



The ‘best friend effect’: a promising tool to encourage HPV vaccination in Japan

Asami Yagi¹ · Yutaka Ueda¹ · Yoshimi Tomine² · Sayaka Ikeda³ · Mamoru Kakuda¹ · Satoshi Nakagawa¹ · Kosuke Hiramatsu¹ · Ai Miyoshi¹ · Eiji Kobayashi¹ · Toshihiro Kimura¹ · Kei Hirai⁴ · Tadashi Kimura¹

Received: 15 March 2022 / Accepted: 12 August 2022 / Published online: 3 September 2022
© The Author(s) under exclusive licence to Japan Society of Clinical Oncology 2022

Abstract

Background In Japan, HPV vaccination rates has dramatically declined since 2013. Since mothers are the ones making the decision to vaccinate their daughters against HPV, we probed the mothers’ intention to receive vaccinations for themselves and to vaccinate their daughters against HPV, and their reasoning.

Methods An internet survey was conducted in March of 2021. Through the screening, 1576 participants were extracted from a survey panel and divided into 3 groups based on their daughter’s birth fiscal year (Group 1: 1994 to 1999, Group 2: 2000 to 2003, Group3: 2004 to 2008). The chi-square test and residual analysis were used for the statistical analysis of comparison among the groups. Logistic regression analysis was used to identify independent variables with mothers intention to get their daughters vaccinated under specific situations.

Results The percentage of respondents without anxiety regarding their daughter’s general vaccination was significantly higher in Group 1 ($p < 0.05$). In the mothers of daughters born in or after 2000 when vaccination rates declined (Groups 2 and 3), a situation in which ‘The daughter’s best friends were vaccinated before her’ made the mothers think positively about HPV vaccination, and to the same degree as a situation in which ‘You received a notice from your local government recommending vaccination’ (Group 2: 41.6% (214/514) and 40.5% (208/514), Group 3: 48.5% (257/530) and 47.0% (249/530)).

Conclusion If mothers who have had their daughters vaccinated were to recommend HPV vaccination to their close friends, ‘the best friend effect’ should promote others to be vaccinated.

Keywords HPV · Vaccine · Cervical cancer · Vaccine hesitancy · Japan · Internet survey · Mother · Health communication · Best friend effect

Abbreviations

HPV Human papillomavirus
FY Fiscal year

MHLW Ministry of Health, Labor, and Welfare
OR Odds ratio

Background

In 2020, an estimated 600,000 women were diagnosed worldwide with cervical cancer, accompanied by 341,000 deaths [1]. The burden of cervical cancer typically falls most heavily on women who lack proper access to health services, which is mainly those in low-and middle-income countries [2].

Japan has one of the highest Human Development Index numbers, yet its incidence of cervical cancer has been increasing since 2000, a trend not seen in any other advanced country [3]. In 2018, 10,978 women in Japan were diagnosed with cervical cancer, in 2019, some 2,921 died from it [4, 5]. The estimated age-standardised average incidence of

✉ Yutaka Ueda
ZVF03563@nifty.ne.jp

¹ Department of Obstetrics and Gynecology, Osaka University Graduate School of Medicine, 2-2, Yamadaoka, Suita, Osaka 565-0871, Japan

² Cancer Scan, 1-3-8, Nishigotanda, Shinagawa-Ku, Tokyo 141-0031, Japan

³ Center for Cancer Control and Information Services, National Cancer Center, 5-1-1, Tsukiji, Chuo-Ku, Tokyo 104-0045, Japan

⁴ Clinical Psychology, Graduate School of Human Sciences, Osaka University, 1-2, Yamadaoka, Suita, Osaka 565-0871, Japan

caercical cancer in 2018 was 13.1 per 100,000 women globally, but varied widely among countries, with rates ranging from less than 2, and up to 75, per 100,000 women [6]. Using the age-adjusted incidence rate estimated from the Global Cancer Statistics 2020, the incidence rate of cervical cancer for Japan was 15.2 per 100,000, more than twice the 6.2 rate reported for the United States [1].

