ORIGINAL ARTICLE

Measles in Selangor: A Comparative Analysis Between Adults and Children Using the E-Measles Registry, 2015-2024

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ABSTRACT

Introduction: Measles remains a persistent public health concern in Malaysia. Despite sustained high vaccination coverage in states such as Selangor, reported cases continue to increase. This trend suggests a possible shifting age-distribution of measles, a pattern that has been observed in countries with a high vaccination rate. Understanding the epidemiology and clinical characteristics of measles between adults and children is critical in guiding targeted public health interventions aimed at control and elimination of measles. This study aimed to describe the incidence of measles in adults and children in Selangor, and to compare their sociodemographic, clinical, vaccine, and exposure-related differences.

Materials and Methods: This comparative cross-sectional study used secondary data from the Selangor e-Measles Registry from 2015 to 2024. Confirmed cases were classified as adults (≥18 years) and children (<18 years). The incidence of each group was calculated annually over ten years. Descriptive statistics, chi-square test, Fisher's exact test, and Mann-Whitney U test were used to describe and compare the differences between the two groups. Data were analysed using SPSS version 29.

Results: A total of 3954 confirmed measles cases were included in the study, with 540 (13.7%) adult cases and 3414 (86.3%) cases in children. Between 2015 and 2024, the incidence of measles was consistently higher in children as compared to adults, with risk ratios ranging from 14.43 (95% CI: 11.25, 18.73) in 2017 to 87.65 (95% CI: 27.39, 278.66) in 2022. With the exception of 2019-2022, adults showed a gradual increase in number over the study period, with the highest proportion in 2023 (16.4%). Significant differences between adults and children were observed (p<0.05) according to nationality, ethnicity, clinical symptoms, hospitalisation, complications, vaccination status, and duration since the last vaccination.

Discussion: The findings suggest that despite the increase in adult cases, measles predominantly affects children in Selangor. The findings highlight the need to strengthen vaccination efforts through the National Immunisation Programme (NIP) and prioritising Supplementary Immunisation Activities (SIAs) among children aged below 6 years old. Additionally, the gradual rise in cases in adults and children aged 7-12 years old should be monitored closely to detect emerging epidemiological shifts. Significant clinical differences between adults and children highlight the need for training of healthcare providers and public education to support diagnosis, prevent outbreaks, and avoid complications. Digitalisation of health records, such as the documentation of vaccination history, is needed. Conclusion: Measles in Selangor showed age-specific trends and differences. Addressing these issues through strengthened childhood immunisation, targeted interventions and continuous surveillance is essential to achieve measles control and elimination in Selangor and Malaysia.

KEYWORDS:
Measles, Adult, Children, Comparative analysis, Registry

INTRODUCTION

Measles is a highly contagious viral disease with an estimated basic reproductive number (R_0) of 9-18, one of the highest for direct transmission. R_0 reflects the average number of secondary cases that can occur on the introduction of an infectious person to a susceptible population.[1] Prior to the introduction of the measles vaccine in 1963, an estimated 2.6 million measles deaths occurred each year globally.[2] With the increased coverage of vaccination worldwide, a 73% decrease in measles deaths was observed between 2000 and 2018.[3] The availability of a safe and effective vaccine, absence of animal reservoirs, and readily diagnosable clinical symptoms make it a suitable disease for global eradication, with all World Health Organization (WHO) regions committing to measles elimination.[4]

In the Western Pacific Region (WPR), Singapore, Brunei, Australia, Japan, Korea, New Zealand, Macao, and Hong Kong have achieved Measles Elimination as early as 2014. Despite the global measles resurgence in 2018-2019, they managed to maintain a measles incidence of <1 per million population from 2021 to 2023, which is the target for elimination.[5] This contrasts with Malaysia, which, although committed to measles elimination since 2004 and maintains high immunisation coverage, reported an increase in the trend of confirmed measles from 3.8 to 58.7 per million population between 2021 and 2023, the highest in the WPR

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in 2023.[6] Selangor, the most populous state in Malaysia, undoubtedly contributed to this burden, reporting 70.9 cases per million population in 2023 despite maintaining vaccination coverage above 95%.[7]

This paradox between the high coverage but rising incidence raises concerns about a shifting epidemiology to involve more adults. This has been observed in countries like China, where adults aged 26 to 45 years became one of the primary sources of measles after the implementation of their nationwide SIAs.[8] In Spain, 68.9% of cases were aged >20 years.[9] This shift has raised important questions about the clinical presentation, severity, and outcomes of measles among adults and whether they differ from those in children. Several studies have demonstrated that adults are more likely to be hospitalised and develop complications. For instance, a study in France reported higher hospitalisation rates and increased diarrhoea with dehydration compared to children.[10] However, most of these studies were hospital-based and focused on clinical outcomes, often neglecting broader sociodemographic, vaccine, and exposure-related variables of interest.

