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The Evaluation of human papillomavirus vaccination coverage for school aged girls in Badung District, Bali, Indonesia, 2016 – 2018

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ABSTRACT

Background and purpose: Since 2016, Badung District, Bali has implemented a free HPV vaccination program for school children, with vaccination coverage reported to be over 90% in 2016-2018. This study aims to objectively assess the coverage of HPV vaccination among school children in Badung District.

Methods: This survey used a cross-sectional design that conducted between March and June 2019. Sample selection was done by systematic random sampling, following the WHO guidelines. A total of 216 families met the sample criteria, with a total of 249 children from all families. Respondents in this study were eligible girls' mothers or families who knew the child's vaccination history. Variables of this study were sociodemographic characteristics of respondents and children, HPV vaccination recall and HPV child vaccination validation. The data collected were analyzed descriptively to calculate the coverage of recall and validation of HPV vaccination.

Results: The majority of respondents were mothers (70.83%) with a high school education (51.85%). The median age was 43 years (IQR=8 years). Each family had a mean of 1.15 eligible children (SD=0.39). Of the 249 children, most were aged 16-19 years (43.37%), with age at vaccination mostly ≤12 years (46.52%). HPV vaccination coverage by recall was 82.32% (95%CI: 77.56-87.09), with HPV vaccination coverage by validation was 76.59% (95%CI: 70.74-82.43).

Conclusion: After validation, vaccination coverage was lower than vaccination coverage by recall. The health office needs to improve the vaccination registration system, in particular the uniformity of registration and record keeping to ensure proper traceability of vaccination history.

Keywords: human papillomavirus, vaccination coverage, school aged children

INTRODUCTION

The 2020 global estimate of new cervical cancer case was at the fourth highest of new cases of all cancers in women, with 604 thousand cases, accounted for 3.4%. The number of mortality was 341 thousand or 3.1% of all cancer deaths among women.[1,2] The Asian region accounts for about 58% of new cases and mortality from cervical cancer, with 351 thousand new cases and 199 thousand mortality.[1] In 2018, the number of new cervical cancer cases reached 32,000 people, 10.7% of total cancer incidence, with 18,000 deaths, 10.3% of total cancer mortality.[3] The age standardized rate (ASR) of cervical cancer incidence in Indonesia was 23.4 per 100,000 populations, with 13.9 mortality per 100,000. This was higher than the global rate of 13.1 per 100,000 and 6.9 per 100,000 respectively.[3,4]

Cervical cancer mortality usually occur during the productive years,[5] when mothers are raising children and contributing to the socio-economic life of the family. The mortality should be preventable if the cancer was detected and treated at early stage. In 2006, WHO introduced human papilloma virus (HPV) vaccination at the age of 9-13 years when women are not yet at risk of sexually active behavior, and also early detection at the age of 30-49 years.[6] Based on the Minister of Health of the Republic of Indonesia Regulation Number 34/2015, the national program for cervical cancer prevention efforts is limited to early detection of cervical cancer using the visual inspection of acetic acid (VIA) or pap smear method.[7] Then, the vaccination was introduced gradually from 2016.[8]

HPV vaccination is a specific form of protection against cervical cancer that is administered before infection and has an effective protection rate up to 70% against HPV type 16 and 18 infections.[9,10] In a systematic review and meta-analysis, it was described that the prevalence of HPV types 16 and 18 cases was reduced by up to 83% in women aged 13-19 years and by 66% in those aged 20-24 years after 5-8 years of vaccination.[11] Meanwhile, a study of cost-effectiveness of HPV vaccination policy in Indonesia found that vaccinating nearly 2.3 million girls aged 10 years, 34,723 with quadrivalent, 43,414 with bivalent, and 51,522 with nonvalent could be an effective strategy to prevent cervical cancer.[12]

Previous studies showed varied result of HPV vaccination coverage and awareness toward the vaccine. A systematic review conducted by Loke et al of 28 studies between 2006 and 2015 showed that HPV vaccination coverage for at least one shot varied from 2.4% to 94.4%. The lowest coverage was in Hong Kong at 2.4-9.1% and the highest in Scotland at 94.4%. This study also showed low awareness and knowledge of HPV infection and vaccination, although the vaccine has been available for 10 years.[13]

A meta-analysis of 58 studies in China also found that awareness and knowledge of the HPV vaccine were only 15.9% and 17.5%, respectively. Reasons for not vaccinating were associated with perceived vaccine safety and effectiveness (68.2%).[14]

The implementation of HPV vaccination has been included in the flagship program of the Badung District Health Office since 2012. The vaccination is provided free of charge to women of childbearing age. This program initially targeted women who worked as civil servants and since 2016, the implementation of HPV vaccination in Badung District expanded to school children in which carried out by public health centres (*puskesmas*).