Subsidies from local government programs for HPV vaccinations of girls started in Japan in 2010. By early 2013, the HPV vaccination program for girls aged 12–16 had become the national norm. But disaster loomed, the national news media began reporting alleged occurrences of a diverse set of symptoms in young girls soon after HPV vaccination. As a result, Japan's Ministry of Health, Labor, and Welfare (MHLW), out of an abundance of caution, quickly announced a 'temporary suspension' of its official recommendation for the national HPV immunization program.

Public confidence in the safety of the HPV vaccine disintegrated, and Japan's HPV vaccination rate collapsed to near zero. As a result, the HPV vaccination rates have varied greatly, depending on the girl's birth year [7]. The HPV vaccination void has persisted from 2013 until at least FY2019. In FY2020, local governments finally resumed mailing out individual notifications for vaccination availability; the vaccination rate increased slightly as a result [8], but this new rate was far from the 70%-plus rate achieved in early 2013, when HPV vaccinations for teen girls was at its highest.

Vaccine hesitancy was listed as eight on its list of the ten greatest threats to global health that WHO announced in 2019 [2]. A variety of studies reported that anti-vaccine messages receive more attention on social media platforms than pro-vaccine messages [9–12]. In Japan, public's general expectations for vaccine efficacy and their confidence vaccine safety are lower than in other countries [13, 14]. A previous study showed trust in social media as source of information, being a mother, and lower perceived risk of infection was related to higher risk of Japanese parental vaccine hesitancy for COVID-19 vaccine [15]. Despite their vaccine hesitancy, as of April 27, 2022, the percentage of the Japanese public vaccinated against COVID-19 was 81.8%, which was similar to that of other developed countries [16]. However, when it comes to HPV vaccination, surveys have found that mothers are the ones making the decision to vaccinate their daughters against HPV and most Japanese mothers would stipulate that some preconditions must be met prior to their daughters' HPV vaccination [17–20]. In addition, these previous studies indicated that 'herd phenomenon' can affect decisions regarding getting vaccinated.

In an environment where the prevailing vaccination rate has been roughly zero for a considerable number of years, factors that could encourage HPV vaccination have not been well delineated. As the information dissemination ability from various positions continues to grow, greater insight

into what messengers and messages can be shared proactively need to be better understood. It is within this context, this study was designed. The primary objective of this study was to clarify which conditions that Japanese mothers might impose prior to encouraging the vaccination of their daughter were the most critical and what might be the best way of fulfilling them.

Methods

Internet survey

An internet survey was conducted in March of 2021, more than 7 years after HMLW's suspension of its recommendation for HPV vaccination. Based on their registration information and answers from a screening survey, a representative group of participants was extracted from a large pool of consumer survey panelists. The survey panel was unbiased quality control, acquired from various media on the Web to reflect the general population by MACROMILL, INC. The information provided us included the panel member's sex, age, household income, work status, area of residence, educational level, and the presence of children. We only selected women with daughters aged 10–29 and we confirmed the fiscal year of the daughter's birth.

The selected women were divided into three groups based solely on their daughter's birth FY: Group 1: Daughters were born between FY 1994 and 1999 (the generation of girls in which the vaccination rate was about 70% as a result of widespread public subsidies and routine vaccinations); Group 2: Born between FY 2000 and 2003 (the generation in which the vaccination rate declined sharply, and in which the vaccination rate has remained at that level beyond the age of routine vaccination); Group 3: Born between FY 2004 and 2008 (the generation that was currently eligible at that time for routine vaccination but whose vaccination rate was still extremely low). If the respondents had multiple eligible daughters, only answers for the eldest were collected. Following our pre-screening survey for participant selection, we conducted our main survey. Responses were collected until each group reached over 500 respondents. The number of responders in Groups 1, 2, and 3 was 532, 514, and 530, respectively.

