the method used to ascertain estimated vaccination coverage.

The potential bias from each study was assessed by considering the comparability of the 142 study populations in the pre- vs postvaccination periods (i.e. similar setting and population 143 demographics), the extent of adjustment for potential confounders, the suitability of the 144 specimen type to assess HPV-DNA infection, the suitability of the assay used for accurate 145 146 HPV-DNA testing (and whether this differed between the pre- and postvaccination periods) and the method used to estimate HPV vaccination coverage. External validity was assessed 147 by considering whether the study samples were population-based. Each item was scored as 148 either 'low risk' or 'high risk'. 149

150 Published data on the prevalence and prevalence ratios for individual high-risk HPV types were not always available. Authors were contacted to request the HPV type-specific 151 prevalence in the prevaccination and postvaccination period and the prevalence ratio 152 comparing the two periods for each of the nonvaccine high-risk HPV types. Adjusted 153 prevalence ratio (PR; adjusted for demographics and sexual behavior data) were requested or 154 the unadjusted PR if no data on confounders were available; unadjusted PRs were calculated 155 156 if raw data were provided. For one study (Mesher et al), adjusted odds ratios were included rather than prevalence ratios in order to additionally adjust for the change in assay between 157

the pre- and postvaccination periods using data from a previously conducted validationstudy.(16)

### 160 Data analysis

Estimates weighted to account for selection processes were used if provided by authors (with 161 unweighted numbers presented in Tables and Figures). Data were stratified by age-group due 162 to expected differences in vaccination coverage and vaccine effectiveness in those vaccinated 163 at an older age. Data were requested from authors for the same age-groups for each study 164 (≤19 years old and 20-24 years old). Söderlund-Strand et al included data from young women 165 aged under 13 years old hence we requested data restricted to 16-19 year olds. 166 To allow calculation of a prevalence ratio for a prevalence of zero (in either the 167 prevaccination or postvaccination period), a continuity correction of 0.5 was added to all 168 cells. When the prevalence was zero for both the prevaccination and postvaccination period, 169 the study was omitted from the meta-analysis for the relevant age-group and HPV-type. 170 Results were further stratified by the vaccine used (i.e. bivalent or quadrivalent). Prevalence 171 ratios within each subgroup were combined to obtain a summary prevalence ratio using a 172 fixed effects model if data were not shown to be heterogeneous (lack of heterogeneity was 173 determined by a p-value $\geq 0.10$  using Cochrane's Q test and/or an I<sup>2</sup> value< 25%).(17) In 174 sensitivity analyses, analyses were restricted to studies that used cervical, vulval or vaginal 175 swabs as the specimen type due to the lower sensitivity to detect HPV DNA infection using 176 urine samples.(18) 177

178

### 179 **Results**

### 180 Included studies

181 A total of 4,648 unique papers were identified after de-duplication of searches from all four databases (Figure 1). An initial search of title and abstracts excluded 4,508 (97.0%) papers 182 due to ineligibility. For the remaining 140 papers, a full paper search was conducted which 183 184 identified ten eligible papers. Reasons for ineligibility are shown in Figure 1. One study met all eligibility criteria but the type-specific prevalence ratios were not available from 185 authors.(19) Therefore, a total of nine studies were included in the systematic review and 186 meta-analysis. (16; 20-27) All eligible studies were repeat cross-sectional studies which 187 compared changes in prevalence in populations prior to and after the introduction of a 188 189 national HPV vaccination programme (Table 1). Only one study considered changes in HPV infection among males so only female populations were considered in the present analysis. 190 191 Two studies were population-based national surveys (Markowitz et al (25) and Sonnenberg et 192 al (22)), three studies were conducted among young women attending for chlamydia screening (Chow et al (26), Mesher et al (16), and Söderlund-Strand et al (27)), two studies 193 comprised young women attending a primary care clinic, community health centre and/or a 194 hospital-based adolescent clinics (Cummings et al (20) and Kahn et al (21)), and two studies 195 comprised women attending for cervical screening (Cameron et al (24) and Tabrizi et al (23)) 196 (Table 1). 197

The assessment of methodological quality is summarised in Figure 2. The majority of studies collected some demographic and sexual behaviour data to allow appropriate adjustment of the relative risks, although the number of factors collected was limited in some studies (Cameron et al *(24)*, Mesher et al *(16)*, Tabrizi et al *(23)*, and Söderlund-Strand et al *(27)*) (Figure 2). Details of which data were used for adjusted prevalence ratios are given in Table 1.

# 204 *HPV types included in the nonavalent but not the bi- and quadrivalent HPV vaccines*

## 205 (HPV31, HPV33, HPV45, HPV52, and HPV58)

206 *HPV types for which there is previous evidence for cross-protection (HPV31, HPV33, and* 

- 207 *HPV45*): There was evidence of a reduction in the prevalence of HPV31 (Figure 3; Table 2),
- for females aged  $\leq 19$  years old (PR=0.73, 95% CI: 0.58-0.91). There was little evidence of a
- change in prevalence for HPV33 or HPV45 in the younger age-group (PR=1.04, 95%CI:
- 210 0.78-1.38 for HPV31, PR=0.96, 95%CI: 0.75-1.23 for HPV45). Results were heterogeneous
- for HPV31, HPV33 and HPV45 in the older age-group hence summary prevalence ratios
- were not calculated (Figure 3; Table 2).
- 213 Other HPV types (HPV52 and HPV58): There was evidence of an increase in the prevalence
- of HPV52 in  $\leq$ 19 year old females (PR=1.34, 95% CI: 1.13-1.59) (Figure 4; Table 2), but a
- summary prevalence ratio was not calculated for the older age-group due to heterogeneity.
- There was no evidence of a change in the prevalence of HPV58 for the younger age-group
- 217 (PR=1.01, 95%CI: 0.80-1.26) although borderline evidence of an increase among those aged
- 218 20-24 years (PR=1.14, 95%CI: 0.99-1.31).

## 219 Other high-risk and possibly high-risk HPV types

- 220 No consistent patterns across the studies were observed for the non-nonavalent vaccine HPV
- types (Figure S1; Table 2). There was evidence of an increased prevalence between the
- prevaccination period and postvaccination period in  $\leq$ 19 year old females for HPV39, HPV53
- and HPV73 (PR=1.27, 95%CI: 1.05-1.54, PR=1.51, 95% CI: 1.10-2.06 and PR=1.36, 95%
- CI: 1.03-1.80 respectively). For the 20-24 year olds, there was some evidence of an increase
- 225 in HPV39 (PR=1.13, 95% CI: 1.00-1.28).

### 226 Sensitivity analyses

As a sensitivity analysis, we performed three additional stratified analyses (all stratified by age-group); (i) by vaccine used (i.e. bivalent or quadrivalent), (ii) by potential bias of study (relatively low potential bias, defined as fewer than three domains classified as high-risk of bias, or relatively high potential bias, defined as three or more domains classified as high-risk of bias) (Figure 2) and (iii) by vaccination coverage (low <50%, high  $\geq$ 50%).

232 For studies in settings using the bivalent vaccine, there was some evidence of an increased

prevalence between the prevaccination period and postvaccination period in  $\leq$ 19 year old

females for HPV52, HPV53, HPV56, and HPV70 (Table S1; Figures S2, S3, and S4). The

prevalence of HPV53 among 20-24 year old women also increased. For the quadrivalent

vaccine, there was evidence of an increase in HPV39, HPV51, and HPV59 for females  $\leq 19$ 

237 years old. Among 20-24 year olds, there was evidence of an increase in the prevalence of

HPV52 and HPV70 (Table S1; Figures S2, S3, and S4).

Many of the analyses stratified by potential bias of included studies gave similar results to the 239 unstratified analyses (Table S2). However, in the younger age-group, for studies with 240 relatively low potential bias there was no evidence of increases in HPV52 or HPV39 (which 241 were seen when studies were unstratified). For studies with relatively high potential bias, in 242 the younger age-group there was evidence of an increase in the prevalence of HPV51 and 243 HPV70 which was not seen in the unstratified analysis. In the older age-group there was 244 evidence of a decrease in HPV 33 for those studies at a relatively low potential bias (no 245 summary estimate was provided in the unstratified analysis due to heterogeneity). For studies 246 247 with a relatively high potential bias there was evidence of an increase in the prevalence of HPV52 and HPV58. There was also evidence for a decrease in the prevalence of HPV82 for 248 both those with relatively high potential bias and relatively low potential bias (although there 249

was a larger decrease in those studies with relatively high potential bias; no summaryestimate was provided in the unstratified analysis due to evidence for heterogeneity).

Vaccination coverage was high for all studies in the younger age-group (Table S3). For older 252 women, there was a decrease in HPV31 for studies with high vaccination coverage (no 253 summary estimate was provided for the unstratified analysis due to heterogeneity). There was 254 evidence of an increase in HPV39 and HPV58 (as with the unstratified analysis) although 255 only for the studies with low coverage. There was also evidence of increases not seen in the 256 unstratified analysis (HPV70 for low coverage studies and borderline evidence for HPV26 for 257 258 high coverage studies; both types had no summary estimate for the unstratified analysis due to heterogeneity). 259

### 260 Discussion

Comprehensive postvaccination surveillance should consider not just the reductions in 261 vaccine type-specific infection and associated diseases but also evaluate any other potential 262 impacts of the reduction of the targeted infection. Thus, we assessed changes in the 263 nonvaccine HPV types to determine evidence of cross protection for individual types and the 264 265 potential concern that the reductions seen in certain HPV types after HPV vaccine introduction could create a niche for other, nonvaccine high-risk HPV types to become more 266 common (i.e. type-replacement). We demonstrated evidence of a reduction in the prevalence 267 268 of HPV31 in the younger age-group. In our main analysis, we show increases in other nonvaccine HPV types, HPV39, HPV52, HPV53, HPV58, and HPV73 but these increases 269 were inconsistent between age-groups and the vaccine used. 270

A previous systematic review evaluated changes in high-risk HPV types combined, and
found some evidence of a reduction of the HPV types closely related to the vaccine types
(HPV31, HPV33, and/or HPV45) when considered as a single group (PR=0.72, 95% CI:

0.54-0.96 for 13-19 year olds).(11) Our review provides evidence of a reduction in the
prevalence of HPV31, but little evidence of a reduction in HPV33 or HPV45.

Comparing HPV prevalence in a prevaccination period to a similar population in 276 postvaccination period allows us to consider the population-level impact of HPV vaccination 277 on HPV prevalence. However, these repeat cross-sectional study designs have some 278 limitations. Although all studies included similar populations in the pre- and postvaccination 279 periods, there may have been temporal changes in these populations over time which could 280 affect HPV prevalence, independent of HPV vaccination. For example, there have been 281 282 increases in other STI diagnoses over this same time period in some countries.(28) Furthermore, in many countries the incidence of genital warts was increasing prior to the 283 vaccine introduction(29-31) and has continued to increase postvaccination in those not 284 285 eligible for vaccination.(11) It is therefore possible that the increases in some HPV types we observed are associated with broad increases in sexual risk over time. Changes in 286 demographics and sexual behaviour between the populations were considered when 287 available, but it is likely that there were some unrecorded population changes and/or other 288 temporal changes in the relative proportions of high-risk HPV types over time. (32;33) There 289 290 is also more geographical variation in the relative frequency of nonvaccine HPV types in 291 populations compared with HPV16 prevalence which, prior to vaccination programs, was the 292 most frequent high risk type observed in almost all populations. (34)

The change in assay between the pre- and postvaccination for one of the studies (Mesher et al) was a potential source of bias. A validation study comparing these two testing assays allowed odds ratios (ORs) to be adjusted for the differences in diagnostic accuracy. This adjusted odds ratio could not be converted to a prevalence ratio using the log-binomial model and thus was included as an OR. However, given the low prevalence of individual HPV

types, the use of an OR for this study (rather than a PR) is unlikely to have affected theresults substantially.

Another limitation is that the broad-spectrum assays which have been used in these studies 300 301 (and in baseline prevaccination evaluations globally) can lack sensitivity to detect individual HPV types when multiple types are present, particularly in the presence of another HPV type 302 with a higher viral load. In the postvaccination period, in the absence of HPV16 and HPV18 303 this could lead to an apparent, artificial increase in nonvaccine types (because they were 304 underestimated in the pre-vaccine period due to the predominance of HPV16 and/or HPV18). 305 306 This potential unmasking effect has been demonstrated in analytical studies; (35;36) hence some of the increases in nonvaccine types observed could be due to unmasking. 307

Given the low prevalence of some other nonvaccine HPV types, it is a challenge to assess 308 309 changes in prevalence for individual types since the introduction of HPV vaccination. By combining data from several studies, we had enhanced power to consider changes in the 310 individual HPV types. However, even with data from 13,886 women aged ≤19 years old and 311 23,340 women aged 20-24 years old, we still had limited power to consider changes in the 312 very rare HPV types or to investigate the reasons for the heterogeneity in findings for some 313 HPV types, with inconsistent evidence for increases of specific nonvaccine types between 314 age-groups and the two vaccines. Conversely, type 1 errors can occur with multiple testing 315 and modest evidence for increases should be interpreted with caution. 316

We decided against performing random-effects meta-analyses in the presence of betweenstudy heterogeneity because in most instances there was inconsistency in the direction of
effect, making the summary estimate (the average value of these opposing effects)
uninformative(*37*). Exploring the causes of heterogeneity could provide some further insight
into the reasons for these increases, and we carried out subgroup analyses by vaccine used, by

322 potential bias and by vaccine coverage. The results of the stratification by potential bias suggest that increased prevalence ratios for some HPV types may have been reported more 323 often in the studies with relative high potential bias. However, for all three sensitivity 324 325 analyses the small number of studies in each stratum limited the interpretation of these analyses. Similarly, we were limited to only eight studies for each age-group and thus at 326 present have insufficient power to perform meta-regression analyses (as meta-regression 327 should generally not be considered when there are fewer than ten studies)(37). As further data 328 accrue, one useful future analysis would be to explore the association between the reductions 329 330 in the HPV vaccine-types and any increases in nonvaccine HPV types (that are not due to unmasking) - if increases were due to type-replacement then we would expect to see 331 increasing prevalence of nonvaccine HPV types as prevalence of vaccine HPV types 332 333 decreases.

It is encouraging that we confirm the reductions in a cross-protected HPV type. The results of
this systematic review and meta-analysis do not provide any clear evidence for typereplacement, as it is not clear to what extent any increases seen are due to other temporal
changes, changes in the study populations, and/or an unmasking effect of broad spectrum
HPV assays. Large scale epidemiological analyses using various designs have not detected
evidence of any significant interactions between high-risk types; the known high evolutionary
stability of these viruses, lessens the risk that type-replacement will be a problem.(*38;39*)

The majority of women included in the surveillance studies were those vaccinated at older ages (i.e. potentially vaccinated after HPV exposure) and some studies include populations with relatively low coverage compared to nationally reported vaccination coverage for routine cohorts. Future studies should continue to monitor population prevalence of these types. In particular, populations vaccinated at a younger age with higher vaccination coverage

- should be considered and, perhaps more importantly, the absolute prevalence of CIN3 lesions
- 347 attributed to each high-risk HPV type.