According to the Badung District Health Office, coverage of the first dose of HPV vaccination in 2016 was 98% among junior high school students and 96% among high school students. In 2017, the coverage decreased to 97% among junior high school students and 93% among senior high school students, while coverage among primary school students reached 93%.[15] Although the coverage rate was over 90%, the initial high school vaccination campaign did not include private high schools, hence the calculation of school-based coverage may not reflect the coverage of all targeted school-age children in Badung District.

During these years, internal monitoring activities have been carried out by the health office at all public health centres implementing vaccination in Badung District. However, an output evaluation related to vaccination coverage has never been conducted. Therefore, a community-based vaccination coverage survey was conducted to more accurately estimate HPV vaccination coverage.[16-18] This calculation can be used to determine the level of herd immunity in the community, and also to compare the gap between program data and actual results, so it will help the district health office and policy makers to improve program achievements by setting more accurate program targets with more appropriate coverage calculations. This study aims to objectively assess the coverage of HPV vaccination among school children in Badung District.

METHOD

This survey used a cross-sectional design where data collection was conducted from March to June 2019. The population unit of this survey was families in Badung District. Since 2016, the implementation of HPV vaccination in Badung District was carried out among middle and high school students, while in 2017 and 2018, vaccination was carried out among students aged 11 years and older, namely primary school grades 5 and 6, junior high school and senior high school. The vaccine used was the quadrivalent type, Gardasil. Children under 13 years of age received 2 doses of the vaccine, while those 13 years and older received 3 doses.

The sample size calculation used the formula of the 2018 WHO vaccination coverage evaluation guideline[17] which included the vaccination coverage indicator of 95%, precision=5%, alpha=5%, target respondents per cluster=5, intra-cluster correlation coefficient (ICC)=0.13, average number of houses visited to find 1 eligible subject=5, response rate=90% and non-response inflation factor=1.11. From this indicator, a sample of 50 clusters with 28 families for each cluster was obtained.

The cluster in this study was the *banjar*, which is the smallest administrative unit in the Balinese community. The sampling was started by randomly selecting 50 *banjar* from all the *banjars* in Badung District. Then 28 families from each *banjar* were selected from the list of families owned by the *Kelian* (head) of the *banjar*. The selection of *banjars* and families was done using systematic random sampling techniques. Families with eligible children were those with children aged 12-19 years at the time of data collection, based on the calculation of the vaccination implementation plan for three years (2016-2018). The respondent was the mother of the eligible child or, if the mother was unavailable, the father or other relative aged 17 years or older with knowledge of the child's condition.

A total of 1400 households (28 households times 50 *banjars*) were visited by enumerators. Of which 226 households had eligible children (16.14%) and 10 households refused to be interviewed or could not be found (response rate=95.58%).

Data were collected from the selected families which had eligible children using questionnaires that had

been prepared based on the variables studied, namely the socio-demographics of respondents (age, sex, education, occupation, relationship with children, family income, number of children in the family and the number of eligible children for this survey) and children (age, age at vaccination, current education, and child order), as well as the vaccination history of children (number/completeness, date, location, and card of vaccination). Data collection was conducted by trained enumerators.

Validation of vaccination data was carried out by the field coordinator by comparing the data from the interview with evidence of vaccination in the form of vaccination cards and vaccination registers held by the *puskesmas* and Badung District Health Office. Vaccination validation was carried out by checking the data in the register in terms of the child's name, date of vaccination, place of vaccination and the signature of the official, teacher or child concerned. If any data was missing, the school and health centre were notified. If at least 2 data were missing or if the vaccination card does not exist, the data could not be found in the registry, it was included in the invalid criteria.