We asked several questions related to how the mothers gathered their health information and what concerns they had about cancer and vaccination. We probed their knowledge of cervical cancer, the mothers' intention to receive general vaccinations for themselves, and to vaccinate against HPV their daughter. Their intentions toward getting their daughters vaccinated under specific theoretical situations were analyzed, especially for the mothers of daughters born

in or after FY2000 when vaccination rates declined (Groups 2 and 3).

Statistics

We used the chi-square and residual analysis tests for our statistical analysis, which was done with MedCalc software (MedCalc Software, Ltd., Belgium). The level of statistical significance was set at $p < 0.05$. After conducting the chi-square test, we used a residual analysis to test which categories had significant proportion differences. Logistic regression analysis was conducted to identify independent variables with mothers' intention to get their daughters vaccinated under specific situations. The following factors were examined: the mother's age, work status, groups based on their daughter's birth year, anxiety about the vaccine and cancer and knowledge of cervical cancer.

Residuals analysis in cross-tabulations

The chi-square test was used as a test of independence, i.e., a test of the difference in proportions between independent samples. However, the chi-square test cannot indicate where the differences are within individual categories. Residual analysis was used to determine which categories

of proportions were significantly different after the chi-square test was performed, as a p value with the residuals standardized.

Ethical statement

This study was approved by the Institutional Review Board and the Ethics Committee of the Osaka University Medical Hospital. The research was performed in accordance with the Declaration of Helsinki and relevant guidelines. Informed consent was obtained from all participants.

Results

Study targets and participant characteristics and ways in which respondents collect information about health

The respondents' general characteristics are shown in Table 1. The median age of Groups 1, 2, and 3 was 53, 48, and 44, respectively. Group 3 had a significantly younger median age (44, $p < 0.05$) and the highest percentage of working mothers (69.2%). We compared three groups by how they collected their health information. The majority collected information through the internet, via searches,

Table 1 Responder characteristics

	Group 1 (<i>n</i> = 532)		Group 2 (<i>n</i> = 514)		Group 3 (<i>n</i> = 530)	
	<i>n</i>	(%)	<i>n</i>	(%)	<i>n</i>	(%)
Age						
< 39 years	18**↓	(3.4)	43**↓	(8.4)	118*↑	(22.3)
40–49 years	110**↓	(20.7)	309*↑	(60.1)	331*↑	(62.5)
> 50 years	404*↑	(75.9)	162**↓	(31.5)	81**↓	(15.2)
Work status						
Housewife	223*↑	(41.9)	160	(31.1)	150**↓	(28.3)
Work***	284**↓	(53.4)	332	(64.6)	367*↑	(69.2)
Other****	25	(4.7)	22	(4.3)	13**↓	(2.5)
Ways in which respondents collect information about health						
Internet search, SNS, Netnews	318**↓	(59.8)	350	(68.1)	379*↑	(71.5)
Books, magazines, newspapers	25	(4.7)	10**↓	(1.9)	21	(4.0)
TV	130*↑	(24.4)	98	(19.1)	78**↓	(14.7)
Family doctor	21*↑	(3.9)	11	(2.1)	9	(1.7)
Local government office	0	(0.0)	1	(0.2)	1	(0.2)
Friends/family	28	(5.3)	29	(5.6)	29	(5.5)
Others	10	(1.9)	15	(2.9)	13	(2.5)

*Significantly more

**Significantly less, $p < 0.05$ (chi-square test with residual analysis)

***Work (full-time), Work (part-time), Self-employed / Family business, Freelancer

**** Student, Unemployed, Other

Nominally significant threshold was set at $p < 0.05$

social networking services (SNS), and online news (Group 1: 59.8%, Group 2: 68.1%, Group 3: 71.5%). The percentage of internet users was significantly higher in Group 3 ($p < 0.05$).

Groups 2 and 3 were mothers of daughters with very low vaccination rates, and a comparison of these two groups showed that Group 3 had significantly more respondents under 39 years of age but no differences on the other questions ($p < 0.05$, Supplementary Table 1).