In Malaysia, research and interventions have mostly targeted children. A recent study suggest that older age is associated with higher odds of contracting measles.[11] This is concerning because measles is commonly perceived as a disease affecting children. Clinicians may not suspect it in adult patients who initially present with fever and cough. A delay in diagnosis leads to late isolation, inappropriate treatment, and an increased risk of complications.[12] Adults may also unknowingly serve as index cases during outbreaks, as reported in an outbreak in Sweden.[13]

Although global reports have highlighted a shift in measles epidemiology toward adults in countries with high vaccination coverage, such a trend has not been formally documented in Malaysia. Given the lack of local data comparing adult and child measles cases at the population level, this study's primary objective was to describe the age-specific trend of measles' incidence in Selangor from 2015-2024, using secondary data from Selangor's e-Measles Registry. The second objective was to describe and determine whether significant sociodemographic, clinical, exposure, and vaccine-related differences existed between adults and children with measles in Selangor.

MATERIALS AND METHODS

Study Design

This comparative cross-sectional study was designed to compare sociodemographic, clinical-related, exposure-related, and vaccine-related aspects of measles in adults and children in Selangor from to 2015-2024 using secondary data from the e-Measles Registry.

Study Area

This study was conducted in Selangor, Malaysia. Selangor has a total population of 7.4 million in 2024, the highest in Malaysia.14 For the purpose of monitoring diseases and health programmes, the Selangor State Health Department has divided the districts into large districts (Petaling, Hulu Langat, Klang and Gombak) and small districts (Sepang, Hulu Selangor, Kuala Langat, Kuala Selangor and Sabak Bernam) based on the total population, with large districts having a population of >900,000 people.[14]

Study Population, Sample and Data Source

This study included two study populations. The first population comprised all confirmed cases of adults (aged ≥18 years) with measles in Selangor, and the second population comprised all confirmed cases of children (aged <18 years) with measles in Selangor. Samples for each population were obtained from the Selangor e-Measles Registry from 2015 to 2024. A confirmed case is defined as any "laboratory-confirmed case detected by the presence of measles-specific IgM antibodies or measles virus in clinical samples",[15] or that is "clinically compatible with measles with an epidemiological link to a confirmed case",[15] or "clinically compatible without an epidemiological link or lab confirmation but was decided to be registered by the Expert Review Committee".[16] All confirmed measles cases from the e-Measles Registry Selangor from 2015-2024 of all nationalities were included in the sample. The sample excluded imported cases of measles.

The Selangor e-Measles Registry is an online database system used by the Ministry of Health Malaysia since 2005 to standardise and record the investigation and registration of measles cases in Malaysia. The data in the e-Measles Registry comprises all suspected measles cases that have been registered in the e-Notification system. These cases were investigated within 48 hours, and once confirmed to be measles, the cases will be registered either as laboratory-confirmed measles, epidemiologically-linked measles, or clinically compatible measles. The data owner is the Communicable Disease Control (CDC) Unit, Selangor State Health Department, at the state level.

For the calculation of incidence, data for the denominator, which is the total population of children (aged below 18 years) and adults (aged ≥18 years) in Selangor, were obtained upon request by email from the Department of Statistics Malaysia, through their official website. The data was shared in Microsoft Excel format by the Chief Assistant Director of the Population and Demography Division.

Sample Size Calculation

Minimum sample size was calculated using Pocock's formula for two proportions with the level of significance set at 0.05 and the power of the study set at 80%. Considering 20% missing data, using proportions reported by Zhao et al.,[17] the calculated minimum sample size for each group was 279 cases. However, for this research, universal sampling was done for all eligible and clean confirmed adults and children measles cases obtained from e-Measles Registry Selangor from 2015-2024.

