Complete Basic Immunization of Children 12-23 Months Based on Geographical Differences and Determinants of Utilization

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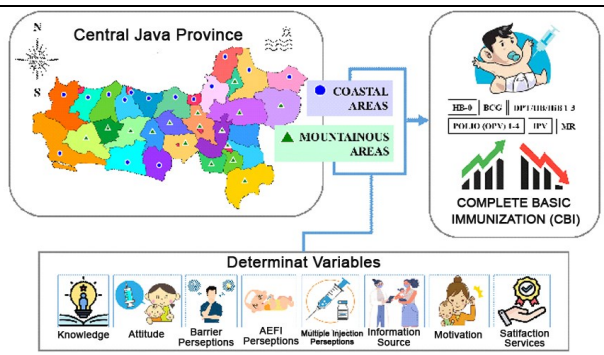
ABSTRACT

Although immunization has been proven to be cost-effective in preventing dangerous infectious diseases, its complete utilization is not optimal. Therefore, this study aims to analyze the Complete Basic Immunization (CBI) coverage among children aged 12-23 months based on differences in geographical characteristics areas, and factors influencing its utilization. This was an analytic study conducted with a quantitative method and cross-sectional approach, and was carried out in 31 districts in Central Java Province, which were categorized into coastal and mountainous areas. The target population included all children aged 12-23 months, and a sample of 685 children was selected using a purposive sampling technique. The collected data were analyzed using independent t-test for numerical, and chi-square for categorical data. Based on the results, the CBI coverage did not differ between children living in coastal and mountainous areas, except for HB-0, BCG, and DPT/HB/HiB-1 immunizations which were significantly different. Furthermore, the mean score of attitudes, perceptions (about barriers, AEFI, multiple injections), information sources, motivation, and service satisfaction among children living in coastal areas were higher and proved to be significantly different from those living in mountainous areas. Access to healthcare facilities and their availability also emerged as a differentiating factor between the two areas. To improve CBI utilization, effective strategies include using appropriate communication, information, and socialization media, particularly through internet technology. These strategies should be integrated into Information, Education, and Communication (IEC) program, alongside improving access and immunization service systems.

ABSTRAK

Meskipun imunisasi terbukti cost-effective dalam mencegah penyakit menular yang berbahaya, namun pemanfaatannya belum optimal. Tujuan penelitian adalah untuk menganalisis cakupan Imunisasi Dasar Lengkap (IDL) anak usia 12-23 bulan berdasarkan perbedaan karakteristik wilayah geografis dan faktor-faktor yang mempengaruhi pemanfaatannya. Penelitian ini merupakan penelitian analitik dengan metode kuantitatif dan pendekatan cross sectional. Dilakukan di 31 kabupaten di Provinsi Jawa Tengah yang terbagi menjadi wilayah pesisir dan pegunungan. Populasi adalah seluruh anak usia 12-23 bulan dan sampel sebanyak 685 anak yang dipilih dengan menggunakan teknik purposive sampling. Data dianalisis menggunakan independent t-test untuk data numerik dan chi-square untuk data kategorikal. Cakupan IDL tidak berbeda antara mereka yang tinggal di daerah pesisir dan pegunungan, kecuali imunisasi HB-0, BCG dan DPT/HB/HiB-1 yang berbeda nyata. Skor rata-rata sikap, persepsi (tentang hambatan, KIPI, suntikan ganda), sumber informasi, motivasi, dan kepuasan layanan pada penduduk yang tinggal di daerah pesisir lebih tinggi dan terbukti berbeda secara signifikan dengan penduduk yang tinggal di daerah pegunungan. Faktor akses dan ketersediaan fasilitas pelayanan kesehatan menjadi faktor pembeda. Penggunaan media komunikasi, informasi dan sosialisasi yang tepat melalui teknologi internet merupakan strategi yang efektif dalam KIE, selain meningkatkan akses dan sistem pelayanan imunisasi.