Validated vaccination coverage was calculated using the numerator of validly vaccinated children and the total number of eligible children. The calculation of vaccination coverage data both by recall and validation was weighted to take into account the sampling technique, the number of households with eligible children from the selected households, and the household response rate. Data were analysed descriptively and presented as frequencies and proportions (with 95% confidence intervals).

This study has received ethical approval from the Ethics Committee of the Prof. dr. IGNG Ngoerah Central General Hospital/ Faculty of Medicine, Udayana University with number: 1142/UN14.2.2.VII.14/LP/2019 dated 23 April 2019.

RESULT

Of the 216 families interviewed, 249 children were eligible for further analysis. Most of the respondents were mothers (70.83%), then fathers (16.20%), so it can be seen that most of the respondents were female (78.24%). The majority of respondents' education was high school with a median age of 43 years (IQR=8 years) and almost all respondents were Hindu (94.91%). The most common occupation was housewife (32.41%), followed by private employee (18.06%) and self-employed (15.28%).

In terms of family income, the median was IDR 2,000,000 (IQR 2,500,000), which is still below the regional minimum wage in Badung District (IDR 2,700,297 in 2019). Each household has a mean of 2.59 living children (SD=0.81) and a mean of 1.15 eligible children (SD=0.39). Of the 216 households that responded to the survey, 249 eligible children were recorded.

Of the 249 children, most were currently aged 16-19 years (43.37%), with the age at vaccination mostly ≤12 years (46.52%). Children's current education was mostly in junior high school (35.34%) and senior high school (32.13%). The majority of children were the first and second child (39.36% and 40.96%). Detailed characteristics of eligible children can be seen in Table 2.

Table 3 shows the results of HPV vaccination coverage in Badung District based on respondent recall and validation of vaccination records. Of the total 249 eligible children, 205 were vaccinated against HPV (82.32%; 95%CI: 77.56-87.09). First vaccination coverage was 80.72% (95%CI: 75.79-85.66), second vaccination

68.27% (95%CI: 62.45-74.09) and third vaccination 61.05% (95%CI: 55.77-67.92). The completeness of vaccination was 77.07%.

Based on the respondents' recall, the vaccination coverage for 2016 was 69.77%, while the coverage for 2017 and 2018 was 95.79% and 92.94%, respectively. As for the coverage based on school level, the primary school coverage was 78.46%, the secondary school coverage was 81.03% and the high school coverage was 88.23%. From the calculation results, it was found that the validated coverage was generally lower than the coverage by recall, Badung District's coverage by validation was 60.39%. Further details are shown in Table 3 below.

Table 1. Socio-demographic characteristics of respondents evaluating HPV vaccination coverage in Badung District, 2019

Characteristics		n	%
Age (years)	Median (IQR)	43 (8)	
	Minimum - Maximum	16-73	
Sex	Female	169	78.24
	Male	47	21.76
Education	Elementary School	32	14.81
	Junior High School	39	18.06
	Senior High School	112	51.85
	Diploma	12	5.56
	Bachelor	21	9.72
Occupation	Housewife	70	32.41
	Civil Servants	19	8.80
	Private Employed	39	18.06
	Self Employed	33	15.28
	Farmer	16	7.41
	Others	39	18.06
Relationship with children	Mother	153	70.83
	Father	35	16.20
	Grandparents	3	1.39
	Others	25	11.57
Family Income (million IDR)	Median (IQR)	2 (2.5)	
No of Children in the Family	Mean (SD)	2.59 (0.81)	
No of Eligible Children	Mean (SD)	1.15 (0.39)	

Table 2. demographic characteristics of eligible children in the evaluation of HPV vaccination coverage in Badung District, 2019

Variables		f (n=249)	%
Age (years)	10-12	47	18.88
	13-15	94	37.75
	16-19	108	43.37
Age at vaccination (years)	≤12	107	46.52
	13-15	84	36.52
	16-19	39	16.96
Current education	Elementary School	54	21.69
	Junior High School	88	35.34
	Senior High School	80	32.13
	Diploma/Bachelor	15	6.02
	Working/not continuing school	12	4.82
Child order	First	98	39.36
	Second	102	40.96
	Third and so on	49	19.68