Study Variables

Variables included and sourced from e-Measles Registry were sociodemographic variables (gender, ethnicity, nationality and residential district), clinical related variables (fever, cough, coryza, conjunctivitis, hospitalisation, developed complications, diarrhoea, pneumonia and other

complications), exposure related variables (contact history, case status and case detection) and vaccine-related variables (vaccination status, type of healthcare facility providing the dose, time since last vaccination).

Data Analysis

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) software version 29.0 IBM SPSS Inc.

In accordance with the first objective, which was to describe the age-specific trend of measles' incidence in Selangor from 2015-2024, the following formula was used to calculate the annual incidence of measles in adults and children:

$$\frac{\text{Number of age-specified measles cases in a specified year}}{\text{Mid-year age-specified population estimates in a specified year}} \times 1{,}000{,}000$$

Subsequently, Poisson regression with log link and population offset was used to assess annual changes in measles incidence separately for adults and children. Year was entered as a categorical variable, and statistical significance for year-to-year differences was evaluated using Wald p-values.

As for the second objective, the sociodemographic, clinical, vaccine, and exposure-related factors of adult and child measles in Selangor from the e-Measles registry from 2015-2024 were described according to the types of variables. Continuous variables are described as median and interquartile range (IQR). Categorical variables are described in frequency and proportion, n (%). Following that, the Chi-square test and Fisher's exact test were used to compare categorical data, and the Mann–Whitney U test was used to compare continuous data to determine the differences between adults and children with measles in Selangor.

Data Collection, Extraction and Management

Data without identifiers were obtained from the data owners at the CDC Unit, Selangor State Health Department. The downloaded data from the e-Measles Registry were in Microsoft Excel format. Missing data were analysed and cleaned. Using a reputable source that is transparent in its data collection method and regularly monitored by the data owner helped reduce potential measurement bias and enhance data validity. Our analysis found that only 20 of 3981 cases had missing data. Listwise deletion was used for missing data. The final sample was transferred to the Statistical Package for the Social Sciences (SPSS) software version 29.0, IBM SPSS Inc., for further analysis. Figure 1 shows how the data was managed after data collection.

To ensure privacy and confidentiality, all personally identifiable information, such as name, identification number, address, and phone number, was omitted by data owners prior to the data being handed over for further management. For ease of identification during data management and analysis, an "ID" column was created using numbers starting from 1 to n (reflecting the total number of cases) based on the order of data received. The data received were safely stored in a password-protected folder and computer, accessible only to members of the research team.

RESULTS

Table I shows the annual incidence of measles in adults and children in Selangor from 2015-2024. The lowest incidence in children was 12 per million population in 2021, and the highest incidence was 396.6 per million population in 2018. The lowest incidence in adults was 0.2 per million population in 2021, and the highest incidence was 27.1 per million population in 2018. The relative risk (RR) of contracting measles was 14.4-87.7 times higher in children than in adults.

Figure 2 shows the trend of cases and incidence of measles according to age group. The incidence of measles in children showed an increasing trend from 2015 to 2018, before dropping in 2019 to 2022 and subsequently rose back in 2023 and 2024. The number of measles cases in children ranged from 22 to 728. A similar trend is seen in adults, but to a lesser degree. Cases of measles in adults ranged from 1 to 135 cases. The drop in 2019-2022 was related to the pandemic effect of COVID-19. Poisson regression confirmed the trend to be statistically significant. Adults and children both showed significant increases in 2018 ($p<0.001$) and significant decreases from 2019-2022, with the strongest reductions in 2020-2021 (all $p<0.001$).

Table II shows the annual number of measles cases and incidence in Selangor. Children were categories into four age groups: <1 year old, 1-6 years old, 7-12 years old and 13-17 years old. The highest yearly incidence was among children aged <1 year. Further analysis of our data suggests that out of all the confirmed cases in children <1 year old, 950(66.8%) were not yet eligible for vaccination. This equals 88.3% of the unvaccinated in the <1 year age group.