GRAPHICAL ABSTRACT



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INTRODUCTION

Immunization has been proven to be an effective method for preventing child mortality caused by highly dangerous infectious diseases that are preventable. This intervention not only provides personal protection but also extends its benefits to the entire community (Kemenkes RI 2021; Mallory et al., 2018; Setiawan & Wijayanto 2022). Moreover, immunization is a highly cost-effective intervention with a measurable impact on reducing childhood morbidity and mortality (Chan, 2014; Efendi et al., 2020; Kanchan et al., 2018). Despite routine immunization efforts in Indonesia and other Southeast Asian countries since the 1980s, cases of various immunization-preventable diseases (PD3I) such as diphtheria, polio paralysis, and measles have persisted. In 2019, the Philippines reported polio an outbreak of serotypes 1 and 2, followed by Malaysia in 2020 (Snider et al., 2022), which then spread throughout the region (Kemenkes RI, 2020). A total of 16 countries including Indonesia in 2022, reported cases of type 2 polio, despite Indonesia having received a polio-free certificate from WHO in 2014 (Harizon et al., 2020; Kemenkes RI 2020). Malaysia also experienced a significant increase in measles cases, from 125 (2013) to 1467 (2018). This included 4 cases of diphtheria and 19 cases of pertussis (Wong et al., 2020). Furthermore, a measles outbreak occurred in Italy in 2017, due to vaccine hesitancy and resistance, which was exacerbated by the global accessibility of anti-vaccine information through the internet (Siani, 2019). The emergence of several cases of immunization-preventable diseases highlights the obstacles faced in the implementation of immunization programs. Mathematical analysis conducted in the US showed that unvaccinated children were 4-5, 2, and 5-8 times more susceptible to measles, chickenpox, and rubella respectively (Fefferman & Naumova, 2015).

The primary obstacle to immunization programs is the low utilization and coverage rates. A study conducted by Setiawan & Wijayanto using Susenas 2020 data showed that only 30.8% of children aged 12-23 months in Sumatra had complete immunization status, and 10.3% did not receive basic immunization. Several factors including living conditions, maternal education, employment status, place of birth, as well as inequality in the distribution of health facilities affected the basic immunization completeness (Setiawan & Wijayanto, 2022). Socioeconomic factors were found to be closely related to non-immunized children (Herliana & Douiri, 2017). A comparison with countries such as Nepal and Bangladesh where complete immunization coverage exceeded 85%, showed that India's coverage rate was only 43.6%. Maternal education and wealth index were also identified as confounding factors that affected immunization completeness (Kanchan et al., 2018). Furthermore, a study in Southern Nigeria indicated that only 51.1% of respondents had a child card, and of these, only 76.3% had complete immunization status. Maternal education played a significant role in timely immunization, while low knowledge and socioeconomic resources were the main barriers to incomplete basic immunization for children (Nalley & Maduka, 2019; Siramaneerat & Agushybana, 2021). This result was in line with a study in Kenya highlighting that educated mothers were 54% more likely to be fully immunized than those with less education. Children born in health facilities had a 41% higher likelihood of complete immunization, while those born and living in coastal areas were at least 74% more likely of receiving immunization completeness. Conversely, children born in urban areas were 26% less likely to be fully immunized than those living in rural areas. Children in wealthy households were 43-57 times more likely to be fully immunized than those born into poor households. Those born after six years also had

a 37% lower chance of being fully immunized (Allan e t al., 2021).

According to data from the 2020 Indonesian Health Profile, the coverage for CBI coverage has shown a decreasing trend, with rates of 90.6% (2018), 93.7% (2019), and 83.3% (2020). Basic Health Survey (Riskesdas) in 2018 also showed that the CBI coverage was only 57.9%. Furthermore, the immunization dropout rate measured by comparing DPT/HB/HiB-1 with Measles-Rubella (MR) coverage has increased from 2.5% (2018) to 3.1% (2019), and 4.2% (2020). In 2021, the national basic immunization coverage slightly increased to 84.2% but has not yet reached the strategic plan target of 93.6%. At the provincial level, CBI coverage was in the range of 42.7%-100% with Aceh province having the lowest coverage and South Sulawesi the highest. Despite the dropout rate of 6.9%, it still did not meet the target of <5%. According to Indonesian Health Profile in 2021, there were 11 cases of Tetanus Neonatorum (TN) with nine deaths (CFR 82%), of which nine (82%) were not immunized. In 2020, 3434 suspected measles cases were found, and in 2021, 2931 cases were recorded in an increasingly spread-out area. Only 3 provinces had no suspected measles cases. For diphtheria, 259 cases were found in 2020 and decreased in 2021 to 235, although the case fatality rate (CFR) increased from 5.02% (13 deaths in 2020) to 11% (25 deaths in 2021). In general, these results showed that a rising CFR indicated an increased risk of death (Kemenkes RI, 2021).