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351

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	Cameron		Cumming		Markowitz	Mesher et	-Strand et	Sonnenber	
	et al	Chow et al	s et al	Kahn et al	et al	al	al	g et al	Tabrizi et al
Study	Repeat	Repeat	Repeat	Repeat	Repeat	Repeat	Repeat	Repeat	Repeat
design	cross-	cross-	cross-	cross-	cross-	cross-	cross-	cross-	cross-
-	sectional	sectional	sectional	sectional	sectional	sectional	sectional	sectional	sectional
	studies	studies	studies	studies	studies	studies	studies	studies	studies
Country of	UK	Australia	LISA	LISA	LISA	UK	Swadan	UK	Austrolio
study	(Scotland)	Australia	USA	USA	USA	(England)	Sweden	(Britain)	Australia
Vaccine	Rivalent	Quadrival	Quadrival	Quadrival	Quadrivale	Bivalant	Quadrival	Bivalant	Quadrivale
introduced	Divalent	ent	ent	ent	nt	Divalent	ent	Divalent	nt
Year(s) of	Prevaccina	Prevaccina	Prevaccin	Prevaccin	Prevaccina	Prevaccin	Prevaccin	Prevaccin	Prevaccinat
sample	tion: 2009-	tion:	ation:	ation:	tion: 2003-	ation:	ation:	ation:	ion: 2005-
collection	2010	2004-2007	1995-2005	2006-2007	2006	2008	2008	1999-2001	2007
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tested	Postvaccin	tion: 136	ation: 150	ation: 365	Postvaccin	2354	11457	ation: 328	10n: 202
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Study		Australian		Females				Sexually	
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	(aged 20-	vears old	Famalas	old) who		females		(aged 18-	(aged 18 24
	21 years	and	(aged 1/1-	had had	Females	(aged 16-	Females	44 years	(ageu 18-24
	old)	vounger)	17 years	sexual	(aged 14-	25 year	(all ages)	old)	attending
	attending	attending	old)	intercours	24 years	25 year	attending	selected	for cervical
	for	for	attending	е,	old)	attending	for	via	screening at
	cervical	chlamydia	one of	recruited	participati	for	chlamydia	household	sentinel
	screening	screening	three	from	ng in	chlamydia	screening	s using	family
	as part of	at a sexual	nrimary	hospital	population	screening	in a	stratified	nlanning
	national	health	care	based	based	at	defined	probabilit	clinics in
	cervical	centre in	clinics in	adolescent	NHANES	communit	region of	y sample	Sydney
	screening	Melbourne	Indiana	clinic and	survey	v sexual	Sweden	survey	Melbourne
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		chlamvdia		centre				survey)	
Specimen		Cervical	G 10	Cervicova	G 16	Residual			Sample of
type	Residual	and high	Self-	ginal	Self-	vulval	Genital		exfoliated
21	LBC*	vaginal	collected	swabs by	collected	vaginal	swabs	Urine	cervical
	specimen	swab	vaginal	clinician	cervicovag	swab	(either	sample	cells
	1	samples	swab	or self-	inal swab	specimen	alone or		preserved

#### Table 1: Characteristics of studies selected for systematic review

				collected swab			immersed in urine)		in PreservCyt
Assay for HPV-DNA testing	Multimetri x HPV assay	PapType HPV assay	Linear Array HPV Genotypin g test	Linear Array HPV Genotypin g test	Linear Array HPV Genotypin g test	Prevaccin ation: Linear Array HPV Genotypin g test in those testing positive for Hybrid Capture 2 Postvaccin ation: In- house multiplex PCR and Luminex based genotypin g system	PCR testing with genotypin g by matrix- assisted laser desorption ionization time-of- flight (MALDI- TOF) mass spectrome try	In house multiplex PCR and Luminex based genotypin g system	Amplicor DNA test for 13 high- risk types (If negative, tested for presence of mucosal DNA using L1 consensus primer set PGMY09- PGMY11). If positive for Amplicor or PCMY09/P GMY11 PCR- ELISA were genotyped using the Linear Array HPV genotyping test
Demograp hic and sexual behaviour data collected	Scottish Index of Multiple Deprivatio n, month/yea r of birth These data were not used to adjust the HPV prevalence ratios in	Age- stratified prevalence ratios were adjusted for by number of male partners, 100% condom use with all partners in	Samples matched on age at enrolment, clinic site and reported sexual activity. Data on ethnicity, sexual partners in previous last year,	Age, race, health care insurance, knowledg e about HPV vaccines, smoking status, gynaecolo gic history (number of pregnanci es, history	Ethnicity, poverty index and, for those reported ever having sex; age at first sex, lifetime number of partners, number of partners in the	Age stratified prevalence ratios were adjusted for age, chlamydia positivity at time specimen taken and collection venue type	All samples were anonymise d (individua l age was known)	Extensive demograp hic and sexual behaviour data collected. These data were not used to adjust the HPV prevalence ratios in	Age, current use of hormonal contracepti on, smoking status and postcode of residence These data were not used to adjust the

	this meta- analysis	the past 12 months status and anatomical sampling method (cervical vs high vaginal sample)	sexual partners in previous 2 months, lifetime sexual partners, instances of vaginal intercours e in previous year and instances of vaginal intercours e in the previous 2 months These data were not used to adjust the HPV prevalence ratios in this meta- analysis	of STIs), sexual behaviour s (age at first sex, number of male lifetime partners, number of male partners in previous 3 months, anal sex, condom use) These data were not used to adjust the HPV prevalence ratios in this meta- analysis	previous 12 months. These data were not used to adjust the HPV prevalence ratios in this meta- analysis			this meta- analysis	HPV prevalence ratios in this meta- analysis
Vaccinatio n status	Data linked from Scottish Immunisat ion call/recall system and Child Health Schools Programm e system	Self- reported. Data not available for all women	Collected from medical notes	Collected from immunisat ion registry for 87% of women. Collected from self- administer ed questionna ire for remaining 13% of women	Self- reported	Not collected for individual s	Not collected for individual s	Self- reported	Self- reported and validated against the National HPV vaccine register

\* LBC = Liquid based cytology

		Heterogeneity		
Age-group / HPV type	Number of studies	$I^2$	p-value	
≤19 year old females				
HPV types included in nonavalent vaccine				
HPV 31	8	6.4%	0.381	
HPV 33	8	0.0%	0.471	
HPV 45	8	5.5%	0.387	
HPV 52	8	24.0%	0.238	
HPV 58	8	0.0%	0.727	
Other high-risk HPV types				
HPV 35	8	25.1%	0.229	
HPV 39	8	0.0%	0.984	
HPV 51	8	43.6%	0.088	
HPV 56	8	74.3%	< 0.001	
HPV 59	8	66.8%	0.004	
HPV 68	8	0.0%	0.690	
Other possibly high-risk HPV types				
HPV 26	6	0.0%	0.478	
HPV 53	6	3.6%	0.394	
HPV 70	6	23.6%	0.257	
HPV 73	6	0.0%	0.961	
HPV 82	6	49.0%	0.081	
20-24 year old females				
HPV types included in nonavalent vaccine				
HPV 31	8	28.8%	0.198	
1101/22	0	50.00/	0.047	

Table 2: Prevalence ratio for nonvaccine high-risk HPV types stratified by age-group

Prevalence ratio\* (95% CI)

0.73 (0.58-0.91)

1.04 (0.78-1.38)

0.96 (0.75-1.23)

1.34 (1.13-1.59)

0.727 1.01 (0.80-1.26) 0.229 \_ 0.984 1.27 (1.05-1.54) 0.088 -0.001 \_ 0.004 0.690 1.26 (0.88-1.81) 0.478 1.63 (0.84-3.16) 0.394 1.51 (1.10-2.06) 0.257 1.34 (0.75-2.39) 0.961 1.36 (1.03-1.80) 0.081 -0.198 **HPV 33** 0.047 8 50.9% HPV 45 8 64.3% 0.007 HPV 52 8 31.0% 0.180 \_ HPV 58 0.0% 8 0.806 1.14 (0.99-1.31) Other high-risk HPV types HPV 35 8 7.9% 0.369 1.07 (0.85-1.34) HPV 39 8 0.0% 0.522 1.13 (1.00-1.28) HPV 51 8 49.8% 0.052 -HPV 56 8 82.6% < 0.001 \_ HPV 59 8 63.6% 0.007 HPV 68 8 35.6% 0.145 Other possibly high-risk HPV types HPV 26 44.3% 0.110 6 HPV 53 6 30.8% 0.204 HPV 70 6 25.1% 0.246 HPV 73 59.2% 0.032 6 HPV 82 6 38.3% 0.151 -

356

\* Summary prevalence ratio only calculated if data were not shown to be heterogeneous

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### **Figure Legends**

Figure 1: Flow chart for eligible studies included in systematic review

Figure 2: Potential Bias and external validity of included studies

**Figure 3:** Prevalence ratio for high-risk HPV types with evidence of cross-protection (HPV31, HPV33, HPV45) stratified by age-group, percentages in square brackets represent vaccination coverage (at least one dose) for each study/age-group

**Figure 4:** Prevalence ratio for other high-risk HPV types included in the nonavalent vaccine (HPV52, HPV58) stratified by age-group, percentages in square brackets represent vaccination coverage (at least one dose) for each study/age-group

**Technical Appendix Figure 1:** Prevalence ratio for other probably high-risk HPV types (HPV35, HPV39, HPV51, HPV56, HPV59 and HPV68) stratified by age-group, percentages in square brackets represent vaccination coverage (at least one dose) for each study/age-group

**Technical Appendix Figure 2:** Prevalence ratio for high-risk HPV types with evidence of cross-protection (HPV31, HPV33, HPV45) stratified by age-group and vaccine type, percentages in square brackets represent vaccination coverage (at least one dose) for each study/age-group

**Technical Appendix Figure 3:** Prevalence ratio for other high-risk HPV types included in the nonavalent vaccine (HPV52, HPV58) stratified by age-group and vaccine type, percentages in square brackets represent vaccination coverage (at least one dose) for each study/age-group

**Technical Appendix Figure 4:** Prevalence ratio for other probably high-risk HPV types (HPV35, HPV39, HPV51, HPV56, HPV59 and HPV68) stratified by age-group and vaccine

type, percentages in square brackets represent vaccination coverage (at least one dose) for each study/age-group

Figures





### **\*\*** Includes studies where the vast majority of the population were unvaccinated

# Figure 2: Potential Bias and external validity of included studies

Chow et al	Н	Н	L	L	L	L	Н
Cummings et al	Н	L	L	L	L	L	L
Kahn et al	Н	L	L	L	L	L	L
Kavanagh et al	L	L	Н	L	L	L	L
Markowitz et al	L	L	L	L	L	L	Η
Mesheretal	Н	Н	Η	L	L	L L H L L L L L L L L H L L H L L H L L H L L H L L L L L	
Sõderlund-Strand et al	Н	Н	Н	L	L       L       L       H         L       L       L       L       L         L       L       L       L       L         L       L       L       L       H         L       L       L       H       H         L       L       H       H       H         L       L       L       H       H         L       L       L       H       H         L       L       L       H       H         L       L       L       H       H         L       L       L       H       H         Kerinson       Kerinson       Kerinson       Kerinson         Accination       Kerinson       Kerinson       Kerinson       Kerinson		
Sonnenberg et al	L	L	L	Н	L	L L H L L L L L L L L H L L H L L H L L H L L H L L L portion saturation statutes particular statutes	
Tabrizi et al	L	L	Η	L	L	L	L
Population tassed free and post actin to population tassed free and post for pree and post for pree and poly in the population of the popu	stredan st stredan stredan str	ation dation and anne serve	ed for set of the set	HRV SCIP	unact de	nteal	A STATUS

**Key** L = Low risk of bias

H = High risk of bias

Figure 3: Prevalence ratio for high-risk HPV types with evidence of cross-protection (HPV31, HPV33, HPV45) stratified by age-group, percentages in square brackets represent vaccination coverage (at least one dose) for each study/age-group

A: HPV 31	Preva	lence	Prevalence
	Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)
≤19 years old			
Cummings [89%]	3.3	6.7	2.00 (0.60, 6.69)
Tabrizi [88%]	3.6	1.0	0.27 (0.02, 2.85)
Chow [79%]	10.9	6.4	0.69 (0.24, 1.94)
Kahn [77%]	5.9	2.3	0.38 (0.15, 0.98)
Mesher [71%]	4.1	1.3	0.50 (0.25, 0.96)
Sonnenberg [62%]	• 0.4	0.8	1.93 (0.17, 22.20
Söderlund-Strand [55%]	6.4	5.1	0.79 (0.60, 1.03)
Markowitz [51%]	2.8	1.8	0.64 (0.25, 1.66)
Subtotal (I-squared = 6.4%, p = 0.381)			0.73 (0.58, 0.91)
20-24 years old			
Tabrizi [83%]	5.2	4.7	0.91 (0.45, 1.84)
Cameron [67%]	4.9	3.1	0.63 (0.48, 0.81)
Chow [66%]	• 6.2	7.8	1.38 (0.47, 4.04)
Markowitz [33%]	2.6	3.0	1.18 (0.52, 2.70)
Kahn [31%]	4.6	5.9	1.31 (0.43, 3.99)
Söderlund-Strand [24%]	8.1	7.6	0.93 (0.79, 1.09)
Sonnenberg [16%]	• 1.9	2.7	1.40 (0.50, 3.94)
Mesher [15%]	3.9	3.3	1.10 (0.62, 1.97)
Subtotal (I-squared = 28.8%, p = 0.198)			
.05 .1 .2 .5 1	2 5 10 30		

B: HPV 33		Prevalence F		Prevalence
		Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)
≤19 years old				
Cummings [89%]		1.3	0.0	0.40 (0.02, 8.17)
Tabrizi [88%]	_	3.6	0.5	0.13 (0.01, 2.07)
Chow [79%]		→ 0.0	1.8	2.52 (0.12, 51.66)
Kahn [77%]		0.8	1.1	1.44 (0.24, 8.57)
Mesher [71%]	-	2.3	3.4	1.62 (0.90, 2.92)
Sonnenberg [62%]	•	0.6	1.3	2.24 (0.24, 20.87)
Söderlund-Strand [55%]		3.5	3.2	0.91 (0.65, 1.29)
Markowitz [51%]		0.5	0.3	0.59 (0.10, 3.43)
Subtotal (I-squared = 0.0%, p = 0.471)				1.04 (0.78, 1.38)
20-24 years old				
Tabrizi [83%]		4.0	1.8	0.44 (0.18, 1.06)
Cameron [67%]		6.4	4.3	0.67 (0.54, 0.84)
Chow [66%]	_	3.7	3.2	0.51 (0.47, 4.04)
Markowitz [33%]		3.8	1.1	0.28 (0.08, 1.01)
Kahn [31%]		- 0.9	0.0	0.31 (0.01, 7.55)
Söderlund-Strand [24%]		3.9	4.0	1.01 (0.80, 1.27)
Sonnenberg [16%]	-	2.9	1.7	0.59 (0.21, 1.68)
Mesher [15%]		2.5	3.1	1.37 (0.73, 2.57)
Subtotal (I-squared = 50.9%, p = 0.047)				
		1 1		
.05 .1 .2 .5 1	2 5	10 30		

<u>C: HPV45</u>		Preva	lence	Prevalence
	Pre	e-vacc (%)	Post-vacc (%)	Ratio (95% CI)
≤19 years old				
Cummings [89%]	-	6.0	4.0	0.67 (0.19, 2.39)
Tabrizi [83%]		0.0	0.5	0.41 (0.02, 9.89)
Chow [79%]		3.6	4.5	1.01 (0.19, 5.30)
Kahn [77%]		5.5	4.9	0.89 (0.43, 1.86)
Mesher [71%]		3.0	3.0	0.75 (0.46, 1.21)
Sonnenberg [62%]	•	> 0.7	4.6	6.47 (0.84, 49.99)
Söderlund-Strand [55%]		3.0	3.5	1.14 (0.82, 1.61)
Markowitz [51%]		1.4	0.6	0.46 (0.13, 1.54)
Subtotal (I-squared = 5.5%, p = 0.387)				0.96 (0.75, 1.23)
20-24 years old				
Tabrizi [83%]	•	1.1	3.2	2.77 (0.66, 11.54)
Cameron [67%]		2.9	1.6	0.53 (0.37, 0.76)
Chow [66%]	_	4.9	6.0	0.92 (0.30, 2.79)
Markowitz [33%]	_	2.0	1.9	0.92 (0.31, 2.74)
Kahn [31%]		→ 1.8	11.9	6.53 (1.52, 28.06)
Söderlund-Strand [24%]		4.7	4.2	0.88 (0.71, 1.10)
Sonnenberg [16%]		2.0	4.0	2.02 (0.70, 5.82)
Mesher [15%]		3.4	3.6	0.96 (0.60, 1.56)
Subtotal (I-squared = 64.3%, p = 0.007)				,
	1 1	I		
.05 .1 .2 .5 1 2	5 10	30		
←		$\longrightarrow$		
Favours vaccination	oes not favour vaccin	ation		

Figure 4: Prevalence ratio for other high-risk HPV types included in the nonavalent vaccine (HPV52, HPV58) stratified by age-group, percentages in square brackets represent vaccination coverage (at least one dose) for each study/age-group