Table 3. HPV vaccination coverage by recall and validation in Badung District 2019

	Eligible Children	Vaccinated Children (recall)	Vaccination Coverage (by recall)			Valid Vaccinated	Vaccination Coverage (validation)			Coverage Difference (%)
			%	95%CI			%	95%CI		
				lower	upper			lower	upper	
Badung District	249	205	83.58	77.96	89.19	157	60.39	52.56	68.23	27.75
First Vaccination	249	201	82.39	76.66	88.11	157	60.39	52.56	68.23	26.70
Second Vaccination	249	170	68.78	61.38	76.17	133	52.32	44.44	60.19	23.93
Third Vaccination	95	58	65.82	55.19	76.44	38	39.27	28.00	50.54	40.34
Complete Vaccination	205	158	77.41	69.54	85.28	114	67.24	58.17	76.31	13.14
Year of First Vaccination*										
2016	43	30	73.37	57.79	88.96	19	42.00	19.60	64.41	42.76
2017	95	91	93.50	84.34	102.66	75	64.79	46.07	83.52	30.71
2018	85	79	95.08	90.52	99.65	62	69.49	53.99	84.99	26.91
School when vaccination										
Elementary School	65	51	75.66	55.26	96.05	41	42.38	22.34	62.43	43.99
Junior High School	116	94	80.72	71.24	90.19	66	54.19	41.00	67.39	32.87
Senior High School	68	60	95.76	91.63	99.89	50	73.94	56.23	91.66	22.79

*for respondents who answered vaccination year below 2016 was not analyzed

There were 44 children who did not received the HPV vaccination. The main reason was schooling outside the Badung District area (40.91%), followed by being absence during the vaccination schedules at school (34.09%), attending private schools (22.73%) and children were not enrolled to school (2.27%).

Table 4 showed the characteristics of the invalid data, with 17.67% invalid for the first dose, 14.86% for the second dose, 21.04% for the third dose and 28.29% for the full dose. Most of the invalid data were because the child's details were not available in the register, which was around 95%. Other issues that influence the validation process were inconsistent registration forms, different student names, no data on children who received supplementary vaccination or sweeping, and not all vaccinated children have their vaccination card during the visit.

Table 4. Characteristics of invalid data by number of vaccinations

Number of Eligible Children	First Vaccination		Second Vaccination		Third Vaccination		Complete Vaccination	
	f	%	f	%	f	%	f	%
	n=249		n=249		n=95		n=205	
Invalid Data	44	17.67	37	14.86	20	21.05	58	28.29
Data is not in the register	42	95.45	35	94.59	19	95.00	55	94.83
Incomplete/Un-synchronized child' name	2	4.55	2	5.41	0	0	2	3.45
Date data is missing	0	0	0	0	1	5.00	1	1.72

DISCUSSION

The overall vaccination coverage from this survey was found to be lower than the HPV vaccination program data in Badung District, although the coverage from the 2017 and 2018 recall data was close to the program coverage results. The difference in results is due to the different approach in calculating vaccination coverage, with the program calculation based on the target number of school children, while the coverage assessment is based on children in the general community. The same phenomenon was observed in a Cambodian study, where community-based survey results reported 85% coverage, but administrative records reported HPV vaccination coverage of 98%.[15,18]

Vaccination coverage serves as a critical metric for evaluating program effectiveness. Measurement methods include registries, administrative reports, and community-based surveys, with the latter generally considered more reliable due to potential inaccuracies in administrative data. National surveys typically provide immunization coverage data every 3-5 years, adhering to rigorous statistical and field protocols to mitigate bias. Alternative methods like health facility assessments offer practical insights into service delivery, costs, and data quality. While administrative reports enable real-time monitoring and prompt intervention, enhancing their accuracy remains pivotal. Ultimately, effective use of collected data is essential for optimizing program performance.[19,20]

WHO recommend HPV vaccination for girls aged 9-13 years. To reach them, approaches can be made through health facilities, schools or direct outreach. In this case, the Badung District Health Office is using a school-based approach to reach girls aged 9-13 years. So far, program activities have only targeted public schools and have not yet covered private schools, starting with high schools and junior high schools in 2016, then primary schools in 2017, and it is planned to continue vaccinating only in primary schools.[15,19] While this survey used a targeted approach in the general population in accordance with WHO guidelines for vaccination coverage assessment. This difference in results, where the evaluation results were lower, may occur because the survey found that there were children who did not receive HPV vaccination (17.67%) because they attended schools outside Badung District, there was no school schedule, or they attended private schools.