Parents' hesitation to immunize their children is mainly related to concerns about vaccine safety and potential side effects, poor personal experiences in the past, false beliefs about vaccines, as well as distrust of the government, health system, and healthcare providers. This is particularly evident among fanatical religious groups and ethnic minorities (Mursinah et al., 2020). A study by Efendi et al. reported that mothers with a first child were 2.84 times more likely to provide complete vaccination than those with more children. Moreover, mothers with low socioeconomic levels and no routine antenatal care during pregnancy were less likely to fully immunize their children, and those whose deliveries were assisted by health workers correlated with complete immunization (Efendi et al., 2020). Universal access to affordable health services is a priority, especially for low socioeconomic groups who often delay or cancel immunizations. Low accessibility not only leads to poor coverage, but also creates large unimmunized vulnerable groups at risk of contracting or transmitting diseases (Mallory et al., 2018). In Asian countries, especially in Southeast Asia, the factors of social elements, culture, traditions, norms, and religion strongly influence health service-seeking behavior including immunization services (Arnault & Woo, 2018).

Several studies have provided evidence about the magnitude of immunization-preventable diseases and identified their associated risk factors. A study conducted in Bali used digital maps to show the distribution of suspected measles cases in densely populated urban areas, while rubella cases were found to be more prevalent in rural areas with incomplete immunization status (Handayani & Kardiwinata, 2021). Another study using 2017 IDHS data showed that 40% of children aged 12-23 months were not fully immunized with 45.3% in urban and 54.7% in rural areas. Therefore, interventions to improve immunization coverage should consider significant risk factors in both rural and urban areas (Hardhantyo & Chuang, 2021). A study in Kenya also showed that travel time was a barrier to obtaining childhood immunization services in areas with poor accessibility (Joseph et al., 2020). Another study conducted in Myanmar focused on the

deadly Japanese Encephalitis (JE) disease in 2016, illustrated that the largest cases occurred in deltaic and lowland areas, as well as during the rainy season, but more deaths occurred in hilly and coastal areas with lower JE catch-up immunization coverage (Win et al., 2020). Epidemiologically, it was reported that characteristic differences in geographical and topographical areas affected the spread pattern and disease development, hence, the identification of risk factors related to these characteristics is important. Basic immunization was also found as a risk factor for stunting, especially in lowland areas along with the incidence of diarrhea, while in highland areas, the risk factor was the history of exclusive breastfeeding (Satriani & Yuniastuti, 2020).

Central Java Province is one of 34 provinces in Indonesia that has experienced a decrease in CBI coverage. Data from the Provincial Health Profile in 2021 showed a decreasing trend in CBI coverage to 86.7%, which reduced from 2020 (94.3%) to 2019 (98.5%). This coverage has not reached the strategic plan target of 94.6%. The risk of immunization-preventable disease outbreaks was also quite high and spread across various regions. A total of 113 cases of polio paralysis were found in 2020, which then increased to 196 cases in 2021. Although the incidence of diphtheria was reduced to one case in 2020 (from 9 cases in 2019), there was an increase in 2021 to 11 cases. The total number of measles cases has reduced in the last 3 years, from 1389 cases (2019), down to 683 cases (2020) and 507 (2021). Despite the reduction in the number of cases, the area has expanded and spread across 62.9% of all districts in Central Java province. Geographically, the Central Java province is divided into lowlands in the coastal areas of both the North and South coasts, as well as highlands or mountains in the central area. Different geographical conditions are associated with access to health services and socio-cultural life affecting community behavior, including immunization utilization.

Location and geographic distribution play a role in determining the utilization of ANC visits, deliveries, child immunizations, and other health services (Defar et al., 2019). Several studies have shown that different geographical characteristics differentiate health service coverage, including immunization. A study in Myanmar found that people living in rural or remote areas had to pay more for immunization services than those living in urban areas. Geographic and ethnic diversity also contributes to the complexity of achieving health service equity (Win et al., 2022). A similar study carried out in Vietnam showed that children from ethnic minorities and those living in rural areas were less likely to receive timely immunization. The child's place of residence was identified as the main predictor of immunization timeliness (An et al., 2016). It is also known that some areas have experienced cases of immunization-preventable disease in the last 3 years, while some have not. Therefore, this study aims to analyze the CBI coverage in children aged 12-23 months based on different geographical characteristics and factors influencing its utilization. The results are expected to provide policy recommendations aimed at strengthening basic immunization coverage, based on the differences in geographic conditions and demographic characteristics.