A: HPV52							Pre	Prevalence		
							Pre-vacc (%	Post-vacc (%)	Ratio (95% CI)	
≤19 years old										
Cummings [89%]		-					4.7	2.7	0.57 (0.12, 2.68	
Tabrizi [88%]			_			_	7.1	6.2	0.87 (0.21, 3.64	
Chow [79%]					· —		14.5	10.9	0.88 (0.39, 2.01	
Kahn [77%]				-	*		8.6	12.1	1.40 (0.84, 2.34	
Mesher [71%]							4.1	8.7	2.03 (1.39, 2.97	
Sonnenberg [62%]					•	_	4.4	5.4	1.22 (0.39, 3.84	
Söderlund-Strand [55%]					•		5.2	6.8	1.29 (1.01, 1.65	
Markowitz [51%]					-		3.8	3.2	0.85 (0.45, 1.60	
Subtotal (I-squared = 24	4.0%, p = 0.23	38)			$\diamond$				1.34 (1.13, 1.59	
20-24 years old										
Tabrizi [83%]				_	-		7.5	2.7	1.17 (0.66, 2.06	
Cameron [67%]					-		9.3	10.0	1.07 (0.91, 1.25	
Chow [66%]				-	Ξ.—	_	8.6	16.1	1.69 (0.78, 3.68	
Markowitz [33%]					<u> </u>		8.0	6.0	0.76 (0.37, 1.56	
Kahn [31%]							7.3	6.8	0.93 (0.36, 2.40	
Söderlund-Strand [24%]					-		8.1	10.6	1.31 (1.14, 1.51	
Sonnenberg [16%]					<b>—</b>		3.8	3.8	1.01 (0.45, 2.25	
Mesher [15%]							5.2	8.8	1.74 (1.21, 2.51	
Subtotal (I-squared = 3	1.0%, p = 0.15	55)								
		-								
	.05	.1	.2	.5	1 2	5	10 30			

3: HPV58					Preval	ence	Prevalence
					Pre-vacc (%)	Post-vacc (%)	Ratio (95% C
19 years old							
Cummings [89%]					2.7	2.7	1.00 (0.19, 5.
Tabrizi [88%]	_	•			14.3	10.5	0.73 (0.27, 1.
Chow [79%]	_		•		3.6	6.4	1.52 (0.32, 7.
Kahn [77%]		-			7.1	8.3	1.18 (0.65, 2.
Mesher [71%]			-		4.5	4.2	1.25 (0.84, 1.1
Sonnenberg [62%]		•			4.0	3.0	0.76 (0.23, 2.
Söderlund-Strand [55%]			-		2.7	2.5	0.91 (0.61, 1.3
Markowitz [51%]					1.9	1.0	0.53 (0.22, 1.3
Subtotal (I-squared = 0.0%, p = 0.727)		$\diamond$					1.01 (0.80, 1.3
0-24 years old							
Tabrizi [83%]			-		12.1	11.2	0.93 (0.60, 1.
Cameron [67%]			-		3.6	4.0	1.09 (0.84, 1.
Chow [66%]	_	•			4.9	6.0	0.92 (0.30, 2.
Markowitz [33%]					3.0	1.9	0.63 (0.21, 1.
Kahn [31%]					10.0	11.9	1.19 (0.56, 2.
Söderlund-Strand [24%]		-	÷		4.1	4.8	1.20 (0.97, 1.
Sonnenberg [16%]					2.5	2.7	1.08 (0.42, 2.
Mesher [15%]		+	•		3.8	3.7	1.51 (0.94, 2.
Subtotal (I-squared = 0.0%, p = 0.806)		$\diamond$	>				1.14 (0.99, 1.
.05 .1	.2	.5 1	2	5	10 30		
~					$\longrightarrow$		

# **Technical Appendix**

## Search strategies

## Medline search strategy: 2410 (19 Feb 2016)

- 1. Epidemiologic Studies/
- 2. exp case-control Studies/
- 3. (case\* and control\*).tw
- 4. exp Cohort Studies/
- 5. cohort\*.tw
- 6. Cross-sectional Studies/
- 7. (cross\* and section\*).tw
- 8. Seroepidemiologic Studies/
- 9. Sentinel Surveillance/
- 10. Public Health Surveillance/
- 11. Incidence/
- 12. Prevalence/
- 13. Odds Ratio/
- 14. odds ratio.tw
- 15. risk ratio.tw
- 16. rate ratio.tw
- 17. relative risk.tw
- 18. screening method.tw
- 19. effectiveness.tw
- 20. observational.tw
- 21. (step\* and wedge\*).tw
- 22. Or/1-21
- 23. Human Papillomavirus DNA Tests/
- 24. exp Papillomavirus Infections/
- 25. exp Papillomaviridae/
- 26. (HPV or papilloma\*).tw
- 27. Uterine Cervical Neoplasms/
- 28. Genital Neoplasms, Female/
- 29. Genital Diseases, Female/
- 30. Uterine Cervical Dysplasia/
- 31. (Penile ADJ1 wart).tw
- 32. (cervi\* or genit\*).tw
- 33. warts.tw
- 34. condyloma\*.tw
- 35. neoplas\*.tw
- 36. dysplas\*.tw
- 37. lesion\*.tw
- 38. cancer\*.tw
- 39. carcin\*.tw
- 40. maligna\*.tw
- 41. disease\*.tw
- 42. (carcinoma adj2 situ).tw

- 43. Or/33-42
- 44. And/32,43
- 45. Or/23-30,44
- 46. (Immunis\* or immuniz\* or vaccin\*).tw
- 47. Papillomavirus Vaccines/
- 48. Or/46-47
- 49. Humans/
- 50. limit to yr=2007-2016
- 51. And/22,45,48,49,50

## Embase search strategy: 3843 (19 Feb 2016)

- 1. Epidemiology/
- 2. Cross-sectional study/
- 3. (cross\$ ADJ1 section\$).tw
- 4. exp case control study /
- 5. (case\$ ADJ1 control\$).tw
- 6. cohort analysis/
- 7. cohort\$.tw
- 8. exp Disease surveillance/
- 9. exp health survey/
- 10. incidence/
- 11. exp prevalence/
- 12. sentinel surveillance/
- 13. seroepidemiology/
- 14. risk/
- 15. infection risk/
- 16. population risk/
- 17. risk reduction/
- 18. observational study/
- 19. (odd\$ ADJ1 ratio).tw
- 20. (risk ADJ1 ratio).tw
- 21. (rate ADJ1 ratio).tw
- 22. (relative ADJ1 risk).tw
- 23. (screening ADJ1 method).tw
- 24. effectiveness.tw
- 25. observational.tw
- 26. (step\$ ADJ1 wedge\$).tw
- 27. Or/1-26
- 28. exp Papilloma virus /
- 29. hpv.tw
- 30. Papilloma\$.tw
- 31. Uterine cervix disease/
- 32. Uterine cervix dysplasia/
- 33. exp Uterine Cervix Tumor/
- 34. urogenital tract tumor/
- 35. genital tract tumor/
- 36. female genital tract tumor/
- 37. female genital tract cancer/

- 38. gynecologic cancer/
- 39. genital tract cancer/
- 40. female genital tract cancer/
- 41. Urogenital tract cancer/
- 42. Female genital tract cancer/
- 43. female genital tumor/
- 44. female genital tract infection/
- 45. genital tract infection/
- 46. gynecologic infection/
- 47. (peni\$ ADJ1 wart\$).tw
- 48. (cervi\$ or genit\$).tw
- 49. wart\$.tw
- 50. condyloma\$.tw
- 51. neoplas\$.tw
- 52. dysplas\$.tw
- 53. lesion\$.tw
- 54. cancer\$.tw
- 55. carcin\$.tw
- 56. maligna\$.tw
- 57. disease\$.tw
- 58. (carcinoma ADJ2 situ).tw
- 59. Or/49-58
- 60. And/48,59
- 61. Or/28-47,60
- 62. (Immunis\$ or immuniz\$ or vaccin\$).tw
- 63. Wart virus vaccine/
- 64. Or/62,63
- 65. Humans/
- 66. limit to yr=2007-2016
- 67. And/27,61,64,65,66

# LILACS search strategy: 58 (19 Feb 2016)

((cross\$ AND section\$) OR (case\$ AND control\$) OR (cohort\$) OR (odd\$ AND ratio) OR (risk AND ratio) OR (rate AND ratio) OR (relative AND risk) OR effectiveness OR observational OR ("step wedge" OR "step-wedge" OR stepwedge)) AND (hpv OR Papilloma\$ OR ((cervi\$ or genit\$) AND (wart\$ OR neoplas\$ OR dysplas\$ OR lesion\$ OR cancer\$ OR carcin\$ OR adeno\$ OR squamous\$ OR disease\$ OR (carcinoma AND situ)))) AND (Immuni\$ or vaccin\$) AND (PD 2007 OR PD 2008 OR PD 2009 OR PD 2010 OR PD 2011 OR PD 2012 OR PD 2013 OR PD 2014 OR PD 2015 OR PD 2016)

*AIM search strategy: 17* (19 Feb 2016) hpv OR Papilloma\$

# **Supplementary Tables**

Table S1: Prevalence ratio for non-vaccine high-risk HPV types stratified by age-group and vaccine type

		Biva	alent vacc	eine		Quadi	rivalent va	ccine
	Mumha	Hetero	ogeneit	Dravalanaa	Numb	Hetero	ogeneity	Dravalanca
Age-group / HPV type	r of studies	I <sup>2</sup>	y p- valu e	ratio* (95% CI)	er of studie s	$I^2$	p- value	ratio* (95% CI)
<19 vear old females			0					
HPV types included in nonavalent								
vaccine								
	2	10.4	0.29	0.54 (0.29-	(	8.7	0.26	0.75 (0.60-
HPV 31		%	0.78	1.03)	6	% 0.0	0.36	0.96) 0.89 (0.64-
HPV 33	2	0.0%	5	2.92)	6	%	0.687	1.24)
	2	75.4	0.04			0.0	0.51.6	1.01 (0.76-
HPV 45		%	4	- 1 93 (1 34-	6	% 0.0	0.716	1.34) 1.20 (0.99 <b>-</b>
HPV 52	2	0.0%	8	2.77)	6	%	0.627	1.47)
	2		0.44	1.19 (0.81-		0.0		0.92 (0.69-
HPV 58	-	0.0%	5	1.73)	6	%	0.742	1.22)
Other high-risk HPV types								
LIDV 25	2	85.2	0.00		6	0.0	0.014	0.91 (0.58-
11F V 55		/0	0.75	1.30 (0.89-	0	0.0	0.914	1.26 (1.01-
HPV 39	2	0.0%	5	1.91)	6	%	0.932	1.58)
	2	74.9	0.04		6	35.2	0.172	1.16 (1.00-
HPV 51		% 183	6 0.26	- 2 08 (1 43-	6	% 64 9	0.1/2	1.36)
HPV 56	2	%	9	3.04)	6	%	0.014	-
	2	51.9	0.14			0.0		1.27 (1.03-
HPV 59		%	9	-	6	%	0.478	1.57)
HPV 68	2	0.0%	4	5.47)	6	%	0.601	1.20 (0.82-
Other possibly high wish HPV types				,				,
Other possibly high-risk III v types	2		0.87	1.89 (0.84-		26.8		1.21 (0.38-
HPV 26	2	0.0%	3	4.26)	4	%	0.251	3.81)
1101/52	2	0.00/	0.89	2.22 (1.25-	4	0.0	0.445	1.28 (0.88-
HPV 53		0.0%	4 0.95	3.94) 4.07 (1.43-	4	% 0.0	0.445	0.82 (0.41-
HPV 70	2	0.0%	7	11.55)	4	%	0.97	1.64)
	2	0.00/	0.92	1.39 (0.98-	4	0.0	0.000	1.32 (0.83-
HPV /3		0.0%	0.99	2 00 (0 50-	4	% 65.1	0.806	2.07)
HPV 82	2	0.0%	8	7.95)	4	%	0.035	-
20-24 year old females								
HPV types included in nonavalent								
vaccine			0.00			0.0		0.05 (0.01
HPV 31	3	57.8	0.09	_	5	0.0	0.889	0.95 (0.81-
in v si	2	55.0	0.10		5	48.1	0.009	1.10)
HPV 33	3	%	8	-	5	%	0.103	-
HPV 45	3	74.2	0.02	_	5	56.9 %	0.055	_
III V <del>4</del> 5	2	65.6	0.05	1.26 (0.87,	5	0.0	0.055	1.28 (1.12-
HPV 52	3	%	5	1.83)	5	%	0.53	1.46)
1101/ 50	3	0.09/	0.49	1.17 (0.94-	5	0.0	0 6 9 4	1.12 (0.93-
11F V 38		0.070	9	1.40)	5	/0	0.084	1.54)
Other high-risk HPV types			0.06	1 22 (0 70		42.1		
HPV 35	3	0.0%	8	1.87)	5	43.1 %	0.134	-
	3	44.8	0.16	1.32 (0.93,		0.0		1.09 (0.93-
HPV 39	5	%	3	1.88)	5	% 47.0	0.743	1.28)
HPV 51	3	0.0%	0.57	1.57 (1.16-	5	47.0 %	0.11	1.19 (0.88,
	2	75.4	0.01	1.45 (0.82,	č	87.5	< 0.00	
HPV 56	2	%	7	2.59)	5	%	1	-
HPV 59	3	80.1 %	0.00	-	5	0.0 %	0.604	1.13 (0.94-
					-			

HPV 68	3	67.4 %	0.04 6	-	5	0.0 %	0.842	0.99 (0.72- 1.37)
Other possibly high-risk HPV types								
	3	69.0				21.1		1.35 (0.28-
HPV 26	5	%	0.04	-	3	%	0.282	6.47)
	3		0.36	1.23 (1.05-		16.9		0.90 (0.64-
HPV 53	5	0.3%	7	1.45)	3	%	0.3	1.25)
	3		0.38	1.11 (0.81-		0.0		2.47 (1.24-
HPV 70	5	0.0%	2	1.51)	3	%	0.811	4.94)
	2	43.8	0.16			76.3		
HPV 73	5	%	9	-	3	%	0.015	-
	2	73.7	0.02			0.0		0.94 (0.39-
HPV 82	3	%	2	-	3	%	0.989	2.26)
HPV 82	-	%	2	-	3	%	0.989	2.26)

\* Summary prevalence ratio only calculated if data were not shown to be heterogeneous