Cervical cancer knowledge and concerns about vaccinations and cancer

Table 2 shows a comparison of the mothers' knowledge of cervical cancer and their concerns about vaccination and cancer. In general, the percentage of respondents in Group 3 who felt anxiety regarding general vaccination for themselves (72.6%) was significantly higher than the other two groups (Group 1, 66.0%, and Group 2, 67.7%; $p < 0.05$). The percentage of respondents without anxiety regarding their daughter's general vaccination was significantly higher in Group 1 ($p < 0.05$). On the other hand, the percentage of mothers in the three groups who answered that they had anxiety regarding their daughter's general vaccination was 75.4%, 80.5%, and 81.9%, respectively, which was higher than the percentages of mothers who answered they were feeling anxiety about general vaccinations for themselves (66.0%, 67.7%, and 72.6%; $p < 0.001$, $p < 0.001$, and $p < 0.001$, respectively).

The percentage of mothers who answered that they worried that their daughters might get cervical cancer was significantly lower in Group 1 (70.3%; $p < 0.05$). The percentage of mothers who answered that they worried that their

daughters might get cervical cancer was significantly high in Group 3 (70.3%; $p < 0.05$).

The percentage of mothers who knew what ages had the highest risk of cervical cancer was significantly higher in Group 1 (57.9%) and significantly lower in Group 3 (47.5%) ($p < 0.05$, $p < 0.05$, respectively). The percentage of mothers who knew the actual rate for losing fertility in women with cervical cancer did not differ between the three groups. However, about 80% of the mothers in each group had no idea about the loss of fertility due to cervical cancer.

In comparison with the group of mothers of daughters with very low vaccination rates, a significant difference was found in the response to the question "I am worried that my daughter will get cervical cancer" (81.7%, $p = 0.02$, Supplementary Table 2).

The proportion of mothers who would think more positively about vaccination in various situations

Table 3 shows a comparison by Fisher's exact test between Groups 2 and 3 regarding mothers who would think more positively about the vaccination of their daughter under twelve hypothetical scenarios labeled A–L. Group 2 and Group 3 were mothers of the mostly un-HPV-vaccinated generation of daughters. In Group 2, at 55.6%, the percentage of mothers who would think more positively about their daughters' HPV vaccination was the highest in Situation A, where '60–80% of her daughter's classmates were vaccinated before her'. This was followed by Situation B, 'A doctor recommends the vaccination', which, at 53.5%, accounted for the majority of mothers. The responses next trended to 'Situation C: Half of the daughter's classmates were vaccinated before her', 'Situation D: The daughter's best friends were vaccinated before her', and 'Situation E: You receive

Table 2 Knowledge of cervical cancer and concerns about vaccination and cancer

Question	Answer	Group 1 (<i>n</i> = 532)		Group 2 (<i>n</i> = 514)		Group 3 (<i>n</i> = 530)	
		<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Do you feel anxiety about vaccination in general?	Yes	351	(66.0)	348	(67.7)	385*↑	(72.6)
	No	181	(34.0)	166	(32.3)	145**↓	(27.4)
Do you feel anxiety about your daughter's general vaccination?	Yes	401**↓	(75.4)	414	(80.5)	434	(81.9)
	No	131*↑	(24.6)	100	(19.5)	96	(18.1)
Are you worried that your daughter might get cervical cancer?	Yes	374**↓	(70.3)	390	(75.9)	433*↑	(81.7)
	No	158*↑	(29.7)	124	(24.1)	97**↓	(18.3)
Do you know which age group has the highest rate of cervical cancer?	Yes	308*↑	(57.9)	268	(52.1)	252**↓	(47.5)
	No	224**↓	(42.1)	246	(47.9)	278*↑	(52.5)
Do you know the rate of loss of fertility because of cervical cancer?	Yes	89	(16.7)	86	(16.7)	103	(19.4)
	No	443	(83.3)	428	(83.3)	427	(80.6)

Nominally significant threshold was set at $p < 0.05$

*Significantly more, **significantly less, $p < 0.05$ (chi-square test with residual analysis)

Table 3 Comparison of mothers who think positively about vaccination in each situation