Table III shows the sociodemographic, clinical, vaccine, and exposure-related characteristics of measles in adults and children. It also compares the differences in characteristics between adults and children. There were 3954 cases included in this research- 3414 (86.3%) were children and 540 (13.7%) were adults. The majority of both adults and children, who were Malays, detected through passive case detection, were sporadic cases and did not require hospitalisation. Most children had incomplete vaccination, whereas most adults' vaccination status were unknown. There were several significant differences ($p<0.05$) between measles cases among adults and children in Selangor, namely nationality, ethnicity, clinical symptoms (coryza and conjunctivitis), hospitalisation, developing complications such as diarrhoea and other complications, vaccination status, and duration from the last vaccination.

DISCUSSION

Trend

Children are at a higher risk of contracting measles. Further age-specific division among children revealed that the incidence in children was highest in the age group of <1 year. The high burden of cases among children not yet eligible for vaccination prompted the change in the vaccination protocol in the NIP in 2016, where the first dose was administered at nine months of age and a booster was administered at 12 months of age. This subsequently led to a decrease in the

Table I: Incidence of confirmed measles cases among adults and children in Selangor from 2015-2024 (N=3954)

Age group (years)	Number of confirmed case (N)	Total population at risk	Cumulative incidence (per 1,000,000 population)	Incidence (per 1,000,000 population) by age group	RR (95%CI)	Incidence in Children / Incidence in Adults
2015						
<18 years old	487	1,785,400	85.5	272.8		21.58
≥18 years old	58	4,588,700		12.6		(16.44, 28.22)
2016						
<18 years old	585	1,804,400	103.4	324.2		17.01
≥18 years old	90	4,723,300		19.1		(13.60, 21.12)
2017						
<18 years old	384	1,818,900	68.2	211.1		14.43
≥18 years old	71	4,852,900		14.6		(11.25, 18.73)
2018						
<18 years old	728	1,835,600	126.7	396.6		14.62
≥18 years old	135	4,977,700		27.1		(12.18, 17.46)
2019						
<18 years old	179	1,850,100	29.6	96.8		19.50
≥18 years old	25	5,039,500		5.0		(12.94, 29.37)
2020						
<18 years old	86	1,864,800	12.9	46.1		59.14
≥18 years old	4	5,129,600		0.8		(21.76, 160.77)
2021						
<18 years old	22	1,837,400	3.3	12.0		61.99
≥18 years old	1	5,177,300		0.2		(8.41, 459.44)
2022						
<18 years old	91	1,812,600	13.3	50.2		87.65
≥18 years old	3	5,237,700		0.6		(27.39, 278.66)
2023						
<18 years old	427	1,817,500	70.9	234.9		15.08
≥18 years old	84	5,392,200		15.6		(11.82, 19.11)
2024						
<18 years old	425	1,825,800	67.1	232.8		18.68
≥18 years old	69	5,537,600		12.5		(14.59, 24.05)

Table II: Number of cases and age-specific incidence of confirmed measles cases among children in Selangor from 2015-2024 (N=3414) *

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
<1 year old	165 (1601.9)	234 (2310.0)	186 (1888.3)	362 (3641.9)	113 (1198.3)	64 (709.5)	16 (175.6)	51 (598.6)	119 (1309.1)	113 (1314.0)
1-6 years old	247 (416.8)	271 (445.6)	142 (226.9)	264 (411.1)	50 (75.8)	18 (26.9)	5 (7.7)	33 (51.9)	187 (293.7)	149 (231.0)
7-12 years old	58 (99.4)	54 (93.0)	39 (67.8)	59 (103.3)	16 (27.6)	4 (6.7)	1 (1.7)	6 (9.9)	95 (154.5)	135 (218.3)
13-17 years old	17 (33.6)	26 (50.6)	17 (32.7)	43 (82.2)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.1)	26 (54.8)	28 (58.80)