	Relatively low potential bias <sup>1</sup>						Relatively high potential bias <sup>2</sup>				
	Numb	Hetero	geneity	Prevalence	Numb	Hetero	geneity	Prevalence			
Age-group / HPV type	er of studies	$I^2$	p- value	ratio <sup>3</sup> (95% CI)	er of studies	$I^2$	p- value	ratio <sup>3</sup> (95% CI)			
≤19 year old females											
Nonavalent HPV types											
HPV 31	5	31.2 %	0.213	-	3	0.0%	0.447	0.73 (0.58- 0.93)			
HPV 33	5	0.0%	0.526	0.79 (0.30- 2.06)	3	34.4 %	0.218	-			
HPV 45	5	21.5 %	0.278	0.84 (0.49-	3	0.6%	0.366	0.99 (0.76-			
HPV 52	5	0.0%	0.681	1.09 (0.77-	3	61.9	0.072				
1101/52	5	0.0%	0.672	0.87 (0.58-	2	0.00/	0.505	1.08 (0.82-			
HPV 38 Other high-risk HPV types		0.0%	0.072	1.50)	3	0.0%	0.505	1.42)			
other night tisk in a types	5			0.85 (0.46-		60.6					
HPV 35	5	0.0%	0.424	1.58) 1.21 (0.83-	3	%	0.079	- 1.30 (1.04-			
HPV 39	5	0.0% 45.3	0.907	1.78)	3	0.0%	0.846	1.61) 1.28 (1.09-			
HPV 51	5	% 60.3	0.120	-	3	0.0%	0.433	1.50)			
HPV 56	5	%	0.011	-	3	%	0.007	-			
HPV 59	5	0.0%	0.465	1.29 (0.94- 1.76)	3	85.9 %	0.001	-			
HPV 68 Other possibly high-risk HPV	5	12.6 %	0.333	1.21 (0.76- 1.93)	3	0.0%	0.948	1.33 (0.75- 2.36)			
types											
HPV 26	5	3.3%	0.388	1.27 (0.45- 3.58)	1	-	-	1.93 (0.82, 4.59)			
HPV 53	5	0.0%	0 514	1.32 (0.92-	1	_	_	2.19 (1.18,			
HDV 70	5	0.0%	0.821	0.90 (0.45-	1			4.02 (1.31,			
HPV 70	5	0.0%	0.001	1.33 (0.87-	1	-	-	1.39 (0.96,			
HPV /3	5	0.0% 55.0	0.909	2.05)	I	-	-	2.00) 2.00 (0.42,			
HPV 82	U	%	0.064	-	1	-	-	9.44)			
20-24 year old females											
Nonavalent HPV types		27.7						0.95 (0.81-			
HPV 31	5	%	0.237	-	3	0.0%	0.670	1.11)			
HPV 33	5	0.0%	0.599	0.78)	3	0.0%	0.424	1.05 (0.85-			
HPV 45	5	/8.5 %	0.001	-	3	0.0%	0.948	0.90 (0.74- 1.10)			
HPV 52	5	0.0%	0.905	1.06 (0.91- 1.22)	3	11.8 %	0.322	1.37 (1.20- 1.56)			
HPV 58	5	0.0%	0.859	1.04 (0.85- 1.28)	3	0.0%	0.600	1.23 (1.02- 1.50)			
Other high-risk HPV types											
UDV 25	5	0.00/	0.754	1.42 (0.97-	2	10.7	0.226	0.90 (0.67-			
HPV 35	5	0.0%	0./54	2.08) 1.12 (0.94-	3	%	0.326	1.21) 1.14 (0.97-			
HPV 39	5	8.3% 32.5	0.359	1.34)	3	0.0% 46.9	0.415	1.34)			
HPV 51	5	%	0.205	- 1.03 (0.89-	3	% 94.5	0.152	-			
HPV 56	5	0.0%	0.914	1.21)	3	% 86.4	0.000	-			
HPV 59	5	0.0%	0.443	1.28)	3	%	0.001	-			
HPV 68 Other possibly high-risk HPV	5	0.0%	0.692	1.49)	3	/2.5 %	0.026	-			

Table S2: Prevalence ratio for non-vaccine high-risk HPV types stratified by age-group and potential bias

types

	F	54.8						1.14 (0.37,
HPV 26	5	%	0.065	-	1	-	-	3.50)
	5	36.3						1.52 (0.86,
HPV 53	5	%	0.179	-	1	-	-	2.69)
	5	34.5						1.64 (0.79,
HPV 70	5	%	0.191	-	1	-	-	3.37)
	5	56.0						1.92 (1.04,
HPV 73	5	%	0.059	-	1	-	-	3.53)
	5			0.75 (0.60-				0.22 (0.10,
HPV 82	3	0.0%	0.984	0.94)	1	-	-	0.51)

1 Average-low potential bias includes studies; Cameron et al, Cummings et al, Kahn et al, Markowitz et al, Sonnenberg et al and Tabrizi et al

2 Average-high potential bias includes studies; Chow et al, Mesher et al and Söderlund-Strand et al

3 Summary prevalence ratio only calculated if data were not shown to be heterogeneous

	Low	vaccina	tion covera	ge (<50%)	High vaccination coverage (≥50%)				
Age-group / HPV type	Numb er of	Hetero	geneity	Prevalence ratio <sup>1</sup>	Numb er of	Hetero	geneity	Prevalence ratio <sup>1</sup>	
	studies	$I^2$	p- value	(95% CI)	studies	$I^2$	p- value	(95% CI)	
≤19 year old females									
Nonavalent HPV types									
HPV 31	0		-		8	6.4%	0.381	0.73 (0.58- 0.91)	
HPV 33	0		-		8	0.0%	0.471	1.04 (0.78-	
HPV 45	0		-		8	5.5%	0.387	0.96 (0.75- 1.23)	
HPV 52	0		-		8	24.0 %	0.238	1.34 (1.13- 1.59)	
HPV 58	0		-		8	0.0%	0.727	1.01 (0.80- 1.26)	
Other high-risk HPV types						25.1			
HPV 35	0		-		8	25.1 %	0.229	-	
HPV 39	0		-		8	0.0%	0.984	1.27 (1.05- 1.54)	
HPV 51	0		-		8	43.6 %	0.088	-	
HPV 56	0		-		8	74.3 %	<0.00 1	-	
HPV 59	0		-		8	66.8 %	0.004	-	
HPV 68	0		_		8	0.0%	0.690	1.26 (0.88- 1.81)	
Other possibly high-risk HPV types								,	
HDV 26	0				6	0.0%	0.478	1.63 (0.84-	
HI V 20	0		-		0	0.070	0.478	1.51 (1.10-	
HPV 53	0		-		6	3.6% 23.6	0.394	2.06) 1.34 (0.75-	
HPV 70	Û		-		6	%	0.257	2.39) 1.36 (1.03-	
HPV 73	0		-		6	0.0% 49.0	0.961	1.80)	
HPV 82	0		-		6	%	0.081	-	
20-24 year old females									
Nonavalent HPV types	c.			0.96 (0.83-		25.5			
HPV 31	5	0.0% 36.3	0.838	1.12)	3	%	0.261	0 65 (0 53-	
HPV 33	5	% 55.9	0.179	-	3	0.0% 62.7	0.618	0.81)	
HPV 45	5	%	0.06	-	3	%	0.068	- 1 10 (0 94-	
HPV 52	5	%	0.248	-	3	0.0%	0.513	1.27)	
HPV 58	5	0.0%	0.689	1.45)	3	0.0%	0.807	1.30)	
Other high-risk HPV types		20.4						1 20 (0.80	
HPV 35	5	30.4 %	0.219	-	3	0.0%	0.590	1.29 (0.80- 2.07)	
HPV 39	5	5.3%	0.377	1.37)	3	0.0%	0.482	1.30)	
HPV 51	5	30.7 %	0.056	-	3	57.8 %	0.201	-	
HPV 56	5	30.5 %	0.218	-	3	91./ %	<0.00 1	-	
HPV 59	5	/3.5	0.004	-	3	0.0%	0.673	1.15 (0.96- 1.37)	
HPV 68 Other possibly high-risk HPV	5	%	0.034	-	3	0.0%	0.810	1.20 (0.78-	

types

		53.8						1.76 (1.00-
HPV 26	4	%	0.09	-	2	0.0%	0.862	3.12)
	4			1.31 (0.95-		76.6		
HPV 53	4	0.0%	0.522	1.81)	2	%	0.039	-
	1	11.8		1.72 (1.06-				1.08 (0.76-
HPV 70	4	%	0.334	2.79)	2	0.0%	0.335	1.53)
	1	52.5						1.02 (0.82-
HPV 73	4	%	0.097	-	2	0.0%	0.503	1.26)
	1	33.7						0.75 (0.59-
HPV 82	4	%	0.21	-	2	0.0%	0.675	0.94)

1 Summary prevalence ratio only calculated if data were not shown to be heterogeneous

# 1 Supplementary Figures

Technical Appendix Figure 1: Prevalence ratio for other probably high-risk HPV types (HPV35, HPV39, HPV51, HPV56, HPV59 and HPV68) stratified by age-group, percentages in square brackets represent vaccination coverage (at least one dose) for each study/age-group

