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Adolescence, sexually transmitted infections and human papillomavirus vaccination

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ABSTRACT

INTRODUCTION. Human papillomavirus (HPV) is the most common sexually transmitted infection, with an 80% lifetime risk of infection. This study investigated adolescents' knowledge of sexually transmitted infections and examined whether this knowledge was associated with HPV vaccination status or influenced decisions regarding condom use.

METHODS. This study has a cross-sectional design and was based on data from an annual questionnaire distributed to all ninth-graders in Tønder, Denmark, between 2020 and 2024.

RESULTS. Among 1,254 pupils in ninth grade, 866 (69%) answered the questionnaire. 20% had their sexual debut at a median age of 14 years, and most within the year leading up to the questionnaire. Within the overall group, knowledge of three or more STIs was associated with HPV vaccination (p = 0.001). At their most recent sexual activity, 62% used condoms and/or oral contraceptives. The girls reported greater reliance on contraceptives than boys across different circumstances, with rates of 70-80%compared with 50-55%, respectively. The HPV vaccination was associated with an increased use of condoms.

CONCLUSIONS. HPV-vaccinated adolescents knew more about sexually transmitted diseases and more often used condoms.

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Sexually transmitted infections (STIs), e.g., chlamydia and gonorrhoea, have become more common among adolescents over the past decade [1]. Another common STI is the human papillomavirus (HPV), causing anogenital warts or high-risk HPV infections that may lead to cancers of the cervix, vulva, vagina, penis, anus, and head and neck [2, 3]. HPV is the most common STI, and nearly all sexually active individuals will be infected with HPV at some point in their lives. HPV infections are most prevalent before age 30 years, with a reported prevalence of 25% for new infections [4].

In 2009, Denmark introduced the HPV vaccine into the routine immunisation schedule for 12-year-old girls, with catch-up programmes for women born between 1985 and 1997. Since then, the incidence of anogenital warts has decreased rapidly, and Danish studies have linked HPV vaccination to a reduced risk of cervical neoplasia compared with unvaccinated peers [5-7]. Despite these positive results, some parents opted out of vaccination, probably due to limited knowledge of HPV and the HPV vaccines and reports on social media of possible side effects, e.g., autoimmune reactions [8-10]. Social media reports have led to parental concerns about safety, and as a result, vaccine coverage dropped sharply from 82% in birth cohorts in 1998-2000 to 18% in 2003 [6]. In Denmark, the decline in HPV vaccination in 2015-2016 was due to concerns circulated on social media about

possible side effects of HPV vaccination brought up in the 2015 TV programme; "The Vaccinated Girls" (TV 2). This decline in vaccination coverage was a formidable challenge for the immunisation programme in Denmark. Subsequent research suggests no association between the HPV vaccine and the anticipated initial side effects [11], and international studies indicate that HPV vaccination coverage is increasing [12].

Risk compensation is the idea that individuals adjust their behaviour in response to their perceived level of personal risk. We have previously reported that among another cohort of adolescents, HPV-vaccinated people were more likely than unvaccinated people to stop using condoms despite a higher STI awareness [13]. Besides the decrease in use of condoms, no association was found between HPV vaccination and earlier sexual initiation or increased sexual risk behaviour during the catch-up phase. However, research on sexual behaviour among Danish HPV-vaccinated adolescents is limited, and there is a lack of qualified knowledge about these adolescents' choices [14, 15].

This study aimed to investigate adolescents' knowledge of STIs, their relationship with HPV vaccination status and the extent to which this knowledge affects decisions about condom use as protection against STIs.

Methods

This cross-sectional study used data from an annual questionnaire distributed to all ninth-graders in Tønder, Denmark, between 2020 and 2024 (**Figure 1**).

FIGURE 1 Ninth-graders in Tønder.

The questionnaire was distributed via iPads during class to all pupils across the Tønder municipality's schools.

Students could answer the questionnaire electronically and anonymously during class. The school provided iPads for the survey.

The questionnaire was developed from a questionnaire used between 1986 and 2014 to evaluate sexual education in public schools for ninth-grade pupils in the Viborg Municipality and was distributed every seventh year. The Tønder Municipality School Management, School Board, Municipal Health Promotion Section and other relevant healthcare professionals collaborated to revise the questionnaire. Final approval was granted by the Municipal Council of Tønder and its Department of Youth and Schools in October 2020. According to Danish legislation, questionnaire studies do not require ethical approval, and data collection and management were the responsibility of Tønder Municipality.