*Number of cases (Age-specific incidence per million population)

number of cases among that population, although it is still the major cause of unvaccinated measles cases among children <1 year old. It is worth noting, primary vaccine failure is seen higher in children immunised <1 year old due to underdeveloped immunity and interference by maternal antibodies.[18] Another study among Dutch children revealed that despite having received two doses of MMR, >70% of children who had their first vaccination before 8.5 months lost their protective antibody levels within six years, suggesting that vaccinating too early might also result in secondary vaccination failure.[19] Hence, any decision on hastening the timing of vaccination should be balanced between the risks of measles occurring before vaccination and the risks of vaccination failure, which decreases with increasing age.[20] The next age group with the highest incidence suitable for targeted interventions, such as SIA, are in the 1-6 years category. Despite the reported high vaccination coverage in Selangor, the resurgence of cases suggests an immunity gap that might have happened during COVID-19 pandemic. This was highlighted by the WHO stating that COVID-19 led to the interruption of vaccination, with over 178 million people worldwide at risk of missing vaccines in 2020.[21] The MCV1 coverage reportedly declined from 86% in 2019 to 81% in 2021.[22]

Although our study reported the highest proportion and incidence of cases to be below 6 years old, with Cambodia, Thailand, and Indonesia having a similar burden, we differed from other countries such as the United States, which reported the highest transmissibility occurred among school

Table III: Comparison between adults and children with measles in Selangor from year 2015 to 2024 (N =3954)

	Variables		Adult =>18 years old n=540	Children <18 years old n=3414	p-value
	Sociodemographic Variables				
1	Gender	Male	272 (50.4%)	1834 (53.7%)	0.147[c]
		Female	268 (49.6%)	1580 (46.3%)	
2	Nationality	Malaysian	491 (90.9%)	3235 (94.8%)	<0.001[c]
		Non-Malaysian	49 (9.1%)	179 (5.2%)	
3	Ethnicity	Malay	429 (79.4%)	2985 (87.4%)	<0.001[c]
		Chinese	29 (5.4%)	127 (3.7%)	
		Indian	23 (4.3%)	70 (2.1%)	
		Others	59 (10.9%)	232 (6.8%)	
4	District	Small Districts	90 (16.7%)	475 (13.9%)	0.089[c]
		Large Districts	450 (83.3%)	2939 (86.1%)	
	Clinical variables				
1	Fever	No	5 (0.9%)	15 (0.4%)	0.179[f]
		Yes	535 (99.1)	3399 (99.6%)	
2	Cough	No	120 (22.2%)	764 (22.4%)	0.935[c]
		Yes	420 (77.8%)	2650 (77.6%)	
3	Coryza	No	254 (47.0%)	1244 (36.4%)	<0.001[c]
		Yes	286 (53.0%)	2170 (63.6%)	
4	Conjunctivitis	No	359 (66.5%)	2495 (73.1%)	0.001[c]
		Yes	181 (33.5%)	919 (26.9%)	
5	Hospitalisation	No	353 (65.4%)	2511 (73.6%)	<0.001[c]
		Yes	187 (34.6%)	903 (26.4%)	
6	Developed Complications	No	422 (78.1%)	2990 (87.6%)	<0.001[c]
		Yes	118 (21.9%)	424 (12.4%)	
7	Diarrhoea	No	473 (87.6%)	3209 (94.0%)	<0.001[c]
		Yes	67 (12.4%)	205 (6.0%)	
8	Pneumonia	No	535 (99.1%)	3379 (99.0%)	0.83[c]
		Yes	5 (0.9%)	35 (1.0%)	
9	Other Complications	No	470 (87.0%)	3194 (93.6%)	<0.001[c]
		Yes	70 (13.0%)	220 (6.4%)	
	Vaccination variables				
1	Vaccination Status	No	202 (37.4%)	1996 (58.5%)	<0.001[c]
		Complete	43 (8.0%)	413 (12.1%)	
		Incomplete	49 (9.1%)	809 (23.7%)	
		Unknown	246 (45.6%)	196 (5.7%)	
2	Facility Providing Last Vaccine	Government Clinic	77 (77.0%)	961 (74.1%)	0.627[c]
		Rural Clinic	4 (4.0%)	82 (6.3%)	
		Others	19 (19.0%)	254 (19.6%)	
3	Duration from last vaccination		22.87 ± 6.49 (y) (median + IQR)	0.25 ± 2.81 (y) (median + IQR)	<0.001[m]
	Exposure variables				
1	Contact History	No	491 (90.9%)	3113 (91.2%)	0.845[c]
		Yes	49 (9.1%)	301 (8.8%)	
2	Case Detection				
	Active	23 (4.3%)	141 (4.1%)	0.889[c]	
		Passive	517 (95.7%)	3273 (95.9%)	
3	Case Status				
	Sporadic	484 (89.6%)	2984 (87.4%)	0.143[c]	
		Outbreak	56 (10.4%)	430 (12.6%)	