Presence (t)         Presence (t)<	A: HPV 35	Te brack	oto repre	sent vaccinati	on coverag	e (ar io	ascon	Prevalen	ce	Prevalence
Jam Jam Jan	da							Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)
Cammeng (Ph) Change (Ph) Charles (Ph) Cha	S19 years old									
Actor [1914]         0.0         1.4         0.8         0.00         1.4         0.8         0.00         1.4         0.8         0.00         0.00 </td <td>Cummings [89%]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>4.0</td> <td>2.7</td> <td>0.67 (0.14, 3.22)</td>	Cummings [89%]							4.0	2.7	0.67 (0.14, 3.22)
Date (Pr/n)	Tabrizi [88%]							- 0.0	1.4	0.96 (0.05, 18.16
Amery (FVA) Beam (FVA	Chow [79%]				•			1.8	3.6	2.37 (0.27, 20.81
Base of (15)         Bit (15)	Kann [77%]				•			3.5	4.2	1.18 (0.50, 2.79)
Demonstrating (2x)         The control (2x)         The control (2x)         The control (2x)           Destinated Stress (2x)         1         0.0         1.1         0.0         0.0         1.1         0.0         0	Mesner [/1%]			!				- 0.4	2.3	4.42 (1.04, 18.71
Solution (19%)         1         0         0.78 (0.66, 142)           Machanic (19%)         1         0         0.80 (0.2, 122)           Solution (19%)         1         0         0.80 (0.2, 122)           Solution (19%)         1         0         0.80 (0.2, 122)           Solution (19%)         0         1         2         0.80 (0.2, 270)           Solution (19%)         0         1         2         1         1         0         0.80 (0.2, 270)           Solution (19%)         0         1         2         1         1         2         0.80 (0.2, 270)           Maconic (19%)         0         1         2         1         1         2         1         0.00 (0.2, 270)           Maconic (19%)         0         1         2         1	Sonnenberg [62%]							5.1	0.0	1.24 (0.51, 2.99)
Marcard (251%)         1.1         9.9         0.80 (0.2.2.279)           20 A years of Comments (17%)         1.7         2.1         1.23 (0.37, 4.13)           Comments (17%)         1.7         2.1         1.23 (0.37, 4.13)           Solution (4) (4) (25%)         1.7         2.1         1.23 (0.37, 4.13)           Solution (4) (4) (25%)         1.7         2.1         1.23 (0.37, 4.13)           Solution (4) (25%)         1.7         2.1         1.23 (0.37, 4.13)           Solution (4) (25%)         1.7         2.1         1.23 (0.37, 4.13)           Solution (4) (25%)         1.1         2.1         1.10 (0.47, 0.3)           Solution (4) (25%)         1.1         2.1         1.10 (0.47, 0.3)           Solution (4) (25%)         1.1         2.1         1.00 (0.47, 0.3)           Solution (4) (25%)         1.1         2.1         1.00 (0.47, 0.3)           Solution (4) (25%)         1.1         2.1         1.00 (0.47, 0.3)           Solution (4) (25%)         1.3         1.40 (0.5, 0.2)         1.07 (0.6, 1.30)           Solution (4) (25%)         1.3         1.40 (0.5, 0.2)         1.11 (0.1, 1.50)           Solution (57%)         1.3         1.40 (0.5, 0.2)         1.11 (0.1, 1.50)           Solution (	Söderlund-Strand [55%]				_			1.1	0.8	0.78 (0.40, 1.52)
Subtrall (legamed = 25.1%, p = 0.229)         20-24 years old         Cherron ([57])         Cherron ([57])         Cherron ([57])         Cherron ([57])         Cherron ([57])         Solidential (legamed = 7.0%, p = 0.309)         Description ([57])         Description ([57])         Solidential (legamed = 7.0%, p = 0.309)         Description ([57])         Description ([57])         Solidential (legamed = 7.0%, p = 0.309)         Description ([57])         Solidential (legamed = 7.0%, p = 0.309)         Description ([57])         Solidential (legamed = 7.0%, p = 0.309)         Description ([57])         Solidential (legamed = 7.0%, p = 0.309)         Description ([57])         Solidential (legamed = 7.0%, p = 0.309)         Description ([57])         Solidential (legamed = 0.0%, p = 0.309)         Description ([57])         Solidential (legamed = 0.0%, p = 0.309)         Description ([57])         Solidential (legamed = 0.0%, p = 0.309)         Description ([57])         Solidential (legamed = 0.0%, p = 0.309)         Description ([57])         Solidential (legamed = 0.0%, p = 0.309)         Description ([57])         Solidential (legam	Markowitz [51%]		-					1.1	0.9	0.80 (0.23, 2.78)
224 years old	Subtotal (I-squared = 25.1%, p = 0.229)									
Table (1984)       - <t< td=""><td>20-24 years old</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	20-24 years old									
Conserv (BY) Chew (BY) Material (1335)         0	Tabrizi (83%)				•	_		1.7	21	1.23 (0.37, 4.13)
Downlet(b)       Thereal(15)       Thereal(15)       Thereal(15)       Thereal(15)         Sobernetreg (15)       Thereal(15)       Thereal(15)       Thereal(15)	Cameron [67%]							0.9	1.2	1 24 (0 73 2 09)
bit Horizontz [251c]	Chart [66%]					•		→ 0.0	2.2	5.62 (0.22, 07.24
Maxing [353]	Markavitz (229/1				-	_		3.2	5.2	1 78 (0 78 10 06
Kalin (131)       27       7.6       280 (27.108)         Solventud Stand (241)       Solventud Stand (241)       1.1       2.1       1.1       0.65 (0.2.108)         Solventud Stand (241)       Solventud Stand (241)       1.1       2.1       1.1       0.1       0.2       0.60 (0.2.108)         Solventud Stand (241)       Solventud Stand (241)       1.1       2.1       1.1       0.1       0.2       0.60 (0.2.108)         Solventud Stand (241)       Solventud Stand (241)       Solventud Stand (241)       1.1       2.1       1.1       0.1       0.2       0.60 (0.2.108)         Solventud Stand (241)       <	Markowitz [33%]				_			5.2	5.6	1.70 (0.70, 10.00
Botental Stand (24%)       2.5       2.2       0.86 (0.24, 1.6)         Mether (15%)       1.1       2.1       1.2       0.10 (0.24, 0.5)         Subtatel (1+squard = 7.5%, p = 0.369)       1.1       2.1       1.2       0.10 (0.24, 0.5)         BLHP/13       Prevalence (%)       Prevalence (%)       Prevalence (%)       Prevalence (%)         Subtatel (1+squard = 7.5%, p = 0.369)       1.1       2       5       10       0.5         Subtatel (1+squard = 7.5%, p = 0.369)       Prevalence (%)       Prevalence (%)       Prevalence (%)       Prevalence (%)         Subtatel (1+squard = 7.5%, p = 0.369)       1.1       2       5       1.0       0.0         Subtatel (1+squard = 7.5%, p = 0.94)       7.5       6.4       0.62 (0.2, 3.0)       0.0         Subtatel (1+squard = 0.0%, p = 0.94)       2.2       5.6       1.30 (0.63, 1.69)       0.0       1.10 (0.1, 1.30)         Subtatel (1+squard = 0.0%, p = 0.94)       2.5       1.2       5       1.20 (0.54, 0.00)       1.27 (1.05, 1.54)         Subtatel (1+squard = 0.0%, p = 0.94)       2.5       1.2       5       1.20 (0.44, 0.20)       1.27 (1.05, 1.54)         Subtatel (1+squard = 0.0%, p = 0.922)	Kahn [31%]							2.7	7.6	2.80 (0.78, 10.06
Somenterg [15%]       1       2       5       1       2       1	Söderlund-Strand [24%]							2.5	2.2	0.85 (0.62, 1.16)
Mether [15%]         1.1         2.1         1.24 (0.51, 2.89)           1.1         2.1         1.24 (0.51, 2.89)         1.07 (0.8, 1.30)           1.05         1         2         5         1         2         5         10         30           Prevalence Prevaler (%)         Pr	Sonnenberg [16%]		_			_		1.2	1.2	1.01 (0.23, 4.50)
Subtatal (1-squared = 7.5%, p = 0.369)       1.07 (0.85, 1.39)         B: HFV.38       Pervetence (%)       Pervetence (%)       Pervetence (%)         Status (15%)       5.3       4.0       0.75 (0.26, 276)         Fatca (15%)       7.1       6.2       0.76 (0.26, 276)         Fatca (15%)       7.1       6.2       0.07 (0.26, 276)         Fatca (15%)       7.1       6.2       0.07 (0.26, 276)         Fatca (15%)       7.1       6.2       0.07 (0.26, 276)         Sobeland (1-squared = 0.0%, p = 0.084)       2.2       5.6       1.30 (0.86, 1.69)         Subtatal (1-squared = 0.0%, p = 0.084)       2.2       5.5       1.20 (0.74, 2.23)         Subtatal (1-squared = 0.0%, p = 0.084)       2.2       5.6       1.10 (0.14, 0.27)         Subtatal (1-squared = 0.0%, p = 0.084)       2.2       5.6       1.10 (0.14, 0.27)         Subtatal (1-squared = 0.0%, p = 0.022)       1.1       1.10 (0.14, 0.27)       1.10 (0.14, 0.27)         Subtatal (1-squared = 0.0%, p = 0.022)       1.1       2.2       5.6       1.20 (0.14, 0.27)         Subtatal (1-squared = 0.0%, p = 0.022)       1.1       1.10 (0.14, 0.27)       1.10 (0.14, 0.27)         Subtatal (1-squared = 0.0%, p = 0.022)       1.1       1.10 (0.14, 0.27)       1.10 (0.14, 0.27)	Mesher [15%]			-	·			1.1	2.1	1.24 (0.51, 2.99)
Image: constraint of the sector of	Subtotal (I-squared = 7.9%, p = 0.369)			1	>					1.07 (0.85, 1.36)
ELEM 3B         Prevalence (h)	.05	.1	.2	.5 1	2	5	10	30		
ELHC 31         Pre-vacc (%)         Pask (p85% C)           s19 pars old Commings (8%)         5.3         4.0         0.75 (p.2.0.27)           Tabric (85%)         7.1         6.2         0.87 (p.2.7.36)           Chew (7%)         5.3         4.0         0.75 (p.2.0.27)           Someneting (2%)         5.2         5.6         1.33 (p.8.16)           Someneting (2%)         5.2         5.6         1.33 (p.8.16)           Someneting (2%)         3.3         4.3         1.27 (p.5.154)           Subtatal (1-squared = 0.0%, p = 0.984)         7.5         5.8         0.77 (p.4.3, 1.39)           Camericing (2%)         5.1         2.0         6.2         1.27 (p.5.154)           Soldentind-Strand (2%)         5.8         6.5         1.40 (p.68, 2.0)           Soldentind-Strand (2%)         5.1         2.0         5.1         1.0 (p.9.1, 1.30)           Soldentind-Strand (2%)         5.1         2.5         1.2         5         1.0 (p.9.1, 1.30)           Soldentind-Strand (2%)         5.1         2.5         1.2         5         1.3         3.8         2.88 (p.9.02)           Soldentind-Strand (2%)         5.1         2.5         1.2         5         1.0         3.0         7.7 (p.43, 1.								Prevalen	ce	Prevalence
519 years old       5.3       4.0       0.75 (0.20, 2.75)         Tarkiz [85%]       7.1       6.2       0.87 (0.21, 3.64)         Cheming [97%]       7.3       6.4       0.02 (0.23, 3.64)         Khin [77%]       5.3       4.0       0.75 (0.20, 2.75)         Mather [71%]       5.3       4.2       0.87 (0.23, 1.34)         Soberlund-Strand [55%]       4.2       1.08 (0.31, 3.73)         Soberlund-Strand [55%]       3.3       4.3       1.28 (0.62, 2.38)         Subtotal [-lequence = 0.0%, p = 0.984)       7.5       5.8       0.77 (0.43, 1.59)         Chew (65%)       7.4       11.9       1.29 (0.54, 2.68)         Markowitz [5%]       5.8       6.5       1.14 (0.91, 1.36)         Sobderlund-Strand [5%]       5.8       6.5       1.14 (0.91, 1.36)         Markowitz [5%]       5.2       5.6       1.40 (0.41, 4.82)         Subtotal [-lequence] 0.0%, p = 0.522)       1.3       1.3       3.6       2.83 (0.89, 0.22)         Markowitz [5%]       5.1       1.2       5       1.2       5       1.0       30         Subtotal [-lequence] 0.0%, p = 0.522)       1.3       1.3       0.6       1.47       2.44 (1.06, 5.43)         Subtotal [1%]       5	<u>B: HPV 39</u>							Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)
Currenting (prs)       5.3       4.0       0.75 (0.20, 27.5)         Tathic [85%]       7.3       6.4       0.92 (0.23, 364)         Chew (75%)       7.3       6.4       0.92 (0.23, 364)         Maho (77%)       5.3       6.4       0.92 (0.23, 364)         Solentind-Strand [55%]       5.2       5.6       1.33 (0.69, 169)         Solentind-Strand [55%]       3.3       4.3       1.26 (0.63, 237)         Solentind-Strand [55%]       5.8       0.77 (0.43, 1.59)       1.27 (10.5, 1.58)         Solentind-Strand [57%]       5.8       0.77 (0.43, 1.59)       1.27 (10.5, 1.58)         Cameron (67%)       5.8       0.5       1.11 (0.91, 1.36)         Chew (15%)       5.8       0.5       1.11 (0.91, 1.36)         Solentind-Strand [24%)       5.5       1.2 (0.74, 223)         Solentind-Strand [24%)       5.2       5.6       1.40 (0.62, 237)         Solentind-Strand [24%]       5.1       1.40 (0.62, 237)       1.33 (0.60, 160)         Solentind-Strand [24%]       5.1       2.6       7.7       1.5 (0.62, 167)         Solentind-Strand [24%]       5.1       2.6       7.7       7.8 (0.65, C1)         Solentind-Strand [24%]       5.1       2.5       1.40 (0.62, 237)	≤19 years old							5.0	10	0.75 (0.00 0.000
immod gorsy in the second state of	Cummings [89%]		_	•				5.3	4.0	0.75 (0.20, 2.75)
Chov (17%) <ul> <li>Kahn (77%)</li> <li>Somenberg (17%)</li> <li>Somenberg (17%)</li> <li>Somenberg (17%)</li> <li>Somenberg (17%)</li> <li>Somenberg (17%)</li> <li>Somenberg (15%)</li> <li>So</li></ul>	Tabrizi [88%]							7.1	6.2	0.87 (0.21, 3.64)
Kinn [775]       5.9       8.3       1.41 (0.75, 2.68)         Sonenberg [62%]       5.9       8.3       9       4.2       5.6       1.33 (0.89, 1.69)         Söderlund-Strand [55%]       3.9       4.2       5.5       1.30 (0.99, 1.71)       1.27 (10.5, 1.54)         Zo-24 years old       7.5       5.8       0.77 (0.43, 1.39)       1.27 (10.5, 1.54)         Zo-24 years old       7.5       5.8       0.77 (0.43, 1.39)       1.29 (0.54, 3.66)         Markowitz [375]       5.8       6.5       1.11 (0.91, 1.26)       1.29 (0.74, 2.33)         Söderlund-Strand [24%]       5.6       1.40 (0.69, 2.81)       1.3       3.8       2.8 (0.89, 0.80)         Söderlund-Strand [24%]       5.1       1.40 (0.64, 2.82)       1.33 (1.00, 1.42)       1.3       3.8       2.8 (0.89, 0.20)         Söderlund-Strand [15%]         1.3       3.8       2.8 (0.89, 0.20)       1.3 (1.00, 1.28)         Liney SI	Chow [79%]			•				7.3	6.4	0.92 (0.28, 3.04)
Mether [715]       5.2       5.8       1.33 (0.69, 1.89)         Soldertund-Strand [55%]       3.9       4.2       1.06 (0.31, 3.73)         Soldertund-Strand [1-squared = 0.0%, p = 0.984)       3.3       4.3       1.28 (0.69, 1.84)         20-24 years old       7.5       5.8       0.5       1.11 (0.91, 1.36)         Chew (6%1)       7.4       11.9       1.29 (0.62, 2.33)         Markowitz [37%]       6.2       8.0       1.29 (0.62, 2.33)         Soldertund-Strand [24%]       3.6       5.1       1.40 (0.41, 4.82)         Soldertund-Strand [24%]       3.6       5.1       1.40 (0.27, 2.23)         Subtotal (I-squared = 0.0%, p = 0.522)       1.3       2.5       1.0       3.0         C:HPV 51       Prevalence       Prevalence       Prevalence         0.05       .1       2.5       1.0       3.0       2.44 (1.05, 5.64)         Soldertund-Strand [5%]               Subtotal (I-squared = 0.0%, p = 0.522)               Soldertund-Strand [5%]               Chew [7%]	Kahn [77%]			-+				5.9	8.3	1.41 (0.75, 2.66)
Somenberg [62%] Solutional (1-squared = 0.0%, p = 0.984) Subtotal (1-squared = 0.0%, p = 0.984) Somenberg [6%] Subtotal (1-squared = 0.0%, p = 0.522) Subtotal (1-squared = 0.0%, p = 0.522) Subtotal (1-squared = 43.6%, p = 0.088) Subtotal (1-squared = 43.6%, p = 0.082) Subtotal (1-squared = 43.6%, p = 0.052) Subtotal	Mesher [71%]			+				5.2	5.6	1.33 (0.89, 1.98)
Söderlund-Strand [55%]       4.2       5.5       1.30 (0.99, 17)         Markowitz [51%]       3.3       4.3       1.28 (0.69, 2.38)         20-24 years old       7.5       5.8       0.77 (0.43, 1.59)         Cameron [67%]       5.8       6.5       1.11 (0.91, 1.36)         Chew (58%)       6.2       8.0       1.29 (0.74, 2.23)         Soderlund-Strand [24%]       3.6       5.1       1.40 (0.41, 4.82)         Soderlund-Strand [24%]       3.6       5.1       1.40 (0.41, 4.82)         Soderlund-Strand [24%]       3.6       5.1       1.40 (0.41, 4.82)         Soderlund-Strand [24%]       5.2       5.5       1.40 (0.89, 9.02)         Soderlund-Strand [24%]       5.1       2.5       1.2       5.1         Soderlund-Strand [24%]       5.1       2.5       1.40 (0.81, 3.30)         Cumming [85%]       1.2       5.1       2.40 (0.81, 3.30)         Cheves of Comming [85%]       1.3       1.3       9.8       0.60 (0.25, 1.81)         Tabrizi [85%]       1.2       5.4       1.0       0.55 (0.25, 1.41)         Soderlund-Strand [55%]       9.9       1.3       1.4       1.6       1.2 (1.03, 1.43)         Commings [85%]       1.4       0.5       1	Sonnenberg [62%]					-		3.9	4.2	1.08 (0.31, 3.73)
Markowitz [51%]       3.3       4.3       1.28 (0.69, 2.38)         Subotal (!squared = 0.0%, p = 0.984)       7.5       5.8       0.77 (0.43, 1.39)         Cameron [67%]       7.4       11.9       1.29 (0.54, 2.38)         Chow [66%]       7.4       11.9       1.29 (0.54, 2.38)         Markowitz [35%]       6.2       8.0       1.29 (0.74, 2.23)         Kahn [31%]       6.2       6.1       1.40 (0.64, 2.38)         Sobetrund-Strand [24%]       3.6       5.1       1.40 (0.64, 2.38)         Subtotal (!squared = 0.0%, p = 0.522)       1.3       3.6       2.83 (0.89, 9.02)         Markowitz [51%]       5.1       2.5       1.2       5       1.09 (0.51, 1.30)         Subtotal (!squared = 0.0%, p = 0.522)       1.13 (1.00, 1.28)       1.13 (1.00, 1.28)       1.13 (1.00, 1.28)         Subtotal (!squared = 0.0%, p = 0.522)       1.1       2.5       1.2       5       10       30         C: HPV 51       Prevalence Pre-vacc (%)       Prevalence Ratio (95% C)         Subtotal (!squared = 0.0%, p = 0.08)       Subtotal (!squared = 0.0%, p = 0.08)         Subtotal (!squared = 0.0%, p = 0.08)       Subtotal (!squared = 0.0%, p = 0.08)         Subtotal (!squared = 0.0%, p = 0.08)       Subtotal (!squared = 0.0%, p	Söderlund-Strand [55%]			H	•			4.2	5.5	1.30 (0.99, 1.71)
Subtotal (I-squared = 0.0%, p = 0.984)  20-24 years old  Tabriz [15%] Cameron [67%] Cameron [67%] Chew [66%] Markowitz [35%] Subtotal (I-squared = 0.0%, p = 0.522)  C.HPV 51  C.HV 51  C.HV 51  C.HV 51  C.HV 51  C.HV 51  C.HV 5	Markowitz [51%]			-+				3.3	4.3	1.28 (0.69, 2.38)
20-24 years old     7.5     5.8     0.77 (0.43, 1.39)       Cameron (67%)     7.4     11.9     1.29 (0.54, 3.06)       Markowitz (33%)     6.2     8.0     1.29 (0.74, 3.26)       Söderlund-Strand [24%]     6.2     8.0     1.29 (0.74, 3.26)       Söderlund-Strand [24%]     6.2     6.7     1.40 (0.41, 4.82)       Söderlund-Strand [24%]     6.2     6.7     1.09 (0.91, 1.30)       Sobrothergi [15%]     5.2     5.6     1.40 (0.41, 4.82)       Subtotal (l-squared = 0.0%, p = 0.522)     1.3     3.6     5.1     1.40 (0.41, 4.82)       Cummings [16%]     5.2     5.6     1.49 (0.86, 2.33)     1.13 (1.00, 1.28)       Cummings [16%]     1.3     2.5     1.2     5     1.0     30       S19 years old     7.7     7.5     7.8     1.60 (95%)     Ratio (95%) (1.80)       Cummings [16%]     1.4.2     5     1.0     3.0     9.7     1.44 (1.05, 5.44)       Chow [75%]     1.0.2     9.8     0.96 (0.57, 1.61)     1.60 (2.52, 1.61)     1.60 (2.52, 1.61)       Chow [75%]     1.0.2     9.8     0.96 (0.57, 1.61)     1.60 (2.52, 1.61)       Chow [75%]     1.0.2     9.8     0.96 (0.57, 1.61)       Markowitz [51%]     9.4     1.6     1.24 (1.03, 1.48)	Subtotal (I-squared = 0.0%, p = 0.984)			<	$\diamond$					1.27 (1.05, 1.54)
Tabrizi [83%]       7.5       5.8       0.77 (0.43, 1.39)         Camero [67%]       5.8       6.5       1.11 (0.91, 1.36)         Chow [66%]       7.4       11.9       1.29 (0.74, 2.23)         Kahn [31%]       3.6       5.1       1.40 (0.41, 4.82)         Sodertund-Strand [24%]       6.2       6.7       1.90 (0.91, 1.30)         Somenberg [15%]       3.6       5.1       1.40 (0.64, 2.33)         Subtotal (I-squared = 0.0%, p = 0.522)       1.3       3.6       2.83 (0.89, 9.02)	20-24 years old									
Camero (67%) Charco (66%) Markowitz (33%) Solderlund-Strand (24%) Solderlund-Strand (24%) Solderlund-Strand (24%) Solderlund-Strand (24%) Solderlund-Strand (24%) Subtotal (I-squared = 0.0%, p = 0.522)	Tabrizi [83%]				_			7.5	5.8	0.77 (0.43, 1.39)