Tønder Municipality is located in Southern Denmark and has approximately 37,000 inhabitants. Its average income is 13% below the national mean (Denmark: 370,851 DKK), and its median age is 49 years, compared with 42 years for Denmark overall. The municipality has seen a 25% decline in the number of children (age below 18 years) from 2008 to 2018, compared to the 5% increase recorded nationally.

The original validation process for the questionnaire dates back to 1986 and has been reported previously [14]. Over time, additional options for answers and subjects were added, such as HPV, HPV vaccination, gender identity, sugar-dating, sharing of nude photos, knowledge of consent and setting boundaries for sexual behaviour. Since 2023, the degree of knowledge about the consequences of untreated STIs, including HPV, has been included in the questionnaire.

The revised questionnaire used in this study contained 48 items. We divided pupils into two subgroups: HPV-vaccinated and non-vaccinated pupils. Adolescents were categorised as unvaccinated if they did not know their HPV vaccination status, and those who did not answer the HPV vaccination question were excluded.

Statistics

For all data, the Gaussian distribution was tested, and normally distributed data were presented as mean ±SD, whereas non-normally distributed data were presented as median (range). For calculations, we used the χ^2 test with Yates' correction for discontinuity. For continuous variables, ANOVA was performed to compare group means. For the evaluation of contingency tables, the Pearson χ^2 test for independence was first performed with the assumption of no direction of trend. The table was then tested using the χ^2 test for trend. Fisher's exact test was used when the expected count was less than five. For continuous variables such as age and age at debut, ANOVA was performed between groups if normally distributed. All statistical analyses were performed using SPSS version 24, with a significance level of 0.05.

Trial registration: not relevant.

Results

Since the questionnaire was first distributed in 2020, 1,254 ninth-graders received it, of whom 866 (69%) responded. As some pupils opted not to answer certain questions, the denominator varies in the calculations in the tables, excluding those who did not answer them. In total, 817 (94% of 866) pupils answered the HPV vaccination questions, and 815 (94%) answered the gender questions; thus, 808 (93%) pupils provided both their gender *and* HPV status. Among these, 759 (95% of 808) answered questions about their sexual debut. However, 15% of respondents did not answer questions on gender, HPV or sexual debut.

The median age of the participants was 15 years (**Table 1**). 53% of participants were biological females (428 of

808), and 67% (542 of 808) were HPV-vaccinated. 20% had their sexual debut at a median age of 14 years, with most having their debut within one year before answering the questionnaire. At the first sexual encounter, 98 (64%) had been vaccinated.

TABLE 1 Basic characteristics.

	♀			♂			
	HPV+ and HPV–	HPV+	HPV–	HPV+ and HPV–	HPV+	HPV–	All
Respondents, n	433			382			815[a]
Age, median (range), yrs***	15 (14-18)			15 (14-16)			15 (14-18)
Was HPV-vaccinated, n (%)***	365 (84)			177 (46)			542[b] (67)
Had a sexual debut, n (%)	68 (17)			91 (25)			159[c] (20)
Age at debut, median (range), yrs	14 (13-15)			14 (11-18)			14 (11-18)
Answered about							
Vaccination status, n		365	67		177	199	808[d]
Sexual debut (n)		343	65		162	189	759[e]

CC = contraception; HPV = human papillomavirus.
***) p = 0.001.
a) 20 missing answers on sex.
b) 7 missing answers on vaccination status (1 ♀ and 6 ♂)).
c) Denominator for calculations: 779 respondents (411 ♀ and 368 ♂).
d) 7 missing answers on HPV vaccination (1 ♀ and 6 ♂).
e) Denominator for calculations: 759 respondents (408 ♀ (hereof 343 vaccinated) and 351 ♂ (hereof 162 vaccinated).