Situation	Group 2 (n = 514)		Group 3 (n = 530)		p-value (Fisher's exact test)
	n	%	n	%	
<i>About their daughters' HPV vaccination</i>					
A. 60–80% of daughter's classmates were vaccinated before her	286	(55.6)	335	(63.2)	0.013
B. A doctor recommends vaccination	275	(53.5)	299	(56.4)	0.35
C. Half of daughter's classmates were vaccinated before her	224	(43.6)	261	(49.3)	0.07
D. Best friends of daughter's were vaccinated before her	214	(41.6)	257	(48.5)	0.029
E. Receive a notice from the local government recommending vaccination	208	(40.5)	249	(47.0)	0.069
F. 20–40% of daughter's classmates were vaccinated before her	178	(34.6)	215	(40.6)	0.055
<i>About their COVID-19 vaccination</i>					
G. 60–80% of your friends/acquaintances were vaccinated before you	362	(70.4)	388	(73.2)	0.33
H. A doctor recommends vaccination	371	(72.2)	378	(71.3)	0.78
I. Half of your friends/acquaintances were vaccinated before you	314	(61.1)	335	(63.2)	0.48
J. Your best friends were vaccinated before you	299	(58.2)	321	(60.6)	0.44
K. Receive a notice from the local government recommending vaccination	316	(61.5)	342	(64.5)	0.33
L. 20–40% of your friends/acquaintances were vaccinated before you	271	(52.7)	289	(54.5)	0.57

a notice from your local government recommending vaccination', which were all similar in the number of positive responses. There were no significant differences between Group 2 and Group 3 in the percentage of mothers who answered that they thought positively about their daughters' HPV vaccination in situations B, C, and E, nor for 'Situation F: 20–40% of your daughter's classmates were vaccinated before her' ($p = 0.069, 0.35, 0.055$ and 0.07 , respectively).

In situation A, 63.2% in Group 3 responded that they thought positively, however, only 55.6% in Group 2 ($p = 0.013$). In situation D, 48.5% of Group 3 answered that they thought positively, compared to 41.6% of Group 2 ($p = 0.029$). The percentage of positive responses was lower in Group 2 than in Group 3 for all situations.

Multivariate regression analysis for factors affecting the mothers' intention to get their daughters vaccinated under specific situations

We next examined likely factors affecting the mothers' intention to get their daughters vaccinated under the specific situations of A, B, D, and E, using logistic regression (Table 4). 'Not feeling anxiety about their daughters' general vaccination' was an independent factor for having a positive attitudes toward HPV vaccination in all the proposed situations. In declining values, the odds ratio (OR) was 2.04 (1.45–2.86) for situation E, 1.79 (1.27–2.56) for situation B, 1.97 (1.40–2.78) for situation D, and 1.55 (1.09–2.20) for situation A.

'Being worried that their daughter might get cervical cancer' was also an independent factor for having a positive attitude toward HPV vaccination. The OR was 2.18

(1.54–3.07) for situation E, 2.32 (1.67–3.22) for situation B, 2.42 (1.72–3.42) for situation D, and 2.46 (1.77–3.41) for situation A. In situations A and D, 'not being a housewife' was an independent factor for having a positive attitude toward HPV vaccination (OR: 1.35 (1.02–1.78) and 1.34 (1.02–1.77), respectively). In Group 3, being in situation A was an independent factor for having a positive attitudes toward HPV vaccination (OR: 1.35 (1.04–1.76)), whereas in situation D, only marginally significant with having a positive attitude (OR: 1.29 (0.99–1.67)).

Discussion

We have found that, under various model situations, there are specific factors, such as 'I do not have anxiety about my daughters' general vaccination' and 'I am worried that my daughter might get cervical cancer' which are independent factors for having a positive attitude toward encouraging the HPV vaccination of their daughter (Table 4). The situation in which had the most positive effect on a mother was 'The daughter's best friends were vaccinated before her', but a very similar effect was obtained by 'You received a notice from your local government recommending vaccination'. It is noteworthy that the scenario of essentially getting a 'recommendation from local government' did not sway the mothers towards becoming more positive towards vaccination any more than news of their daughter's friends already getting vaccinated. Even though the reliability of vaccine information from her best friends were subjective, and thus less objective than information from the local government, it was still more powerful at generation a positive intention.