Chard (167 kg) Chard (167 kg) Chard (167 kg) Markowitz [33%] Kahn [37%] Somenberg [16%] Masher [71%] Chard [88%] Chard [88%] Chard [89%] Chard (14, 22, 2) Mesher [15%] Subtotal (I-squared = 0.0%, p = 0.522)	Competen (879/1			- 4	-			E 9	6.5	1.11 (0.01, 1.20)
Chow [695] Markowitz [33%] Kahn [31%] Soleentund-Strand [24%] Soleentund-Strand [24%] Soleentund-Strand [24%] Subtotal (I-squared = 49.8%, p = 0.052)	Cameron [67%]			— I				5.6	0.5	1.11 (0.91, 1.36)
Markowitz [35%]       6.2       8.0       1.29 (0.74, 2.32)         Sofertund-Strand [24%]       3.6       5.1       1.40 (0.41, 4.82)         Somenberg [16%]       1.3       3.6       2.83 (0.89, 0.02)         Masher [15%]       5.2       5.6       1.49 (0.96, 2.33)         Subtotal (I-squared = 0.0%, p = 0.522)       1       1       1       1         .05       .1       .2       .5       1.0       3.0         Prevalence Prevace (%) Post-vace (%) Ratio (95% CI)         Cummings [89%]         Tabrizi [88%]       14.3       9.5       0.67 (0.25, 1.81)         Charler [71%]       0.4       1.02       9.8       0.60 (0.27, 1.61)         Sofertund-Strand [55%]       4.1       0.75 (0.43, 1.31)       3.61 (0.2, 1.43)       3.61 (0.2, 1.43)         Sofertund-Strand [55%]       4.1       0.75 (0.43, 1.31)       5.5       4.1       0.75 (0.43, 1.31)         Subtotal (I-squared = 43.6%, p = 0.088)       4.61 (0.2, 2.44) (0.06, 1.43)       4.61 (0.2, 2.44) (0.61, 1.24)         Subtotal (I-squared = 49.8%, p = 0.052)	Chow [66%]				•			7.4	11.9	1.29 (0.54, 3.06)
Kahn [31%]       3.6       5.1       1.00 (0.41, 4.20)         Söderlund-Strand [24%]       6.2       6.7       1.09 (0.91, 1.30)         Somenberg [16%]       5.2       5.6       1.49 (0.86, 2.33)         Subtotal (I-squared = 0.0%, p = 0.522)       1       1       1       1	Markowitz [33%]			-+	•			6.2	8.0	1.29 (0.74, 2.23)
Sdderlund-Strand [24%] Sonneherg [16%] Subtotal (I-squared = 0.0%, p = 0.522) Subtotal (I-squared = 0.0%, p = 0.522)	Kahn [31%]				•	_		3.6	5.1	1.40 (0.41, 4.82)
Sonnenberg [16%] Mesher [15%] Subtotal (I-squared = 0.0%, p = 0.522)	Söderlund-Strand [24%]							6.2	6.7	1.09 (0.91, 1.30)
Mesher [15%]       5.2       5.6       1.49 (0.96, 2.30)         Subtotal (1-squared = 0.0%, p = 0.522)       1	Sonnenberg [16%]			1			_	1.3	3.6	2.83 (0.89, 9.02)
Subtotal (I-squared = 0.0%, p = 0.522) 1.13 (1.00, 1.28) 1.13 (1.00, 1.28) Prevalence Prevalence Prevalence Prevace (%) Post-vace (%) Ratio (85% Cl) 519 years old Curmings (85%) Tabitig (85%) Chow (79%) Chow (79%) Somenberg (65%) 30defund-Stand (55%) Markowitz (51%) Subtotal (I-squared = 43.6%, p = 0.088) 20-24 years old Camoring (67%) Chow (7%) Chow (7%) Cho	Mesher [15%]			L				5.2	5.6	1.49 (0.96, 2.33)
C: HPV 51         Prevalence Prevace (%)         Prevalence Prevace (%)         Prevalence Ratio (85% Cl)           519 years old Cummings [89%] Tabriz [88%]         6.0         14.7         2.44 (1.06, 5.64)           Chw [79%]         10.9         11.8         0.97 (0.25, 1.81)           Sobderlund-Strand [55%]         9.0         4.9         0.55         4.1         0.57 (0.25, 1.81)           Sobderlund-Strand [55%]         9.0         4.9         0.55         4.1         0.75 (0.43, 1.31)           Subtotal (I-squared = 43.6%, p = 0.088)         4.6         0.2         2.46 (0.81, 0.37)         1.38 (0.82, 2.45)           Cameron [67%]         7.2         9.6         1.34 (1.12, 1.59)         5.5         4.1         0.75 (0.43, 1.31)           Subtotal (I-squared = 43.6%, p = 0.088)         4.6         10.2         2.40 (0.81, 0.37)         1.34 (0.30, 1.19)           Soderlund-Strand [57%]         7.2         9.6         1.34 (1.12, 1.59)         1.24 (0.81, 0.65)         1.34 (1.12, 1.59)           Charge (67%]         7.2         9.6         1.34 (1.12, 1.59)         1.24 (0.81, 0.65)         1.34 (1.12, 1.59)         1.24 (0.81, 0.65)         1.34 (1.12, 1.59)         1.24 (0.81, 0.65)         1.34 (1.12, 1.59)         1.34 (0.30, 1.19)         1.35 (0.30), 1.19         1.34 (0.30, 1.19)         1.34	Subtotal (I-squared = 0.0%, p = 0.522)			k	>			0.2	0.0	1.13 (1.00, 1.28)
Prevalence Prevvacc (%)         Prevalence Prevvacc (%)         Prevalence Ratio (95% CI)           \$19 years old         6.0         14.7         2.44 (1.06, 5.64)           Cumming (18%)         6.0         14.7         2.44 (1.06, 5.64)           Cheve (79%)         10.9         11.8         0.97 (0.39, 2.45)           Kahn (77%)         0.9.0         4.9         0.54 (0.27, 1.81)           Somenberg (12%)         9.0         4.9         0.54 (0.20, 1.81)           Solderlund-Strand (55%)         9.0         4.9         0.54 (0.20, 1.81)           Markowitz [51%]         9.0         4.9         0.54 (0.20, 1.81)           Solderlund-Strand (55%)         9.0         4.1         0.75 (0.43, 1.31)           Subtrail (I-squared = 43.6%, p = 0.088)         9.8         8.0         0.82 (0.49, 1.36)           Chaw (18, 13%)         9.9         13.8         1.29 (0.59, 2.85)         1.29 (0.59, 2.85)           Markowitz [33%]         9.9         1.22 (1.08, 3.07)         1.30 (0.09, 1.19)         1.30 (0.09, 1.19)           Somenberg [16%]         9.9         1.24 (0.43, 3.55)         1.57 (1.02, 3.41)         1.57 (1.02, 3.41)           Subtrail (I-squared = 49.8%, p = 0.052)         1.5 2 5 10 30         1.57 (1.02, 3.41)         1.57 (1.02, 3.41)	.05	.1	1	.5 1	2	5	10	30		
C: HPV 51         Prevalence Pre-vacc (%)         Prevalence Ratio (95% C)           s19 years old         6.0         14.7         2.44 (1.06, 5.64)           Cummings [8%]         14.3         9.5         0.67 (0.25, 1.81)           Chevy (75%)         10.9         11.8         0.97 (0.39, 2.45)           Soderfund-Stand [55%)         9.0         4.9         0.56 (1.02, 1.81)           Markowitz [51%]         9.0         4.9         0.56 (1.02, 1.81)           Soderfund-Stand [55%)         9.0         4.9         0.56 (1.02, 1.81)           Markowitz [51%]         9.0         4.9         0.56 (0.20, 1.43)           Soderfund-Stand [55%)         9.0         4.9         0.56 (0.20, 1.43)           Markowitz [51%]         9.8         8.0         0.82 (0.49, 1.36)           Camero [67%]         7.2         9.6         1.34 (1.03, 1.48)           Camero [67%]         9.9         13.8         1.29 (0.99, 2.85)           Markowitz [33%]         9.9         13.8         1.29 (0.99, 2.85)           Markowitz [33%]         9.9         10.2         1.03 (0.00, 1.19)           Somenberg [16%]         9.9         10.2         1.03 (0.00, 1.19)           Somenberg [16%]         1.5         1.9         1										
\$19 years old       6.0       14.7       2.44 (1.06, 5.64)         Tabriz [185%]       14.3       9.5       0.67 (0.25, 1.81)         Chow [79%]       10.2       9.8       0.96 (0.57, 1.61)         Markortz [17%]       0.0       4.9       0.54 (1.02, 1.43)         Sodderlund-Strand [55%]       9.4       11.6       1.24 (1.03, 1.48)         Markowitz [51%]       9.0       4.9       0.54 (1.02, 1.43)         Solderlund-Strand [55%]       9.4       11.6       1.24 (1.03, 1.48)         Markowitz [51%]       9.8       8.0       0.82 (0.49, 1.38)         Cameron [67%]       7.2       9.6       1.34 (1.12, 1.59)         Chow [66%]       9.9       13.8       1.29 (0.59, 2.85)         Markowitz [33%]       4.6       10.2       2.24 (0.81, 6.17)         Sodderlund-Strand [24%]       9.9       13.8       1.29 (0.59, 2.85)         Markowitz [33%]       4.6       10.2       2.24 (0.81, 6.17)         Sodderlund-Strand [24%]       9.9       1.24 (0.43, 3.55)       4.6       10.2       2.24 (0.81, 6.17)         Sodderlund-Strand [24%]       9.9       1.24 (0.43, 3.55)       6.1       5.3       1.87 (1.02, 3.41)         Subtotal (1-equared = 49.8%, p = 0.052)       0.5	<u>C: HPV 51</u>							Prevalen Pre-vacc (%)	Post-vacc (%)	Prevalence Ratio (95% CI)
Cummings [89%]       6.0       14.7       2.44 (106, 564)         Tabriz [88%]       14.3       9.5       0.67 (0.25, 181)         Chow [79%]       10.9       11.8       0.97 (0.39, 2.45)         Kahn [77%]       10.2       9.8       0.66 (0.37, 161)         Somenberg [62%]       9.0       4.9       0.54 (0.20, 1.43)         Soldertund-Strand [55%]       9.4       11.6       1.24 (103, 1.48)         Markowitz [51%]       9.4       11.6       1.24 (103, 1.48)         Subtotal (I-squared = 43.6%, p = 0.088)       9.8       8.0       0.82 (0.49, 1.36)         Camarcen [67%]       9.9       13.8       1.29 (0.59, 2.85)         Markowitz [31%]       4.6       10.2       2.24 (0.41, 6.15)         Soldertund-Strand [24%]       9.9       13.8       1.29 (0.59, 2.85)         Markowitz [31%]       4.6       10.2       2.24 (0.41, 6.15)         Soldertund-Strand [24%]       9.9       13.8       1.29 (0.59, 2.85)         Markowitz [33%]       4.6       10.2       2.24 (0.41, 6.15)         Soldertund-Strand [24%]       9.9       13.2       1.03 (0.90, 1.19)         Soldertund-Strand [24%]       9.9       10.2       1.03 (0.90, 1.19)         Solderund-Strand [24%	≤19 years old									
Tabrizi [88%]	Cummings [89%]							6.0	14.7	2.44 (1.06, 5.64)
Chow [79%]     10.9     11.8     0.97 (0.39, 245)       Kahn [77%]     10.2     9.8     0.96 (0.87, 161)       Mosher [77%]     7.5     7.7     15.8 (10.8, 2.31)       Söderlund-Strand [55%]     9.0     4.9     0.54 (0.20, 1.43)       Söderlund-Strand [55%]     9.4     11.6     1.24 (10.3, 1.46)       Markowitz [51%]     9.8     8.0     0.82 (0.49, 1.36)       Sobtotal (I-squared = 43.6%, p = 0.088)     7.2     9.6     1.34 (1.12, 1.59)       Chow [6%]     7.2     9.6     1.34 (1.2, 1.59)       Markowitz [33%]     4.6     10.2     2.24 (0.81, 6.15)       Söderlund-Strand [24%]     9.9     10.2     1.03 (0.00, 1.19)       Sonnenberg [16%]     1.5     1.9     1.24 (0.43, 3.55)       Markowitz [15%]     0.55     1.2     5     10       Subtotal (I-squared = 49.8%, p = 0.052)     1.5     1.9     1.24 (0.43, 3.55)	Tabrizi [88%]		-					14.3	9.5	0.67 (0.25, 1.81)
Kahn [77%]     10.2     9.8     0.96 (0.57, 161)       Mesher [77%]     7.5     7.7     1.88 (1.08, 2.31)       Söderlund-Strand [55%]     9.0     4.9     0.54 (1.02, 1.43)       Söderlund-Strand [55%]     9.4     11.6     1.24 (1.03, 1.48)       Markowitz [51%]     9.4     11.6     1.24 (1.03, 1.48)       Subtotal (I-squared = 43.6%, p = 0.088)     9.8     8.0     0.82 (0.49, 1.36)       Cameron (67%)       Cameron (67%)     7.2     9.6     1.34 (1.12, 1.59)       Chow (66%)     9.9     13.8     1.29 (0.59, 2.85)       Markowitz [31%]     4.6     10.2     2.24 (0.81, 0.67)       Söderlund-Strand [24%]     9.9     10.2     1.03 (0.00, 1.19)       Somenberg [16%)     1.5     1.9     1.24 (0.43, 3.55)       Mesher [15%]     6.1     5.3     1.87 (1.02, 3.41)       Subtotal (I-squared = 49.8%, p = 0.052)     0.5     1     2     5     10	Chow [79%]							10.9	11.8	0.97 (0.39, 2.45)
Mesher [71%]     7.5     7.7     1.58 (1.08, 2.31)       Sonenberg [62%]     9.0     4.9     0.54 (0.20, 1.43)       Soderlund-Stand [25%]     9.4     11.6     1.24 (1.03, 1.48)       Markowitz [51%]     5.5     4.1     0.75 (0.43, 1.31)       Subtotal (I-squared = 43.6%, p = 0.088)     9.8     8.0     0.82 (0.49, 1.36)       Cameron [67%]     7.2     9.6     1.34 (1.12, 1.59)       Chow [66%]     7.2     9.6     1.34 (1.12, 1.59)       Markowitz [33%]     4.6     10.2     2.24 (0.81, 6.15)       Soderlund-Strand [24%]     9.9     1.82 (1.08, 3.65)       Subtotal (I-squared = 49.8%, p = 0.052)     1.5     1.9     1.24 (0.43, 3.55)       Markowitz [31, 1.2, 2, 5     1     2     5     10	Kahn [77%]			_				10.2	9.8	0.96 (0.57, 1.61)
Sonnenberg [62%]     9.0     4.9     0.54 (0.20, 1.43)       Söderlund-Strand [55%]     9.4     11.6     1.24 (1.03, 1.48)       Markowitz [51%]     5.5     4.1     0.75 (0.43, 1.31)       Subtotal (I-squared = 43.6%, p = 0.088)     9.8     8.0     0.82 (0.49, 1.36)       Cameron (67%)     72     9.6     1.34 (1.12, 1.59)       Chow (66%)     9.9     13.8     1.29 (0.59, 2.85)       Markowitz [33%]     4     9.9     18.2 (10.8, 3.07)       Söderlund-Strand [24%]     9.9     10.2     1.03 (0.90, 1.19)       Sonnenberg [16%]     1.5     1.9     1.24 (0.43, 3.55)       Masher [15%]     6.1     5.3     1.87 (1.02, 3.41)       Subtotal (I-squared = 49.8%, p = 0.052)     1     1     1	Mesher [71%]			].				7.5	7.7	1.58 (1.08, 2.31)
Söderlund-Strand [55%] Markowitz [51%]         9.4         11.6         1.24 (1.03, 1.48)           Markowitz [51%]         5.5         4.1         0.75 (0.43, 1.31)           Subtotal (I-squared = 43.6%, p = 0.088)         9.8         8.0         0.82 (0.49, 1.36)           Cameron (67%)         7.2         9.6         1.34 (1.12, 1.59)           Chow [67%]         9.9         13.8         1.29 (0.59, 2.65)           Markowitz [33%]         4.6         10.2         2.24 (0.81, 615)           Söderlund-Strand [24%]         9.9         10.2         1.03 (0.00, 119)           Sonenberg [16%]         1.5         1.9         1.24 (0.43, 3.55)           Masher [15%]         6.1         5.3         1.87 (1.02, 3.41)           Subtotal (I-squared = 49.8%, p = 0.052)         1.2         5         10         30	Sonnenberg [62%]		_		_			9.0	4.9	0.54 (0.20, 1.43)
Markowitz [51%]         5.5         4.1         0.75 (0.43, 1.31)           Subtotal (I-squared = 43.8%, p = 0.088)         5.5         4.1         0.75 (0.43, 1.31)           20-24 years old         9.8         8.0         0.82 (0.49, 1.36)           Tabrizi [83%]         9.8         8.0         0.82 (0.49, 1.36)           Cameron [67%]         7.2         9.6         1.34 (1.12, 159, 2.85)           Markowitz [33%]         4.6         10.2         2.24 (0.81, 6.15)           Soderlund-Strand [24%]         9.9         10.2         1.03 (0.00, 1.19)           Sonnenberg [16%]         1.5         1.9         1.24 (0.43, 3.55)           Mesher [15%]         6.1         5.3         1.87 (1.02, 3.41)           Subtotal (I-squared = 49.8%, p = 0.052)         1         1         1	Söderlund-Strand [55%]			4	•			9.4	11.6	1.24 (1.03, 1.48)
Subtotal (I-squared = 43.6%, p = 0.088)  20-24 years old  Tabriz [83%] Cameron (67%) Chow (66%) 9.9 13.8 129 (0.59, 2.85) Markowitz [33%] Kahn (31%) Soderfund-Strand [24%] 9.9 10.2 2.240 (0.81, 6.15) Söderfund-Strand [24%] 9.9 10.2 1.5 1.9 1.5 1.9 1.	Markowitz [51%]				_			5.5	4.1	0.75 (0.43, 1.31)
20-24 years old         9.8         8.0         0.82 (0.49, 1.36)           Cameron [67%]         7.2         9.6         1.34 (1.12, 1.59)           Chow [66%]         9.9         13.8         1.29 (0.59, 2.85)           Markowitz [33%]         5.4         9.9         1.82 (1.08, 3.07)           Kahn [31%]         4.6         10.2         2.24 (0.43, 1.615)           Söderlund-Strand [24%]         9.9         10.2         1.03 (0.90, 1.19)           Sonneberg [16%]         1.5         1.9         1.24 (0.43, 3.55)           Mesher [15%]         6.1         5.3         1.87 (1.02, 3.41)           Subtotal (I-squared = 49.8%, p = 0.052)         1         1         1         1	Subtotal (I-squared = 43.6%, p = 0.088)									
Tabrizi [83%]     9.8     8.0     0.82 (0.49, 1.36)       Camaron [67%]     7.2     9.6     1.34 (1.12, 1.59)       Chow [66%]     9.9     1.8     1.29 (0.59, 2.85)       Markowitz [33%]     5.4     9.9     1.82 (1.08, 3.67)       Kahn [31%]     4.6     10.2     2.24 (0.81, 6.15)       Söderlund-Strand [24%]     9.9     10.2     1.03 (0.90, 1.19)       Somenberg [16%]     1.5     1.9     1.24 (0.43, 3.55)       Mesher [15%]     6.1     5.3     1.87 (1.02, 3.41)       Subtotal (I-squared = 49.8%, p = 0.052)     0.5     1     2     5     10     30	20-24 years old									
Instruction (27%)         9.8         8.0         0.82 (0.49, 1.36)           Cameron (67%)         7.2         9.6         1.34 (1.12, 1.59)           Chow (66%)         9.9         13.8         1.29 (0.59, 2.85)           Markowitz (33%)         5.4         9.9         18.8         1.29 (0.59, 2.85)           Markowitz (33%)         5.4         9.9         18.2         2.24 (0.81, 6.15)           Söderlund-Strand [24%)         9.9         10.2         2.24 (0.81, 6.15)         1.03 (0.90, 1.19)           Sonneberg [16%)         1.5         1.9         1.24 (0.43, 3.55)         Mesher [15%]         6.1         5.3         1.87 (1.02, 3.41)           Subtotal (I-squared = 49.8%, p = 0.052)         0.5         1         2         5         10         30	Tabrizi (82%)								0.0	0.92 (0.40.4.20)
Charling for any         7.2         9.6         1.34 (1.12, 1.59)           Charl (6%)         9.9         13.8         1.29 (0.59, 2.85)           Markowitz [33%]         4.6         10.2         2.24 (0.81, 6.15)           Soderlund-Stand [24%]         9.9         10.2         1.34 (0.43, 3.55)           Masher [15%]         1.5         1.9         1.24 (0.43, 3.55)           Masher [15%]         6.1         5.3         1.87 (1.02, 3.41)           Subtotal (I-squared = 49.8%, p = 0.052)         0.5         1.2         5         10         30	Camaran (67%)				-			9.8	0.0	1 24 (4 49, 1.30)
Conv (pors)         9.9         13.8         129 (0.59, 285)           Markowitz [33%]         5.4         9.9         1.82 (1.08, 3.07)           Solderlund-Strand [24%]         4.6         10.2         2.24 (0.81, 6.15)           Solderlund-Strand [24%]         9.9         10.2         1.03 (0.90, 1.19)           Sonneberg [16%]         1.5         1.9         1.24 (0.43, 3.55)           Mesher [15%]         6.1         5.3         1.87 (1.02, 3.41)           Subtotal (I-squared = 49.8%, p = 0.052)         1         1         1         1	Cameron [6/%]							7.2	9.6	1.34 (1.12, 1.59)
Markowitz [33%]         -         5.4         9.9         1.82 (1.08.3.07)           Kahn [31%]         4.6         10.2         2.24 (1.08.1.615)           Soderlund-Strand [24%]         9.9         10.2         1.03 (1.08.1.615)           Somebrerg [16%]         1.5         1.9         1.24 (0.43.3.65)           Mesher [15%]         6.1         5.3         1.87 (1.02, 3.41)           Subtotal (I-squared = 49.8%, p = 0.052)         0.5         1.2         5         10         30	Cnow [66%]			-	•			9.9	13.8	1.29 (U.59, 2.85)
Kahn [31%]         4.6         10.2         2.24 (0.81, 6.15)           Söderlund-Strand [24%]         9.9         10.2         1.03 (0.90, 1.19)           Sonnenberg [16%]         1.5         1.9         1.24 (0.43, 3.55)           Mesher [15%]         6.1         5.3         1.87 (1.02, 3.41)           Subtotal (I-squared = 49.8%, p = 0.052)         1 <td>Markowitz [33%]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>5.4</td> <td>9.9</td> <td>1.82 (1.08, 3.07</td>	Markowitz [33%]							5.4	9.9	1.82 (1.08, 3.07
Söderlund-Strand [24%]         9.9         10.2         1.03 (0.90, 1.19)           Sönnebrerg [16%]         1.5         1.9         1.24 (0.43, 3.55)           Mesher [15%]         6.1         5.3         1.87 (1.02, 3.41)           Subtotal (I-squared = 49.8%, p = 0.052)         1.1         1.1         1.1         1.1           Jos 1.1         2.5         1.2         5         10         30	Kahn [31%]			+	•			4.6	10.2	2.24 (0.81, 6.15)
Sonenberg [15%] Mesher [15%] Subtotal (I-squared = 49.8%, p = 0.052) 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Söderlund-Strand [24%]			-				9.9	10.2	1.03 (0.90, 1.19)
Mesher [15%] Subtotal (I-squared = 49.8%, p = 0.052)	Sonnenberg [16%]				•			1.5	1.9	1.24 (0.43, 3.55)
Subtotal (I-squared = 49.8%, p = 0.052)	Mesher [15%]			-				6.1	5.3	1.87 (1.02, 3.41)
	Subtotal (I-squared = 49.8%, p = 0.052)									
	.05	.1	.2	I I .5 1	2	5	1 10	30		