Abbreviations: IQR = interquartile range, y = years
[c]Chi-square Test, [f]Fisher's Exact Test, [m]Mann-Whitney U Test

children aged 5-17 years old.[23] One possible explanation is that immunisation history is mandatory to be declared at government school entry in Malaysia, where children with missed vaccines could be identified and given catch up vaccination by the school health team. Whereas in the United States, pockets of vaccine refusal exist and tend to cluster within and across schools, causing outbreaks.[24]

Despite adults having a lower risk of contracting measles, the absolute number and proportion of adults contracting measles is still of concern, with the proportion of adults (with the exception of the pandemic era) ranging from 10.64% in 2015 to 16.44% in 2023. This gradual epidemiological shift may be caused by waning immunity among people who lived in the era of single-dose vaccines and low cases, making them more susceptible to the disease.[25] Although the shift is not as prominent as in certain countries like Germany which saw a drastic increase in adults to comprise 43% of total measles cases,[26] it still warrants attention and further monitoring. Selective booster programmes could be done for this age group to curb further rise. Mat Daud et. al., in their recent study also suggested to include booster doses for older age groups or high-risk groups.[11]

Sociodemographic, clinical, and vaccine-related factors

The proportion of measles among non-Malaysian adults was higher than Malaysians. This is logical, as most non-Malaysians who come for work or studies are adults. Mat Daud et. al. stated that non-Malaysian has a higher risk of developing measles due to barriers in accessing healthcare, language, financial issues and lack of awareness regarding importance of vaccine.[11] This finding was echoed in Europe where measles outbreaks were seen highest among non-citizens which involved asylum seekers, workers and students.[27] Malays, the majority, showed a higher proportion of children with measles than other races. Vaccine hesitancy, religious issues, and low confidence in vaccines can be reasons for this situation.[28]

Coryza is more commonly seen in children, showing a significant difference compared to adults. This could be due to the anatomical structure, immature immune system, and high prevalence of atopy in children.[29] There was a significant difference between the presence of conjunctivitis in adults and children, with adults having a higher proportion of conjunctivitis than children. This finding contrasts with the findings in Beijing, where adults and children showed a similar proportion of conjunctivitis.[17] Keratoconjunctivitis in adult measles can manifest as punctuate eruption in the cornea with moderate dry eye symptoms causing severe discomfort, photophobia and foreign body sensation in the eyes.[30] A study in France noted that children were significantly less hospitalised.[10] The same study also noted that diarrhoea and dehydration were more common in adults, requiring more frequent fluid therapy. These findings align with our study, where there was a statistically significant increase in hospitalisation and complications, specifically diarrhoea, in adults compared to children. The reason behind the higher rate of complications and hospitalisations in adults could be due to underreporting or underdiagnosing of measles among adults due to a low index of suspicion. This late diagnosis can result in complications among adults with measles.[12]

In Beijing, more than 600 pneumonia cases were documented in the span of 12 years, with children having significantly higher proportions of pneumonia than adults. However, our study showed no significant differences between the proportion of pneumonia in measles cases among adults and children. The overall low number of pneumonia cases (just 40 over 10 years) suggests that the complication rate may have been underestimated in this study. This discrepancy could be due to the fact that the Beijing study was hospital-based and data were obtained from medical records throughout their hospital visits. In contrast, the Selangor data are population-based. The investigation conducted through phone calls to patients within 48 hours of notification only gives a single snapshot of the patient. The patient may not have developed pneumonia yet or may not have known that he was being treated for a mild form of pneumonia.