More boys than girls had experienced their sexual debut ($p < 0.001$, Table 1). Knowledge of the most common STIs varied by sex, with girls more frequently identifying chlamydia and boys twice as often identifying HIV/AIDS (**Table 2**, both $p < 0.001$). Knowledge of common STIs was associated with HPV vaccination status (Table 2). Adolescents were presented with a list of STIs (chlamydia, herpes, HIV/AIDS, syphilis, HPV, gonorrhoea and condyloma acuminatum). Regardless of sexual debut and HPV vaccination status, 87% knew chlamydia, 80% herpes, 79% HIV/AIDS, 34% syphilis, 38% HPV, 39% gonorrhoea and 44% condyloma acuminatum. Poorer knowledge of two or fewer STIs was more common among unvaccinated than among vaccinated pupils (Table 2, HPV+ versus HPV–, 16 versus 26%, $p = 0.001$). Overall, having knowledge of three or more STIs was associated with HPV vaccination status (0-2 versus 3-6, 0-3 versus 4-6, and 0-4 versus 5-6 by HPV status; χ^2, all $p = 0.001$).

TABLE 2 Knowledge of sexually transmitted diseases.

	HPV+, n (%)		HPV–, n (%)			
What sexually transmitted disease do know/have you heard of?	♀ ($N_♀ = 365$)	♂ ($N_♂ = 177$)	♀ ($N_♀ = 67$)	♂ ($N_♂ = 199$)	All, n (%)	p value, HPV+ vs HPV–
No one	12 (3)	9 (5)	5 (7)	16 (8)	42 (5)	0.001
HIV/AIDS	13 (4)	4 (2)	4 (7)	12 (6)	33 (4)	0.01
Herpes	36 (10)	12 (7)	7 (10)	23 (12)	78 (10)	0.31
Syphilis	96 (26)*	36 (20)*	10 (15)*	29 (15)*	171 (21)	0.001
Chlamydia	91 (25)	40 (23)	22 (33)	47 (24)	200 (25)	0.6
Condyloma	65 (18)	40 (23)	11 (16)	37 (19)	153 (19)	0.7
Gonorrhoea	52 (14)	36 (20)	8 (12)	35 (18)	131 (16)	0.91
All	542		266		808[a]	

HPV = human papillomavirus.
*) $p < 0.05$, ♀ vs ♂.
a) 7 did not want to answer question on HPV vaccination (1 ♀ and 6 ♂).

72% of vaccinated individuals used contraception; 64% of them used condoms. Among non-vaccinated pupils, 62% used contraception, and 56% of them used condoms (condom use, HPV-vaccinated versus unvaccinated pupils, $p = 0.004$).

At sexual debut, 69% of pupils used contraception (**Table 3**). A significant finding was that girls used condoms and other forms of contraception more often than boys. HPV vaccination was associated with increased use of

condoms (Table 3).

TABLE 3 Use of contraception.

	HPV+		HPV−, n (%)			
Use of contraception	♀ ($N_{♀}$ = 52)	♂ ($N_{♂}$ = 46)	♀ ($N_{♀}$ = 13)	♂ ($N_{♂}$ = 40)	All (N = 151[a])	p value, HPV+ vs HPV−
At 1st coitus?, n (%)						
Yes**	40 (77)	31 (67)	11 (85)	22 (55)	104 (69)	0.2
Condom[b]	35 (67)	28 (61)	10 (77)	20 (50)	93 (62)	0.004
Pillb	7 (13)	4 (9)	2 (15)	1 (3)	14 (9)	0.38
At latest coitus?, n (%)						
Yes	37 (71)	28 (61)	9 (69)	20 (50)	94 (62)	0.22
Condom**[c]	21 (40)	23 (50)	5 (38)	13 (33)	62 (41)	0.23
At debut/latest coitus?, n (%)						
Yes**	36 (69)	25 (54)	9 (69)	16 (40)	86 (57)	0.09
Condom & condom*	20 (38)	22 (48)	5 (38)	9 (23)	56 (37)	0.86
Condom & pill**	13 (25)	2 (4)	4 (31)	4 (10)	23 (15)	1
*Using CC?, n (%)***						0.87[d]
(Almost) always	39 (75)	33 (72)	11 (85)	23 (58)	106 (70)	
Sometimes	3 (6)	4 (9)	1 (8)	3 (8)	11 (7)	
(Almost) never	8 (15)	9 (20)	2 (15)	8 (20)	27 (18)	
At debut**	40 (77)	31 (67)	11 (85)	22 (55)	104 (69)	-
At latest coitus**	37 (71)	28 (61)	9 (69)	20 (50)	94 (62)	-
At debut + latest coitus*	36 (69)	25 (54)	9 (69)	16 (40)	86 (57)	-
All	98		53			