Table 4 Multiple regression analysis for factors affecting mothers' intention to get their daughters vaccinated under each specific situation

	Receive a notice from the local government recommending vaccination (Situation E)			A doctor recommends vaccination (Situation B)			Best friends of daughter were vaccinated before her (Situation D)			60–80% of daughter's classmates were vaccinated before her (Situation A)		
	Odds ratio	95% CI	p-value*	Odds ratio	95% CI	p-value*	Odds ratio	95% CI	p-value*	Odds ratio	95% CI	p-value*
Age												
47 or younger	1	0.82	0.13	1		0.44	1		1		0.20	
48 or older	0.97	0.74–1.27		1.23	0.94–1.61		1.11	0.85–1.46		1.19	0.91–1.56	
Work status												
Housewife	1	0.06	0.20	1		0.04	1		1		0.04	
Other	1.30	0.99–1.72		1.20	0.91–1.57		1.35	1.02–1.78		1.34	1.02–1.77	
Group												
Group 2	1	0.10	0.36	1		0.06	1		1		0.02	
Group 3	1.24	0.96–1.60		1.13	0.87–1.46		1.29	0.99–1.67		1.35	1.04–1.76	
Do you feel anxiety about your daughters' general vaccination?												
Yes	1	<0.001		1	0.001		1	<0.001		1	<0.001	
No	2.04	1.45–2.86		1.79	1.27–2.56		1.97	1.40–2.78		1.55	1.09–2.20	
Are you worried that your daughter might get cervical cancer?												
No	1	<0.001		1	<0.001		1	<0.001		1	<0.001	
Yes	2.18	1.54–3.07		2.32	1.67–3.22		2.42	1.72–3.42		2.46	1.77–3.41	
Do you know which age group has the highest rate of cervical cancer?												
No	1	0.43	0.88	1		0.10	1		1		0.24	
Yes	0.90	0.71–1.16		1.02	0.79–1.31		0.81	0.63–1.04		0.86	0.67–1.11	
Do you know the rate of loss of fertility because of cervical cancer?												
No	1	0.07	0.13	1		0.17	1		1		0.88	
Yes	1.35	0.98–1.86		1.28	0.93–1.78		1.25	0.91–1.73		1.03	0.74–1.43	

* Logistic regression analysis

We assume that this ‘best friend effect’ is due to ‘herd behavior’, referring to the characteristic action of people who tend to make their decisions based mostly on the behavior of their colleagues, neighbors, or others [21]. In this model of behavior, the ‘best friend nudge’ is processed by Decision Making System 1, which is intuitive and emotional in nature, and makes ‘quick’ decisions. This effect is not a conscious change by the mother, it is an irrational decision responding to the influence of the behavior of her daughter’s closest friends [14]. The current low HPV vaccination rate in Japan is having a very strong and undesirable negative impact on the ‘herd behavior’ of Japanese society. However, even under such dire negative circumstances, ‘herd behavior toward neighbors’ can also be used to reverse previous negative effects. We have found two other factors that play into the vaccination decision making process, which may be useful to exploit. A mother ‘not having anxiety about vaccinating their daughter’ and ‘worrying that their daughter might get cervical cancer’ were both positive factors toward thinking positively about HPV vaccination. Reducing stress about potential adverse outcomes from being vaccinated, while increasing justified concerns regarding poor outcomes from not being vaccinated, like loss of fertility and death from cervical cancer, by providing timely and reliable information, can be effective tools positive reinforcement.