METHODS

This analytic study was conducted using quantitative methods and a cross-sectional approach. It was carried out in 31 districts in Central Java Province, which was divided into coastal (15 districts) and mountainous areas (16 districts). The target population was all children aged 12-23 months and a sample of 685 children was selected using a purposive sampling technique. Purposive criteria were used to deter-

Table 1
The Characteristics of Respondents Based on Geographical Differences in Central Java Province

Characteristics	Coastal		Mountainous	
	n	%	n	%
Mothers				
Aged[a] (Mean±SD)	30.9±5.8		30.7±5.9	
Education				
Low	51	14.01	38	11.84
Middle	90	24.73	77	23.99
High	223	61.26	206	64.17
Occupation				
Did not work	256	70.33	221	68.85
Work	108	29.67	100	31.15
Income per month[b] (Mean±SD)	2,450,412±1,476,629		2,213,862±1,095,510	
Number of children				
At 1-2 children	274	75.27	255	79.44
≥3 children	90	24.73	66	20.56
Children				
Aged[c] (Mean±SD)	17.1±3.4		16.9±3.4	
Gender				
Male	164	45.05	165	51.40
Female	200	54.95	156	48.60
Childbirth history				
Vaginal parturition	275	75.55	229	71.34
Sectio-cesarea	89	24.45	92	28.66
Baby birth weight[d] (Mean±SD)	3,023.60±379.4		2,973.90±403.2	

Note: [a] = in years; [b] = in rupiah ; [c] = in months; [d] = in grams; n = number; % = percentage; SD = standard deviation.

mine the locus of data collection, based on the PHC with the lowest CBI coverage from each district. From each PHC, one village with the lowest immunization coverage was determined, and respondents were selected accidentally. An average of 23 children were collected from each village. A total of 364 children were living in coastal areas and 321 children were in mountainous areas. The respondents included mothers or caregivers living with their children and submitted informed consent.

The study variables include CBI, knowledge, attitude, perception of barriers, information sources, perception of adverse events following immunization (AEFI), perception towards multiple injections, motivation, and satisfaction with immunization services. Primary data collection was conducted through interviews using a questionnaire that had been tested for validity and reliability, and through observation with the MCH Book to identify the immunization status of children. Enumerators in this study were students participating in Thematic-Field Practice Universitas Diponegoro who had previously been given adequate explanations regarding filling out questionnaires and observation sheets, as well as accidental techniques that must be carried out when collecting field data. All data collected were analyzed through editing, processing, and tabulating stages. Furthermore, univariate analysis was performed using frequency distribution. Differences between both groups were analyzed using the independent t-test for the numerical data scale, and the Chi-Square test for the categorical data scale. When the test results showed a p-value of <0.05, it was regarded to have a statistically significant difference. As a fulfillment of ethical requirements, this study obtained a certificate of Ethical Review Passage from the Health Research Ethics Commission, Faculty of Public Health, Universitas Dipone-

Table 2
Differences Analysis of CBI for Children 12-23 Months Per Antigen Based on Geographical Areas in Central Java Province

Immunization types		Coastal area		Mountainous area		Total		p-value
		n	%	n	%	n	%	
HB-0	No	47	12.91	23	7.17	70	10.22	0.019*
	Yes	317	87.09	298	92.83	615	89.78	
BCG	No	28	7.69	10	3.12	38	5.55	0.015*
	Yes	336	92.31	311	96.88	647	94.45	
DPT/HB/HiB-1	No	27	7.42	11	3.43	38	5.55	0.035*
	Yes	337	92.58	310	96.57	647	94.45	
DPT/HB/HiB-2	No	35	9.62	18	5.61	53	7.74	0.069
	Yes	329	90.38	303	94.39	632	92.26	
DPT/HB/HiB-3	No	49	13.46	31	9.66	80	11.68	0.153
	Yes	315	86.54	290	90.34	605	88.32	
Polio (OPV)-1	No	33	9.07	22	6.85	55	8.03	0.356
	Yes	331	90.93	299	93.15	630	91.97	
Polio (OPV)-2	No	30	8.24	20	6.23	50	7.30	0.388
	Yes	334	91.76	301	93.77	635	92.70	
Polio (OPV)-3	No	39	10.71	27	8.41	66	9.64	0.374
	Yes	325	89.29	294	91.59	619	90.36	
Polio (OPV)-4	No	51	14.01	36	11.21	87	12.70	0.326
	Yes	313	85.99	285	88.79	598	87.30	
IPV (Inactivated Polio Vaccine)	No	95	26.10	81	25.23	176	25.69	0.864
	Yes	269	73.90	240	74.77	509	74.31	
Measles-Rubella (MR)	No	59	16.21	50	15.58	109	15.91	0.904
	Yes	305	83.79	271	84.42	576	84.09	
Complete Basic Immunization (CBI)	Incomplete	143	39.29	122	38.01	265	38.69	0.791
	Complete	221	60.71	199	61.99	420	61.31	

Note: * = Significant with p-value < 0.05 ; n = number ofrespondents; % = percentage.

goro with Number: 361/EA/KEPK-FKM/2022.