CC = contraception; HPV = human papillomavirus; IUD = intrauterine device.
*) $p < 0.05$, **) $p < 0.01$, ♀ vs ♂.
a) Only including the pupils who answered on gender, HPV as well as debut.
b) 6 girls and 3 boys indicated simultaneous use of a condom as well as the pill.
c) 2 girls and 3 boys indicated simultaneous use of a condom as well as the pill.
d) Fisher's exact test for 2 × 3 contingency table.

Discussion

We found that adolescents' HPV vaccination status was associated with increased knowledge of STIs (Table 2), suggesting the provision of sexual health education through the HPV prevention programme. Since the introduction of the HPV vaccine, concerns have been raised that HPV vaccination may lead to earlier sexual debut, promiscuity or risky sexual behaviour, e.g., early sexual debut and no use of condoms at intercourse [9, 16]. A Scandinavian study of 44,052 women aged 18-45 years found no evidence of earlier sexual debut or an increased number of sexual partners among vaccinated adults [17]. The mean age at sexual debut in our study cannot be directly compared with that of previous studies [18], as participants in our study were younger and only 20% of participants reported having had sexual debut. However, given the short time span between vaccination and sexual debut in this study, it is plausible that sexual behaviour and contraception may be influenced by vaccination. The earlier Scandinavian study was conducted after a catch-up vaccination programme, which might have introduced a bias, as people may have been vaccinated due to their sexual behaviour. In contrast, this study aimed to explore the reverse relationship.

Contraceptive use, condoms in particular, was common at first intercourse. HPV-vaccinated adolescents were more likely to use condoms than their unvaccinated peers (Table 2), which aligns with findings from previous studies [5, 19]. Consistent with previous research [13, 14], we observed a decline in condom use from first to most recent intercourse. This trend may be influenced by the nature of the relationship itself and an increase in the use of oral contraceptives (Table 3). We could not substantiate a direct association between this decline and HPV vaccination due to the relatively modest sample size. However, it is reasonable to assume that pupils are aware that reducing the use of barrier methods increases the risk of STIs. In an extensive study evaluating changes in

sexual behaviours at the population level before and after the introduction of a school-based HPV vaccination programme in British Columbia, Canada [20], data from 298,265 heterosexual girls showed that sexual risk behaviours, such as the number of sexual partners, ever having sexual intercourse (OR = 0.79), and having sexual intercourse before age 14 years (OR = 0.76) either remained the same or decreased following the implementation of the vaccination programme. Similar trends were observed for college-aged men and women in the USA and Danish adolescents [11]. However, despite their higher STI awareness, HPV-vaccinated adolescents in Denmark were less likely to use condoms. This trend is likely not directly related to HPV vaccination itself [11].

Additionally, we found that more than one in three students did not use any contraception during their most recent sexual encounter (Table 3). The overall lack of contraception has increased, in parallel with the rise in the incidence of syphilis and gonorrhoea in recent years [14, 19].

It may be questioned whether the relatively modest scope of this study allows for generalisation to other populations. The municipality's social context must be considered, particularly the shift from rural to urban living, a common trend across Europe. This does not necessarily imply that sexual behaviour in Tønder differs from that in other regions.

A challenge in the questionnaire revision process was that no adolescents from the target group were involved in the process or in assessing the quality and understandability of the questions.

The strength of the findings lies in the number of adolescents included and the high response rate. Furthermore, the strength of this study was the degree of comprehensiveness across the municipality and in the repeated data collection over time. By focusing on adolescents who have already had a sexual debut or were likely to do so in the next one or two years, we believe this study provides an accurate and reliable reflection of sexual behaviour, with minimal time and recall bias. Also, we assume there was less recall bias when participants were asked about the timing of their first sexual experience, including details about contraceptive use and knowledge of sexual health.

Conclusion

HPV-vaccinated adolescents demonstrate greater knowledge of STIs and use condoms more frequently than their non-vaccinated peers.

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