To promote HPV vaccination in Japan, where confidence in general vaccines is low and HPV vaccine hesitancy is high, it is necessary for all medical professionals to explore more effective measures for increasing the public’s acceptance of the HPV vaccine [22]. We must address the target population of young girls, but also, more importantly, the thinking of their parents. In our study, mothers belonging to Group 3, with a daughter born between FY 2004 and 2008 (i.e., the generation of teen girls that is currently eligible for routine vaccination, but whose vaccination rate is still extremely low) was an independent factor for a positive attitude toward HPV vaccination in situations where HPV vaccination might again become a widespread social norm. Providing a recommendation for HPV vaccination using ‘the best friend effect’ as the source of the positive influence should be effective for Group 3 mothers. It has been reported that receiving an email from a friend with the title, ‘You should get the flu vaccine’, significantly increased the likelihood of opening the email, when compared to receiving the same email from non-friends [23].

The present study, we found that the percentage of the mothers who thought the most positively about their daughters’ HPV vaccination was the highest in response to ‘Situation A: Where 60–80% of her daughter’s classmates were vaccinated before her’. This effect was greatest among the mothers Group 2 and three mothers, i.e., the mothers of the generation of ‘un-HPV-vaccinated

daughters’. That condition was due to the 2013 suspension of the government’s recommendation of the HPV vaccine. Our study also revealed that, in 50% of the community ‘the best friend effect’ is equivalent to ‘herd behavior’ (Table 3).

One of the limitations of our study is that we stratified the mothers into groups based on the birth FY of the daughters, so the average age of the mothers was unavoidably significantly different in each group. This also resulted in significant differences in certain aspects of their backgrounds, such as their work status. The daughters of the Group 2 mothers were already over the maximum eligibility age of 16 for the free national HPV immunization program. Second, the respondents were mothers previously enrolled in the consumer panel, so they were not random; therefore, generalizing the present results may be problematic. Third, respondents’ daughters’ vaccination histories were not collected.

In October of 2020, the MHLW revised its public information leaflet for the HPV vaccine, and they advised all local governments of the proven effectiveness of providing an individual notification to girls in the targeted age-range [24]. In Japan, we have now shown that positive peer education is going to be essential to overcome the cascade of negative social pressures that have accumulated against HPV vaccination [25].

The governmental recommendation for HPV vaccination resumed in April 2022. Importantly, a government-directed program for ‘catch-up vaccinations’ for those girls in the ‘vaccination gap’ who have now exceeded the normal target age for free vaccinations, has begun. If mothers who have already had their daughters vaccinated can be persuaded to recommend HPV vaccination to their close friends, the ‘best friend effect’ will spread the good news among other mothers. If HPV vaccination can once again become a social norm, ‘social herd behavior’ may encourage further vaccination improvements.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10147-022-02240-7>.

Acknowledgements We would like to thank Dr. G. S. Buzard for his constructive critique and editing of our manuscript.

Funding A grant (#21ck0106562h0002) from the Japan Agency for Medical Research and Development (AMED).

Declarations

Conflict of interest A.Y. received a lecture fee from Merck Sharp & Dohme. Y.U. received lecture fees from GlaxoSmithKline/Japan Vaccine and Merck Sharp & Dohme. T.K. received research funds and grants from Merck Sharp & Dohme.

Ethical approval This study was approved by the Osaka University Medical Hospital.