This survey used a cross-sectional design, which assessed HPV vaccination coverage for 3 years (2016-2018). This may introduce bias, as respondents were required to recall vaccination uptake in the previous 3 years. Respondents were most likely to be mothers who were at home and knowledgeable about childhood vaccination, but if mothers were not at home, they could be replaced by other family members (e.g. fathers, grandparents). This could introduce bias as they may not have a clear understanding of how HPV vaccination was administered to their child. This could have been minimised by conducting another telephone interview to determine the actual situation during the vaccination.

Comparison between vaccination coverage by recall and validation methods shows that validation typically yields lower coverage estimates across various metrics, ranging from 13.14% to 43.99%. Despite WHO recommendations favoring registry data for validation to reduce recall bias, this study observed the opposite effect. Discrepancies in coverage estimates could stem from differences in data formats among stakeholders, along with missing and unsynchronized data between health offices and schools, complicating the validation process. Accurate measurement of immunization coverage is crucial for public health, necessitating improvements in primary vaccination data recording, such as enhancing household records and health service documentation by using digital record and GPS based surveillance.[20-22]

In general, HPV vaccination coverage in Badung District is good but needs to be improved as it is still below 90%. The vaccination program in Badung District uses an outreach approach through schools, as is done in several countries around the world,[23] except that this program has not yet targeted private schools. Expanding outreach to private schools is necessary to increase the percentage of HPV vaccination coverage in Badung District. Outreach through schools is very good, but attention needs to be paid to the social and organizational context in addition to the individual context.[20]

The social and organizational contexts could include good collaboration with the education office in both planning and implementation, community engagement through public health centers and other health services to track and reach children who do not attend school or who attend school outside the Badung area, a vaccination schedule that is aligned with the school year to facilitate outreach to all schools and the community, and the use of detailed vaccination registries that can help solve the problem of tracking non-immunized children.[21,22]

Several weaknesses were identified in this study. The survey employed systematic random sampling to select *banjar* clusters and households based on WHO guidelines, but potential bias could arise if the sampling frame lacks accuracy, particularly concerning household lists in selected areas (*banjar*). Changes in population or administrative discrepancies between health centers and *banjar* over the past three years could also introduce

bias. To mitigate these issues, accurate sampling frame data is crucial in coverage surveys to prevent selection bias, although a 4.42% non-response rate was addressed through weighted analysis. Additionally, caregiver interviews may introduce recall bias regarding the child's vaccination history. Lastly, challenges with paper-based vaccination registers, including inconsistent formats and missing data, complicated the validation of HPV vaccination statuses. To improve survey accuracy and HPV vaccination coverage in Badung district, strategies could focus on enhancing reporting systems with digital solutions, expanding school-based vaccination efforts, reaching out to children outside school settings, and implementing real-time monitoring using mobile technology and GPS.

CONCLUSION

HPV vaccination coverage by recall in Badung District was 82.32% (95%CI: 77-76-87.09%), while HPV vaccination coverage by validation was 63.05% (95%CI: 57.02-69.09%). In general, vaccination coverage by validation is lower than vaccination coverage by recall and based on program coverage data from the Badung District Health Office.

The Badung District Health Office needs to improve the vaccination registration system and the cleanliness of the report files. Vaccination coverage can be improved through good cooperation with the Education Office in planning and implementation, especially the vaccination schedule and registration system, as well as outreach to children who do not attend school or who attend school outside the Badung area.

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AUTHOR CONTRIBUTION

PCDY and AASG contributed from conception and design, acquisition of data, analysis and interpretation of data, until drafting the manuscript. IGAAN, MW and NKE contributes in acquisition of data, analysis and interpretation of data and drafting the manuscript. INS contributes in drafting the manuscript and revising it critically for important intellectual content.

CONFLICT OF INTEREST

There is no any potential conflict of interest occurred in the study or this manuscript.

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