RESULTS

Table 1 shows that the mean age of mothers did not differ too significantly between the coastal and mountain areas, with values of 30.9 years and 30.7 years respectively. The majority of the respondents were highly educated and were housewives (not formally employed). The mean family income of mothers living in coastal areas was IDR 2,450,412, which was greater than those living in the mountains (IDR 2,213,862). Most of the mothers in both groups had 1-2 children. Furthermore, the children's characteristics based on their mean age showed no difference between the two regions, namely 17.1 months, and 16.9 months respectively. There was a higher proportion of girls (54.9%) in the coastal region and a higher proportion of boys in the mountainous region (51.4%). The majority of children from both regions were born with normal deliveries (vaginal parturition), with a mean standard birth weight of 3,023.6 grams (coastal region) and 2,979.9 grams (mountain region). Maternal and child characteristics showed no differences between the two geographical areas.

Table 2 shows that the coverage of CBI utilization was still low at 61.3%, wherein the two geographical areas exhibited nearly similar results of 60.7% (coastal areas) and 62.0% (mountainous areas). Based on vaccine antigen, IPV immunization had the lowest utilization (74.3%), followed by Measles-Rubella (84.1%), Polio-4 OPV (87.3%), and DPT/HB/HiB-3 (88.3%). Relatively similar conditions were also seen for immunization coverage from coastal and mountainous areas. Although most respond-

Table 3
Differences Analysis of CBI Utilization Determinants Based on Geographical Areas Characteristic

Variables	Geographical Areas	n	Mean	SD	Mean Diff	p-value	CI	
							Lower	Upper
Knowledge	Coastal	364	8.25	1.709	0.017	0.897	-0.235	0.269
	Mountains	321	8.23	1.648				
Attitude towards immunization	Coastal	364	25.05	4.274	0.816	0.005*	0.253	1.379
	Mountains	321	24.23	3.203				
Perception of barriers	Coastal	364	0.92	0.741	0.248	0.000*	0.142	0.353
	Mountains	321	0.67	0.654				
Information Sources	Coastal	364	2.86	0.824	0.162	0.011*	0.038	0.287
	Mountains	321	2.69	0.829				
Perception of AEFI	Coastal	364	23.95	4.368	0.574	0.049*	.0.003	1.145
	Mountains	321	23.37	3.213				
Perception of m*ultiple injection*	Coastal	364	22.5	5.765	1.138	0.007*	0.317	1.959
	Mountains	321	21.36	5.097				
Motivation	Coastal	364	25.51	4.348	0.723	0.016*	0.135	1.31
	Mountains	321	24.79	3.341				
Satisfaction of services	Coastal	364	48.82	8.852	1.691	0.014*	0.348	3.035

Note: * = significant with p-value<0.05; n: number of respondents; SD: standard deviation; CI: confidence interval 95%

ents had utilized immunization for all types of antigens, the proportion of respondents living in mountainous areas was greater than those living in coastal areas. Immunization utilization in coastal areas was found to be lower than in mountainous areas. For the vaccine drop-out rate (DO) calculated from the difference between DPT/HB/HiB-1 and Measles-Rubella, all regions have not met the standard of <5%, which was 8.8% for coastal and 12.2% for mountain areas. Although descriptively, there were differences in immunization coverage for all antigens in both groups, only HB-0, BCG, and DPT/HB/HiB-1 antigens were significantly different (p-value <0.05). For DPT/HB/HiB-2, DPT/HB/HiB-3, Polio OPV-1 to Polio OPV-4, IPV, and Measles-Rubella coverage, there was no difference between the two groups. The CBI coverages between the two groups also did not show a significant difference.

Based on the results of different test analyses on various determinants of basic immunization utilization (Table 3), only the knowledge variable showed no significant difference. The variables of attitude towards immunization, barriers, information sources, AEFI, multiple injection perception, as well as motivation and service satisfaction exhibited statistically different values in mean score between coastal and mountainous areas. The variable with the largest mean difference was service satisfaction (1.691), followed by the perception of multiple injections (1.138) and attitude towards immunization (0.816). Table 3 also shows that the mean score of determinant variables in coastal areas was greater than in mountainous areas.