2

	Prevalen	æ	Prevalence
<u>D: HPV 56</u>	Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)
≤19 years old			
Cummings [89%]	3.3	2.7	0.80 (0.16, 4.03)
Tabrizi [88%]	3.6	5.2	1.47 (0.20, 10.93)
Chow [79%]	7.3	8.2	1.13 (0.36, 3.54)
Kahn [77%]	2.8	5.7	2.06 (0.85, 4.97)
Mesher [71%] -	• 3.4	7.8	2.26 (1.51, 3.38)
Sonnenberg [62%]	5.1	6.0	1.19 (0.41, 3.43)
Söderlund-Strand [55%]	5.2	5.4	1.04 (0.80, 1.36)
Markowitz [51%]	3.4	0.9	0.28 (0.13, 0.57)
Subtotal (I-squared = 74.3%, p < 0.001)			
20-24 years old			
Tabrizi (83%)	- 4.6	4.8	1.05 (0.50, 2.20)
Cameron [67%]	9.0	9.3	1.03 (0.88, 1.22)
Chow [66%]	11.1	5.0	0.18 (0.09, 0.35)
Markowitz [33%]	- 4.4	4.0	0.89 (0.40, 2.00)
Kahn [31%]	- 5.4	4.2	0.78 (0.24, 2.47)
Söderlund-Strand [24%]	6.9	8.9	1.30 (1.11, 1.52)
Sonnenberg [16%]	2.4	3.7	1.53 (0.57, 4.13)
Mesher [15%]	2.4	5.9	2.22 (1.33, 3.70)
Subtotal (I-squared = 82.6%, p < 0.001)			

HPV FO								Prevalence		се	Prevalence
<u>. nr v 33</u>								1	Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)
≤19 years old											
Cummings [89%]					-				8.0	9.3	1.17 (0.48, 2.84)
Tabrizi [88%]						_			14.3	9.0	0.63 (0.23, 1.73)
Chow [79%]					+-			_	7.3	16.4	2.60 (0.78, 8.65)
Kahn [77%]						•			11.0	17.4	1.58 (1.02, 2.45)
Mesher [71%]				++-					6.0	3.5	0.59 (0.43, 0.81)
Sonnenberg [62%]			-	_	+	•			2.3	6.1	2.63 (0.35, 19.70)
Söderlund-Strand [55%]					-	-			3.8	4.7	1.23 (0.91, 1.64)
Markowitz [51%]				_		_			3.2	3.4	1.08 (0.57, 2.04)
Subtotal (I-squared = 66.8%, p = 0.004	)										
20-24 years old											
Tabrizi [83%]				_					5.2	6.5	1.25 (0.63, 2.49)
Cameron [67%]					-				6.8	7.6	1.12 (0.93, 1.35)
Chow [66%]				_	F	•	_		7.4	11.9	1.69 (0.67, 4.24)
Markowitz [33%]			_		+				6.0	4.1	0.67 (0.32, 1.43)
Kahn [31%]					-				6.4	6.8	1.07 (0.40, 2.84)
Söderlund-Strand [24%]					-				4.2	4.8	1.15 (0.93, 1.42)
Sonnenberg [16%]				•	F				3.4	1.9	0.54 (0.20, 1.50)
Mesher [15%]									5.0	2.7	0.53 (0.37, 0.76)
Subtotal (I-squared = 63.6%, p = 0.007	)										
		· · ·		1	-	1		1	1		
.0	5 .	1.2	2	.5	1	2	5	10	30		

E. HDV 69	Prevalence	Prevalence
<u>r. nrv to</u>	Pre-vacc (%) Post-va	cc (%) Ratio (95% CI)
≤19 years old		
Cummings [89%]	3.3 4.0	1.20 (0.29, 4.89
Tabrizi [88%]	3.6 0.5	0.13 (0.01, 2.07
Chow [79%]	3.6 3.6	1.11 (0.21, 5.85
Kahn [77%]	6.7 6.8	1.02 (0.54, 1.93
Mesher [71%]	1.9 2.3	1.54 (0.47, 5.02
Sonnenberg [62%]	★ → 0.0 2.6	5.18 (0.29, 90.8
Söderlund-Strand [55%]	0.6 0.8	1.31 (0.65, 2.65
Markowitz [51%]	1.2 2.1	1.80 (0.77, 4.25
Subtotal (I-squared = 0.0%, p = 0.690)	$\diamond$	1.26 (0.88, 1.81
20-24 years old		
Tabrizi [83%]	1.7 1.4	0.82 (0.23, 2.88
Cameron [67%]	1.0 1.3	1.25 (0.77, 2.03
Chow [66%]	2.5 5.0	1.40 (0.31, 6.38
Markowitz [33%]	2.4 2.7	1.10 (0.44, 2.75
Kahn [31%]	6.4 3.4	0.53 (0.16, 1.77
Söderlund-Strand [24%]	1.4 1.4	1.04 (0.70, 1.53
Sonnenberg [16%]	2.5 1.9	0.76 (0.26, 2.21
Mesher [15%]	1.3 3.7	2.86 (1.53, 5.34
Subtotal (I-squared = 35.6%, p = 0.145)		
.05 .1 .2 .5	1 2 5 10 30	
Favours vaccination	Does not favour vaccination	

Technical Appendix Figure 2: Prevalence ratio for high-risk HPV types with evidence of cross-protection (HPV31, HPV33, HPV45) stratified by age-group and vaccine type, percentages in square brackets represent vaccination coverage (at least one dose) for each study/age-group

A: HPV 31	Preva	Prevalence	
	Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)
≤19 yrs old: Bivalent vaccine introduced			
Mesher [71%]	4.1	1.3	0.50 (0.25, 0.96)
Sonnenberg [62%]	• 0.4	0.8	1.93 (0.17, 22.20)
Subtotal (I-squared = 10.4%, p = 0.291)			0.54 (0.29, 1.03)
≤19 yrs old: Quadrivalent vaccine introduced			
Cummings [89%]	· 3.3	6.7	2.00 (0.60, 6.69)
Tabrizi [88%]	3.6	1.0	0.27 (0.02, 2.85)
Chow [79%]	10.9	6.4	0.69 (0.24, 1.94)
Kahn (77%)	5.9	2.3	0.38 (0.15, 0.98)
Söderlund-Strand [55%]	6.4	5.1	0.79 (0.60, 1.03)
Markowitz [51%]	2.8	1.8	0.64 (0.25, 1.66)
Subtotal (I-squared = 8.7%, p = 0.360)			0.75 (0.60, 0.96)
20-24 yrs old: Bivalent vaccine introduced			
Cameron [67%]	4.9	3.1	0.63 (0.48, 0.81)
Sonnenberg [16%]	1.9	2.7	1.40 (0.50, 3.94)
Mesher [15%]	3.9	3.3	1.10 (0.62, 1.97)
Subtotal (I-squared = 57.8%, p = 0.094)			
20-24 yrs old: Quadrivalent vaccine introduced			
Tabrizi [83%]	- 5.2	4.7	0.91 (0.45, 1.84)
Chow [66%]	6.2	7.8	1.38 (0.47, 4.04)
Markowitz [33%]	2.6	3.0	1.18 (0.52, 2.70)
Kahn [31%]	4.6	5.9	1.31 (0.43, 3.99)
Söderlund-Strand [24%]	8.1	7.6	0.93 (0.79, 1.09)
Subtotal (I-squared = 0.0%, p = 0.889)			0.95 (0.81, 1.10)
.05 .1 .2 .5 1	2 5 10 30		

B: HPV 33		Prevalence		Prevalence
		Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)
519 yrs old: Bivalent vaccine introduced				
Mesher [71%]		2.3	3.4	1.62 (0.90, 2.92
Sonnenberg [62%]		0.6	1.3	2.24 (0.24, 20.8
Subtotal (I-squared = 0.0%, p = 0.785)	$\langle \rangle$			1.66 (0.94, 2.92
519 yrs old and under: Quadrivalent vaccine introduced				
Cummings [89%]		1.3	0.0	0.40 (0.02, 8.17
Tabrizi [88%]		3.6	0.5	0.13 (0.01, 2.07)
Chow [79%]		→ 0.0	1.8	2.52 (0.12, 51.6
Kahn [77%]	· ·	0.8	1.1	1.44 (0.24, 8.57
Söderlund-Strand [55%]		3.5	3.2	0.91 (0.65, 1.29
Markowitz [51%]		0.5	0.3	0.59 (0.10, 3.43
Subtotal (I-squared = 0.0%, p = 0.687)	$\diamond$			0.89 (0.64, 1.24
20-24 yrs old: Bivalent vaccine introduced				
Cameron [67%]	•	6.4	4.3	0.67 (0.54, 0.84)
Sonnenberg [16%]		2.9	1.7	0.59 (0.21, 1.68
Mesher [15%]	<b></b>	2.5	3.1	1.37 (0.73, 2.57
Subtotal (I-squared = 55.0%, p = 0.108)				
20-24 yrs old: Quadrivalent vaccine introduced				
Tabrizi [83%]		4.0	1.8	0.44 (0.18, 1.06)
Chow [66%]		3.7	3.2	0.51 (0.47, 4.04
Markowitz [33%]		3.8	1.1	0.28 (0.08, 1.01
Kahn [31%]		0.9	0.0	0.31 (0.01, 7.55
Söderlund-Strand [24%]		3.9	4.0	1.01 (0.80, 1.27
Subtotal (I-squared = 48.1%, p = 0.103)				
		1 1		
.05 .1 .2 .5	1 2 5	10 30		