References

1. Ferlay J, Ervik M, Lam F, et al (2020) Global cancer observatory: cancer today. Lyon, France: International Agency for Research on Cancer. <https://gco.iarc.fr/today>. Accessed 25 Sept 2021
2. World Health Organization, Cervical Cancer Elimination Initiative. <https://www.who.int/initiatives/cervical-cancer-elimination-initiative>. Accessed 25 Sept 2021
3. Yagi A, Ueda Y, Kakuda M et al (2019) Epidemiologic and clinical analysis of cervical cancer using data from the population-based Osaka Cancer Registry. *Cancer Res* 79:1252–1259
4. Cancer incidence. Cancer Statistics. Cancer Information Service, National Cancer Center, Japan (National Cancer Registry, Ministry of Health, Labour and Welfare). https://ganjoho.jp/reg_stat/statistics/data/dl/index.html#a14. Accessed 25 Sept 2021.
5. Cancer mortality. Cancer Statistics. Cancer Information Service, National Cancer Center, Japan (National Cancer Registry, Ministry of Health, Labour and Welfare). https://ganjoho.jp/reg_stat/statistics/data/dl/index.html#a7. Accessed 25 Sept 2021
6. Arbyn M, Weiderpass E, Bruni L et al (2020) Estimates of incidence and mortality of cervical cancer in 2018: a worldwide analysis. *Lancet Glob Health* 8:e191–e203
7. Nakagawa S, Ueda Y, Yagi A et al (2020) Corrected human papillomavirus vaccination rates for each birth fiscal year in Japan. *Cancer Sci* 111:2156–2162
8. Ujiie M, Kitano T, Tsuzuki S (2022) Changing trends in HPV vaccination in Japan. *Hum Vaccin Immunother* 18(1):1–3. <https://doi.org/10.1080/21645515.2021.1986333>
9. Kearney MD, Selvan P, Hauer MK et al (2019) Characterizing HPV vaccine sentiments and content on Instagram. *Health Educ Behav* 46(2S):37–48
10. Chen T, Dredze M (2018) Vaccine images on Twitter: analysis of what images are shared. *J Med Internet Res* 20:e130
11. Song M-Y-J, Gruzd A (2017) Examining sentiments and popularity of pro- and anti-vaccination videos on YouTube. Proceedings of the 8th international conference on social media & society (Article 17). New York, NY: ACM
12. Blankenship EB (2018) Sentiment, contents, and retweets: a study of two vaccine-related twitter datasets. *Permanente J* 22:17–138
13. de Figueiredo A, Simas C, Karafillakis E et al (2020) Mapping global trends in vaccine confidence and investigating barriers to vaccine uptake: a large-scale retrospective temporal modelling study. *Lancet* 396:898–908
14. Piedrahita-Valdés H, Piedrahita-Castillo D, Bermejo-Higuera J et al (2021) Vaccine hesitancy on social media: sentiment analysis from June 2011 to April 2019. *Vaccines (Basel)* 9:28
15. Our World in Data. <https://ourworldindata.org/covid-vaccinations>. Accessed 25 Sept 2021
16. Horiuchi S, Sakamoto H, Abe SK et al (2021) Factors of parental COVID-19 vaccine hesitancy: a cross sectional study in Japan. *PLoS ONE* 16:e0261121
17. Egawa-Takata T, Ueda Y, Morimoto A et al (2015) Survey of Japanese mothers of daughters eligible for human papillomavirus vaccination on attitudes about media reports of adverse events and the suspension of governmental recommendation for vaccination. *J Obstet Gynaecol Res* 41:1965–1971
18. Yagi A, Ueda Y, Egawa-Takata T et al (2016) Development of an efficient strategy to improve HPV immunization coverage in Japan. *BMC Public Health* 16:1013
19. Yagi A, Ueda Y, Tanaka Y et al (2018) Time-dependent changes of the intention of mothers in Japan to inoculate their daughters with the HPV vaccine after suspension of governmental recommendation. *Hum Vaccin Immunother* 14:2497–2502
20. Yagi A, Ueda Y, Masuda T et al (2020) Japanese mothers' intention to HPV vaccinate their daughters: how has it changed over time because of the prolonged suspension of the governmental recommendation? *Vaccines (Basel)* 8:502
21. Kahneman D (2012) *Thinking, fast and slow*. Penguin, New York
22. Okuhara T, Ishikawa H, Okada H et al (2020) Dual-process theories to counter the anti-vaccination movement. *Prev Med Rep* 20:101205
23. Thaler RH, Sunstein CR (2009) *Nudge: improving decisions about health, wealth, and happiness*. Penguin, New York
24. Miyoshi A, Ueda Y, Yagi A et al (2022) Challenge to improve Japan's deplorable HPV vaccination rate by local government actions. *J Obstet Gynaecol Res* 48:1233–1239
25. Ueda Y, Katayama K, Yagi A et al (2021) The chasm we must cross in Japan for re-promotion of the HPV vaccine. *Cancer Prev Res (Phila)* 14:683–686

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.