There was also a significant difference in the vaccination status of adults and children, with a glaringly high proportion of "unknown vaccination" in adults as compared to children (45.6% vs. 5.7%) The high unknown vaccination rates in adults are not specific to Selangor. A study in Mongolia reported that 88% of adult measles cases were uncertain about their vaccination history.[31] This makes it difficult to study their association between vaccination and disease or outbreaks. Hence, it is important to make vaccine documentation readily available. One option is to integrate it into health information systems. We can learn from the example of Louisiana. When residents of Louisiana were evacuated to Texas during Hurricane Katrina, doctors were able to retrieve their vaccination histories because the immunisation systems were online and digitally-linked.[32]

Despite this, our findings suggests that both adults and children mostly received their vaccination in government clinics (77% in adults and 74.1% in children), showing the governmental burden in relation to vaccine provision while reflecting a good documentation process in governmental health clinics that enables patients to recall their vaccination history. Proper documentation of vaccination is also important in the event of suspected vaccine storage or potency issues. The proportion of measles vaccination received in private healthcare facilities on the other hand were 1% in adults and 13.4% in children, indicating the potential role of private healthcare facilities in supporting measles vaccination delivery in the future, provided that proper documentation practices are followed.

For adults, the median duration since the last vaccination was 22.89±6.49 years. Limited research has been published on this to make comparisons within the WPR. Another study reporting on this was from Spain which reported a median of 18.8 years from date of last vaccination for cases with two vaccines and a median of 18.2 years for cases of single dose vaccine, which were attributed to waning immunity.[9]

RECOMMENDATIONS

This study recommends and supports the prioritisation of SIAs targeting children below six years old due to high age-specific incidence among this age group. We also noted a gradual increase in measles in children 7-12 years in the past two years and suggest that school health services monitor this condition closely. Although the risk of contracting measles is higher in children, threats related to adult measles in the form of complications and hospitalisations warrants continuous surveillance and mandates health practitioners to have a higher index of suspicion for adult measles cases. Health education should extend to the public, and the appearance of a diffuse rash a few days after the onset of fever should alert the public and health practitioners of the possible diagnosis of measles despite mild symptoms. Technology and health information systems should be leveraged to improve health record-keeping with regard to vaccination history extending into adulthood.

Strength and Limitations of the Study

This study reported age-specific trends and differences in measles in adults and children in Malaysia, which, to our knowledge, have not been highlighted before. The inclusion of a large dataset spanning several years helped enrich the findings by minimising selection bias. The use of data from a nationally used database decreases information bias. This analysis could help lawmakers and health authorities in policymaking and targeted interventions through immunisation or health promotion. We acknowledge that

the definition of children in this study was based on local definition and research which may limit comparability with other studies.[33] In depth comparison between age groups was not part of the scope of the study. Other limitations include limited control over the quality and accuracy of secondary data, which were mostly collected for surveillance purposes rather than for research. Registry information bias and recall bias, for example as seen in the high 'unknown' vaccination status among adults may distort associations and limits comparisons. Also, the variables compared were limited to those available in the system, limiting the comparison to other variables such as workplace/parental occupation and median household income. Finally, although the sample size was large, this study was conducted in Selangor, which might differ demographically from other areas and might not be generalisable to all settings.

Future Research

Future research should address further on refining age stratifications or focus on a certain age group to improve comparability. Longitudinal and case-control studies are better at assessing causality and associations between factors and outcomes. Studies on assessing the 'unknown' vaccination status and targeted seroprevalence studies may identify immunity gaps. It is also suggested that future research on measles complications to be based on electronic health records, which might be more sensitive in detecting late complications.

CONCLUSION

In Selangor, children experienced substantially higher measles incidence than adults throughout 2015-2024, with the greatest burden in those aged under six. Adults, however, showed more complications, hospitalisation and markedly poorer vaccination documentation. Statistically significant differences were also seen in nationality, ethnicity and clinical symptoms. These findings demonstrate clear epidemiological differences between adults and children and emphasises the need for strengthened childhood immunisation through the NIP and targeted SIAs, improved adult vaccination documentation, and closer monitoring of rising adult cases to support measles elimination in Malaysia.

Ethical Consideration

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and received ethical clearance from the UiTM Research Ethics Committee (FERC-EX-25-14) and Malaysia Medical Research Ethics Committee- NMRR ID-25-00647-YK1. Permission from the Director of the Selangor State Health Department was obtained to use secondary data from the e-Measles Registry Selangor.

CONFLICT OF INTEREST

The authors declare no conflict of interest

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AUTHOR'S CONTRIBUTION

Conceptualisation: NSI, LSS, MM; Methodology NSI, LSS, MM; Field technical support FK, SMWM; Writing-Original Draft NSI; Writing- review and editing: all authors. All authors approved of final manuscript.

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