: HPV45	Preva	Prevalence	
	Pre-vacc (%)	Post-vacc (%)	) Ratio (95% CI)
19 yrs old: Bivalent vaccine introduced			
Mesher [71%]	3.0	3.0	0.75 (0.46, 1.21
Sonnenberg [62%]	→ 0.7	4.6	6.47 (0.84, 49.9
Subtotal (I-squared = 75.4%, p = 0.044)			
19 yrs old: Quadrivalent vaccine introduced			
Cummings [89%]	6.0	4.0	0.67 (0.19, 2.39
Tabrizi [83%]	0.0	0.5	0.41 (0.02, 9.89
Chow [79%]	3.6	4.5	1.01 (0.19, 5.30
Kahn [77%]	5.5	4.9	0.89 (0.43, 1.86
Söderlund-Strand [55%]	3.0	3.5	1.14 (0.82, 1.6
Markowitz [51%]	1.4	0.6	0.46 (0.13, 1.54
Subtotal (I-squared = 0.0%, p = 0.716)			1.01 (0.76, 1.34
0-24 yrs old: Bivalent vaccine introduced			
Cameron [67%]	2.9	1.6	0.53 (0.37, 0.76
Sonnenberg [16%]	2.0	4.0	2.02 (0.70, 5.82
Mesher [15%]	3.4	3.6	0.96 (0.60, 1.56
Subtotal (I-squared = 74.2%, p = 0.021)			
0-24 yrs old: Quadrivalent vaccine introduced			
0-24 yrs old: Quadrivalent vaccine introduced Tabrizi [83%]	1.1	3.2	2.77 (0.66, 11.5
0-24 yrs old: Quadrivalent vaccine introduced Tabrizi [83%] Chow [66%]	1.1	3.2 6.0	2.77 (0.66, 11.5
0-24 yrs old: Quadrivalent vaccine introduced Tabizi (38%) Chow (66%) Markowitz (33%)	1.1 4.9 2.0	3.2 6.0 1.9	2.77 (0.66, 11.5 0.92 (0.30, 2.79 0.92 (0.31, 2.74
D-24 yrs old: Quadrivalent vaccine introduced Tabrizi (83%) Chow (65%) Markowitz (33%) Kahn (31%)	1.1 4.9 2.0 → 1.8	3.2 6.0 1.9	2.77 (0.66, 11.5 0.92 (0.30, 2.79 0.92 (0.31, 2.74
0-24 yrs old: Quadrivalent vaccine introduced Tabrzi [33%] Chow (6%) Markowiz [33%] Kahn (31%) Kahn (31%) Kahn (31%)	1.1 4.9 2.0 1.8 4.7	3.2 6.0 1.9 11.9	2.77 (0.66, 11.5 0.92 (0.30, 2.79 0.92 (0.31, 2.74 6.53 (1.52, 28.0 0.88 (0.71, 1.11
0-24 yrs old: Quadrivalent vaccine introduced Tabrzi [33%] Chow (65%) Markowitz [33%] Kahn (31%) Söderfund-Strant [24%] Subtotal (I-squared = 56.9%, p = 0.055)	1.1 4.9 2.0 1.8 4.7	3.2 6.0 1.9 11.9 4.2	2.77 (0.66, 11.5 0.92 (0.30, 2.79 0.92 (0.31, 2.74 6.53 (1.52, 28.0 0.88 (0.71, 1.10
9-24 yrs old: Quadrivalent vaccine introduced           Tabrzi [83%]           Chow (6%)           Markowitz [33%]           Kahn (15%)           Söderfund-Strant [24%]           Subtotal (I-squared = 56.9%, p = 0.055)	1.1 4.9 2.0 1.8 4.7	3.2 6.0 1.9 11.9 4.2	2.77 (0.66, 11.5 0.92 (0.30, 2.79 0.92 (0.31, 2.74 6.53 (1.52, 28.0 0.88 (0.71, 1.10

Favours vaccination

Does not favour vaccination

Technical Appendix Figure 4: Prevalence ratio for other probably high-risk HPV types (HPV35, HPV39, HPV51, HPV56, HPV59 and HPV68) stratified by age-group and vaccine type, percentages in square brackets represent vaccination coverage (at least one dose) for each study/agedroup.

2 HPV 35		Prevalence		Prevalence	
		Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)	
≤19 yrs old: Bivalent vaccine introduced					
Mesher [71%]		0.4	2.3	4.42 (1.04, 18.71	
Sonnenberg [62%]		5.1	0.0	1.24 (0.51, 2.99)	
Subtotal (I-squared = 85.2%, p = 0.009)					
≤19 yrs old: Quadrivalent vaccine introduced					
Cummings [89%]	-	4.0	2.7	0.67 (0.14, 3.22)	
Tabrizi [88%]		0.0	1.4	0.96 (0.05, 18.16	
Chow [79%]		1.8	3.6	2.37 (0.27, 20.81	
Kahn [77%]		3.5	4.2	1.18 (0.50, 2.79)	
Söderlund-Strand [55%] -	-	1.1	0.8	0.78 (0.40, 1.52)	
Markowitz [51%]		1.1	0.9	0.80 (0.23, 2.78)	
Subtotal (I-squared = 0.0%, p = 0.914)	$\Leftrightarrow$			0.91 (0.58, 1.42)	
20-24 yrs old: Bivalent vaccine introduced					
Cameron [67%]	<b></b>	0.9	1.1	1.24 (0.73, 2.09)	
Sonnenberg [16%]		1.2	1.2	1.01 (0.23, 4.50)	
Mesher [15%]	<b>-</b> _	1.1	2.1	1.24 (0.51, 2.99)	
Subtotal (I-squared = 0.0%, p = 0.968)	$\Leftrightarrow$			1.22 (0.79, 1.87)	
20-24 yrs old: Quadrivalent vaccine introduced					
Tabrizi [83%]		1.7	2.1	1.23 (0.37, 4.13)	
Chow [66%]	•	→ <sub>0.0</sub>	3.2	5.62 (0.32, 97.24	
Markowitz [33%]		3.2	5.8	1.78 (0.78, 10.06	
Kahn [31%]	+	2.7	7.6	2.80 (0.78, 10.06	
Söderlund-Strand [24%]		2.5	2.2	0.85 (0.62, 1.16)	
Subtotal (I-squared = 43.1%, p = 0.134)					
.05 .1 .2 .	5 1 2 5	10 30			

1101/00	Prevalence	Prevalence	
<u>HPV 39</u>	Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)
≤19 yrs old: Bivalent vaccine introduced			
Mesher [71%]	5.2	5.6	1.33 (0.89, 1.98
Sonnenberg [62%]	3.9	4.2	1.08 (0.31, 3.73
Subtotal (I-squared = 0.0%, p = 0.755)			1.30 (0.89, 1.91
≤19 yrs old: Quadrivalent vaccine introduced			
Cummings [89%]	- 5.3	4.0	0.75 (0.20, 2.75
Tabrizi [88%]	7.1	6.2	0.87 (0.21, 3.64
Chow [79%]	7.3	6.4	0.92 (0.28, 3.04
Kahn [77%]	- 5.9	8.3	1.41 (0.75, 2.66
Söderlund-Strand [55%]	4.2	5.5	1.30 (0.99, 1.71
Markowitz [51%]	3.3	4.3	1.28 (0.69, 2.38
Subtotal (I-squared = 0.0%, p = 0.932)			1.26 (1.01, 1.58
20-24 yrs old: Bivalent vaccine introduced			
Cameron [67%]	5.8	6.5	1.11 (0.91, 1.36
Sonnenberg [16%]	• 1.3	3.6	2.83 (0.89, 9.02
Mesher [15%]	5.2	5.6	1.49 (0.96, 2.33
Subtotal (I-squared = 44.8%, p = 0.163)			
20-24 yrs old: Quadrivalent vaccine introduced			
Tabrizi [83%]	7.5	5.8	0.77 (0.43, 1.39
Chow [66%]	- 7.4	11.9	1.29 (0.54, 3.06
Markowitz [33%]	6.2	8.0	1.29 (0.74, 2.23
Kahn [31%]	3.6	5.1	1.40 (0.41, 4.82
Söderlund-Strand [24%]	6.2	6.7	1.09 (0.91, 1.30
Subtotal (I-squared = 0.0%, p = 0.743)			1.09 (0.93, 1.28

	Prevalence	Prevalence	
<u>C: HPV 51</u>	Pre-vacc (%)	Post-vacc (%)	Ratio (95% CI)
≤19 yrs old: Bivalent vaccine introduced			
Mesher [71%]	→ 7.5	7.7	1.58 (1.08, 2.31)
Sonnenberg [62%]	9.0	4.9	0.54 (0.20, 1.43)
Subtotal (I-squared = 74.9%, p = 0.046)			
≤19 yrs old: Quadrivalent vaccine introduced			
Cummings [89%]	6.0	14.7	2.44 (1.06, 5.64)
Tabrizi [88%]	- 14.3	9.5	0.67 (0.25, 1.81)
Chow [79%]	10.9	11.8	0.97 (0.39, 2.45)
Kahn [77%]	10.2	9.8	0.96 (0.57, 1.61)
Söderlund-Strand [55%]	9.4	11.6	1.24 (1.03, 1.48)
Markowitz [51%]	5.5	4.1	0.75 (0.43, 1.31)
Subtotal (I-squared = 35.2%, p = 0.172)			
20-24 yrs old: Bivalent vaccine introduced			
Cameron [67%]	7.2	9.6	1.34 (1.12, 1.59)
Sonnenberg [16%]	1.5	1.9	1.24 (0.43, 3.55)
Mesher [15%]	• 6.1	5.3	1.87 (1.02, 3.41)
Subtotal (I-squared = 0.0%, p = 0.570)	•		1.37 (1.16, 1.62)
20-24 yrs old: Quadrivalent vaccine introduced			
Tabrizi [83%]	9.8	8.0	0.82 (0.49, 1.36)
Chow [66%]	9.9	13.8	1.29 (0.59, 2.85)
Markowitz [33%]	- 5.4	9.9	1.82 (1.08. 3.07)
Kahn [31%]	4.6	10.2	2.24 (0.81, 6.15)
Söderlund-Strand [24%]	9.9	10.2	1.03 (0.90, 1.19)
Subtotal (I-squared = 47.0%, p = 0.110)			
.05 .1 .2 .5 1	2 5 10 30		

1171/ 50		Preval	ence	Prevalence
HPV 56		Pre-vacc (%	<li>b) Post-vacc (%)</li>	Ratio (95% CI)
19 yrs old: Bivalent vaccine introduced		2.4	7.0	2 26 /1 51 3 3
Soppenhera (62%)		3.4	7.8	1 19 (0 41 3 43
Subtotal (Leguared = 18.3%, n = 0.269)		5.1	6.0	2 08 (1 43 3 0
oublotal (Foquarea - 10.076, p - 0.200)				2.00 (1.40, 0.0
9 yrs old: Quadrivalent vaccine introduced				
Cummings [89%]	•	- 3.3	2.7	0.80 (0.16, 4.0
Tabrizi [88%]		3.6	5.2	1.47 (0.20, 10.9
Chow [79%]		7.3	8.2	1.13 (0.36, 3.5
Kahn [77%]		2.8	5.7	2.06 (0.85, 4.9)
Söderlund-Strand [55%]	*	5.2	5.4	1.04 (0.80, 1.3
Markowitz [51%]	<b>_</b> _	3.4	0.9	0.28 (0.13, 0.5
Subtotal (I-squared = 64.9%, p = 0.014)				
0-24 yrs old: Bivalent vaccine introduced				
Cameron [67%]		9.0	9.3	1.03 (0.88, 1.2
Sonnenberg [16%]		- 2.4	3.7	1.53 (0.57, 4.1
Mesher [15%]		2.4	5.9	2.22 (1.33, 3.7
Subtotal (I-squared = 75.3%, p = 0.017)				
0-24 yrs old: Quadrivalent vaccine introduced				
Tabrizi [83%]		4.6	4.8	1.05 (0.50, 2.2
Chow [66%]	- <b>-</b>	11.1	5.0	0.18 (0.09, 0.3
Markowitz [33%]		4.4	4.0	0.89 (0.40, 2.0
Kahn [31%]		5.4	4.2	0.78 (0.24, 2.4
Söderlund-Strand [24%]	-	6.9	8.9	1.30 (1.11, 1.5
Subtotal (I-squared = 87.5%, p < 0.001)				
.05 .1	.2 .5 1 2	5 10 30		
1PV 59		Preval	ence	Prevalence
		Pre-vacc (%	<ul> <li>Post-vacc (%)</li> </ul>	Ratio (95% CI)
19 yrs old: Bivalent vaccine introduced	_			
Mesher [71%]		6.0	3.5	0.59 (0.43, 0.8
Sonnenberg [62%]		2.3	6.1	2.63 (0.35, 19.
Subtotal (I-squared = 51.9%, p = 0.149)				
9 yrs old: Quadrivalent vaccine introduced				
Cummings [89%]		8.0	9.3	1.17 (0.48, 2.8
Tabrizi [88%]		14.3	9.0	0.63 (0.23, 1.7
Chow [79%]		7.3	16.4	2.60 (0.78, 8.6
Kahn [77%]		11.0	17.4	1.58 (1.02, 2.4
Söderlund-Strand [55%]		3.8	4.7	1.23 (0.91, 1.6
Markowitz [51%]		3.2	3.4	1 08 (0 57 2 0
Subtotal (I-squared = 0.0%, p = 0.478)	$\diamond$	0.2	0.4	1.32 (0.97, 1.8
Campron (67%)				
Sonnenberg [16%]	Ē	0.8	7.6	1.12 (0.93, 1.3
Mesher [15%]		3.4	1.9	0.54 (0.20, 1.5
Subtotal (I-squared = 86.1%, p = 0.001)	-	5.0	2.7	0.55 (0.57, 0.7
24 um aldi Quadrivalant vasarina internet				
Takaini (929/1				
1 abrizi [63%]	-+•	5.2	6.5	1.25 (0.63, 2.4
Chow [66%]	+	- 7.4	11.9	1.69 (0.67, 4.2
Markowitz [33%]		6.0	4.1	0.67 (0.32, 1.4
Kahn [31%]	<b>+</b>	6.4	6.8	1.07 (0.40, 2.8
Söderlund-Strand [24%]	-	4.2	4.8	1.15 (0.93, 1.4
Subtotal (I-squared = 0.0%, p = 0.604)	$\diamond$			1.13 (0.94, 1.3
1 1		5 10 30		
50.		5 10 30		
HPV 68		Prevale Pre-vacc (%	ence ) Post-vacc (%)	Prevalence Ratio (95% CI
			,	
9 yrs old: Bivalent vaccine introduced Mesher [71%]		19	23	1.54 (0.47. 5.0
	_	1.0	4.0	

≤19 yrs old: Bivalent vaccine introduced			
Mesher [71%]	- 1.9	2.3	1.54 (0.47, 5.02)
Sonnenberg [62%]	■ 0.0	2.6	5.18 (0.29, 90.89)
Subtotal (I-squared = 0.0%, p = 0.444)	>		1.84 (0.62, 5.47)
≤19 yrs old: Quadrivalent vaccine introduced			
Cummings [89%]	3.3	4.0	1.20 (0.29, 4.89)
Tabrizi [88%]	3.6	0.5	0.13 (0.01, 2.07)
Chow [79%]	3.6	3.6	1.11 (0.21, 5.85)
Kahn [77%]	6.7	6.8	1.02 (0.54, 1.93)
Söderlund-Strand [55%]	0.6	0.8	1.31 (0.65, 2.65)
Markowitz [51%]	1.2	2.1	1.80 (0.77, 4.25)
Subtotal (I-squared = 0.0%, p = 0.601)			1.20 (0.82, 1.76)
20-24 yrs old: Bivalent vaccine introduced			
Cameron [67%]	1.0	1.3	1.25 (0.77, 2.03)
Sonnenberg [16%]	2.5	1.9	0.76 (0.26, 2.21)
Mesher [15%]	1.3	3.7	2.86 (1.53, 5.34)
Subtotal (I-squared = 67.4%, p = 0.046)			
20-24 yrs old: Quadrivalent vaccine introduced			
Tabrizi [83%]	1.7	1.4	0.82 (0.23, 2.88)
Chow [66%]	2.5	5.0	1.40 (0.31, 6.38)
Markowitz [33%]	2.4	2.7	1.10 (0.44, 2.75)
Kahn [31%]	6.4	3.4	0.53 (0.16, 1.77)
Söderlund-Strand [24%]	1.4	1.4	1.04 (0.70, 1.53)
Subtotal (I-squared = 0.0%, p = 0.842)			0.99 (0.72, 1.37)
.05 .1 .2 .5 1 2	5 10 30		
Favours vaccination Does not	favour vaccination		