DISCUSSION

Pambudi et al. (2021) examined the immunization coverage in 34 provinces before and after the COVID-19 pandemic. The results showed a decrease of -17% for basic immunization and -12.9% for follow-up immunization. The study also found a correlation between a decline in basic immunization coverage with an increase in cases of immunization-preventable disease in certain areas. According to the 2017 IDHS database, factors associated with the CBI include antenatal care services,

birth attendants, postpartum services, birth order, maternal education, paternal education, geographic area, and wealth index. The IDHS data also showed that the percentage of children who did not receive complete basic immunization was more prevalent in rural (57.4%) than in urban areas (45.3%) (Hardhantyo & Chuang, 2021). Although several studies have shown the influence of geographic characteristics on immunization completeness, this study found different results. Based on the results, the CBI coverage did not differ between those living in coastal and mountainous areas. This suggests that several factors such as family and socioeconomic status, including maternal education, knowledge, employment status, living conditions, and wealth index played a more significant role in determining the compliance and utilization of basic immunization (Allan et al., 2021; Herliana & Douiri, 2017; Kanchan et al., 2018; Nalley & Maduka, 2019; Setiawan & Wijayanto, 2022).

The low coverage of CBIs from both regions (60.7% and 62.0%) indicated barriers to its completeness. This was evidenced by the good vaccine coverage rates per antigen (>90%) except for IPV and Measles-Rubella vaccines. Several studies have highlighted the reasons for this discrepancy. For instance, resistance to Measles-Rubella was linked to information gaps (Nalley & Maduka, 2019), incessant rejection movement by anti-vaccine groups through social media (Siani, 2019), doubts and distrust of vaccines (Nair et al., 2021), as well as perceptions of vaccine impurity due to misunderstanding of religion (Wong et al., 2020). Low IPV immunization rates were found to be associated with a perceived lack of information, perceptions, attitudes, and parental fear of multiple injections, as well as adverse events (Ahmad & Syuhada, 2019; Eden et al., 2014; Tagbo et al., 2014; Wallace et al., 2014). In terms of public health, vaccination did not only serve to effectively protect children but also negatively affected the health status of those who refused to be vaccinated. The vaccine rejection effect can lead to increased risk and severity of unpredictable diseases for the non-vaccinated group, beyond the simple provision of protection against constant threat (Fefferman & Naumova, 2015).

For immunization types of HB-0, BCG, and DPT/HB/HiB-1, there were significant differences in coverage by geographic region. HB-0 vaccine was given shortly after birth, BCG at 1 month of baby age along with Polio OPV-1, and DPT/HB/HiB-1 at 2 months of age along with Polio OPV-2. Children living in mountainous areas had a higher percentage of coverage than those living in coastal areas. Based on the data collected, one reason for the difference in coverage was easier access and vaccine availability. In Central Java province, which consisted of 15 districts in the coastal area, most were located along the North and South coast of Java Island. The road access along these coasts was very dense because it served as the main transportation route to the island of Java, crossing 1,316 km (North coast) from West to East, and 1,405 km (South coast). Due to the high level of congestion, severe traffic jams and damage to almost all lanes of the road were highly frequent. This condition was different from the transportation routes in the central mountainous area which tend to be quieter and smoother, resulting in faster access to services. Overcoming these geographical constraints posed a significant challenge for immunization program managers alongside addressing the knowledge gap and lack of information about immunization in the community. Significant disparities in lower immunization coverage were also observed in urban areas, especially among the poor in many countries (Crocker-Buque et al., 2017).

The knowledge variable played a crucial role in the utilization of CBI, but it did not differ significantly between the two regional

characteristics. This suggested that the knowledge dimension was similar in the two regions, probably due to the homogeneity of individual characteristics. Knowledge is acquired through various information received such as counseling, education, training, and experience. Based on the results, the level of knowledge was influenced by age, intelligence, beliefs, information source facilities, and sociocultural environment. A study conducted by Mugada et al. proved that residential characteristics and maternal education level were associated with knowledge (Mugada et al., 2017). Harmasdiyani et al. highlighted the increased risk of non-compliance with complete basic immunization among mothers with low education and knowledge. Mothers with low education levels and lack of knowledge had a 9.281 times and 20.9 times risk of immunization noncompliance respectively (Harmasdiyani, 2015). Several other studies such as Carolina et al. (2021) in Jambi and Ebile Akoh et al. (2016) in west region of Cameroon showed that although knowledge was good, it did not guarantee good immunization practices.

Statistical evidence indicated that there were differences in the mean scores of mothers' attitudes towards immunization, barriers, AEFI, and multiple injection perceptions among participants living in coastal and mountainous areas. Attitude refers to a person's reaction or response to an object, which could be positive or negative. As a dimension of behavior, it can be influenced by education, knowledge, experience, values and norms, beliefs, perceptions, culture, and environmental situations. Perception, on the other hand, involves the unique interpretation of a situation that gives meaning to certain information. People's attitudes and perceptions could differ from one another, based on their experiences, expectations, needs, motivations, and emotions. Therefore, when examining attitudes and perceptions related to immunization, it is important to consider these influencing factors. Perceived barriers were also shown to differ between participants living in coastal and mountainous areas, with higher levels for those in coastal areas. According to Saeed, the higher the education level of parents, the better their perceptions and attitudes about immunization (Saeed & Hashmi, 2021). Negative perceptions of AEFI and multiple injections can create barriers to parents' participation in immunizing their children. Previous bad experiences also contribute to low immunization utilization. Vaccination-related pain and anxiety, particularly fear of needles in children and parents, are commonly associated with negative attitudes toward immunization. It is important to acknowledge that vaccination is a painful procedure for infants and children, leading to decreased adherence to schedule (Eden et al., 2014). Pain and anxiety associated with vaccination are significant reasons why parents may be reluctant to vaccinate their children (Luthy et al., 2013). Therefore, immunization program managers should take steps to reduce the pain caused by vaccination to increase adherence to schedule (Eden et al., 2014), and alleviate parents' anxiety levels.

The negative attitudes and perceptions of parents toward immunization often stem from misinformation spread on social media by anti-vaccine groups. These groups disseminate false information about vaccines, side effects, vaccine-preventable diseases, and the development of disease after vaccination. This misinformation greatly influences the parents' decision-making process. To address this problem, program managers need to actively increase knowledge and promote positive attitudes using the appropriate media channel, including social media. One way to foster positive attitudes toward immunization is by emphasizing its importance as a key strategy for effectively preventing dangerous infectious diseases. Howev-

er, it is important to recognize that parents' primary concern about immunization is related to potential pain experienced by their children during and after immunization, rather than vaccine safety (Elran et al., 2018). Statistics also proved that parental knowledge and practices were positively associated with children's immunization status (Al-lela et al., 2014; Browne et al., 2015; Debela et al., 2022). A study in the USA reported that unvaccinated children residing in vaccine-protected communities are at greater risk of significant severe conditions when contracting immunization-preventable diseases (Fefferman & Naumova, 2015).

Aside from misinformation, another obstacle observed concerning immunization was the excessive level of parental anxiety about vaccines which eventually led to resistance. Parents' concerns were mainly related to pain experienced by children after vaccination, such as fever, dizziness, and weakness, which ultimately caused fussing and crying. Pain and anxiety associated with vaccination are important reasons why parents may be reluctant to vaccinate their children (Luthy et al., 2013). Other concerns include potential side effects and uncertainty about vaccines effectiveness (Wallace et al., 2014). The 2018 Riskesdas results showed that the reasons why parents did not immunize their children included fear of side effect/fever (28.8%), family rejection (26.3%), far immunization post (21.9%), busy parents (16.3%), sick children (6.8%) and lack of knowledge about the service location (6.7%). These results proved that parents' anxiety about their children experiencing discomfort and illness after immunization poses obstacles requiring urgent attention. Additionally, low family and environmental supports indicate constraints in perceptions and attitudes towards immunization. Resistance to vaccines was also due to low levels of trust, which led to hesitation, reluctance, delay, and even refusal (Nair et al., 2021). Excessive anxiety and worry caused reluctance to accept the recommended vaccine, resulting in delays, forced re-visits, or even refusal (Wallace et al., 2014).

This study showed that information sources, motivation, and satisfaction with immunization services of mothers living in coastal areas had higher scores and were statistically different from those living in the mountains. This was mainly attributed to their better knowledge, attitudes, and perceptions. Positive attitudes and perceptions serve as the impetus (motivation) for positive practices. In general, districts located along the coastal area, which was the main route of land transportation, have greater access to health services as well as facilities compared to the relatively quieter central route. This condition certainly affected the ease of accessing services for mothers, in terms of time, travel, place, and cost. Distance from home to service facilities and local socioeconomic development was associated with immunization completeness and timeliness (Hu et al., 2014) along with sociodemographic, logistical, and other administrative factors (Galadima et al., 2021). Physical distance to clinics and quality of care, affected immunization coverage, including rural-to-urban migration patterns that have universally negative effects (Crocker-Buque et al., 2017).

Some barriers identified as causes of immunization dissatisfaction include unclear risks of side effects, inconsistencies in appointment schedules that are not often communicated to parents, distance to service facilities, poor service, longer waiting times, and limited vaccine availability resulting in delays (Barrera et al., 2014). According to Elran et al. (2018) immunization adherence rates were influenced by sources of information, especially from those who were pro-vaccination, with health workers being the most influential source of information. Children with parents who did not have access

to information media had a greater chance of missed-opportunity events compared to those with good access (Amalia et al., 2017). Furthermore, a key factor is the ability to filter the right information. Browne et al. explained that humans are information processors who are often biased due to the effects of psychological influences, leading to negative attitudes and skepticism (Browne et al., 2015). Another study also showed that workload and communication barriers were the main factors affecting satisfaction with immunization services for migrant children in Thailand (Pinna et al., 2020). Knowledge, positive attitudes, and home visits were the most important factors in increasing satisfaction with immunization services in Ethiopia (Debela et al., 2022), along with clarity in providing information by health workers (Elran et al., 2018).

Although the coverage of CBI was not statistically different based on geographical differences, various studies have shown that regional characteristics directly or indirectly contribute to attitudes, perceptions, and satisfaction with immunization services, culminating in improved coverage. Demographic and geographic characteristics were reported as differentiating factors in terms of immunization knowledge, attitudes, perceptions, and practices (Efendi et al., 2020; Hardhantyo & Chuang, 2021; Herliana & Douiri, 2017). Various efforts to increase parents' knowledge, improve perceptions, strengthen attitudes and motivation, as well as upgrade service quality must be carried out massively and continuously. The use of appropriate communication, information, and socialization media through internet technology such as social media, WhatsApp, web, YouTube, and other social networks proved to be an effective strategy in fighting vaccine hesitancy (Odone et al., 2015; Stahl et al., 2016). Furthermore, attention must be given to immunization service systems improvement, vaccine stock management and logistics, as well as ease of access to overcome obstacles related to waiting times, scheduling, vaccine stock vacancies, and handling adverse events.

CONCLUSIONS

In conclusion, there was no difference in CBI coverage between those residing in coastal or in mountainous areas, rather, it was significantly influenced by socioeconomic factors. Based on coverage per antigen, only HB-0, BCG, and DPT/HB/HiB-1 immunization coverage differed significantly. Furthermore, attitudes towards immunization, barriers perception, information sources, AEFI perception, multiple injections perception, motivation, and satisfaction with immunization services also differed between the two areas, with people living in coastal areas having better characteristics compared to those residing in the mountains. Access and availability of health service facilities were also identified as differentiating factors. Various efforts should be made to improve knowledge, perceptions, attitudes, motivation, service quality, access, and service quality to minimize immunization constraints and barriers. The use of appropriate communication, information, and socialization media using internet technology is recommended as one of the effective strategies. Moreover, advances in information technology offer an opportunity to increase the efficiency of limited health resources. The roles of all stakeholders are also needed to support immunization coverage achievement through improved access, fulfillment of immunization service facilities including vaccine logistics guarantees, and efforts to minimize rejection in the community. Further studies are needed to improve the results of this study by using multilevel analysis.

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AUTHORS' CONTRIBUTIONS

Ayun Sriatmi designed the study, formulated the concept, wrote the manuscript, analyzed data, reviewed and revised the manuscript; and approved the final version to be published. Martini formulated the concept, reviewed the manuscript, analyzed the data, revised and approved the final manuscript. Sutopo Patria Jati designed the study, formulated the concept, read, reviewed and approved the final manuscript. Novia Handayani and Aditya Kusumawati enrolled participants, performed the field work; collected and acquired the data and also analyzed the data. Armunanto formulated the concept, reviewed the manuscript, read and approved the final version of manuscript.

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COMPETING INTERESTS

The authors confirm that all of the text, figures, and tables in the submitted manuscript work are original work created by the authors and that there are no competing professional, financial, or personal interests from other parties.

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