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Prevalence and determinants of diarrhea among under-five children in five Southeast Asian countries: Evidence from the demographic health survey

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ABSTRACT

Purpose: To describe the prevalence and the correlation between individual, environmental and household, health behavior, and source of information factors with diarrhea among under-five children in five Southeast Asian countries based on the National Health Survey.
Design and methods: Cross-sectional design conducted in five countries in Southeast Asia. Datasets from Demographic and Health Surveys and Multiple Indicator Cluster Surveys in five countries were analyzed.
Results: A total of 12,447 children under 5 years of age from five countries in Southeast Asia (Indonesia 1807, Cambodia 2650, Myanmar 1717, the Philippines 3669, and Timor-Leste 2614) were included in this study. Binary logistic regression was performed to analyze the data. A total of 12,447 under-five children were included in the study. Overall, in five Southeast Asian countries, the prevalence of diarrhea is known from 8.39% in the Philippines to 18.21% in Indonesia. Several factors related to diarrhea are individual; environmental and household; health behavior such as stool disposal, breastfeeding mothers, and children's food history; and source of information factors.
Conclusion: The findings of this study indicate that diarrhea is a serious public health problem in the Southeast Asian region that must be addressed using preventive and curative approaches.
Practice implication: The results indicate the need for cross-collaboration among nurses, medical doctor, and sanitarian is needed to tackle the childhood diarrhea and minimize the severity based on those determinants.

Introduction

Diarrhea is a condition in which the body passes watery stools for ≥3 times a day (Chen et al., 2018). Diarrhea can be classified according to bowel movement frequency and duration and stool characteristics, and clinical management depends on the classification of diarrhea (CaJacob & Cohen, 2016; Chen et al., 2018). Acute, persistent, and

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chronic diarrhea is defined as diarrhea that lasts for 14, > 14, and > 30 days, respectively (Bhatia & Mathew, 2007; Schiller, Pardi, & Sellin, 2017). Despite significant world progress in reducing child mortality from diarrhea over time, diarrhea remains a major cause of childhood morbidity and mortality. It accounts for a quarter of all childhood deaths annually worldwide, and in Africa, it is the third leading cause of child deaths is responsible for an estimated 333,000 child deaths (Negesse, Taddese, Negesse, & Ayele, 2021).

Diarrhea is the second leading cause death and responsible for 370,000 death in children under 5 years in 2019 (WHO, 2022). Although prevention and control of diarrhea have been pursued through The Integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhea (GAPPD), Indonesia only experienced an increase of 7 points in diarrheal prevention and control from 2018 to 2019 (Ivac, and Johns Hopkins Bloomberg School of Public, H, 2019). More than a quarter (26.93%) of diarrheal deaths occurred in children under 5 years of age, and approximately 90% (89.37%) of diarrheal deaths occurred in South Asia and sub-Saharan Africa (Naghavi et al., 2017; Troeger et al., 2018). In addition death, long-term of diarrhea can have an impact on nutritional disorders and stunting (Yunitasari, Pradanie, Arifin, Fajrianti, & Lee, 2021). The mortality rates in children with diarrhea exacerbated by respiratory infections and Human Immunodeficiency Virus (HIV) (Nursalam et al., 2021; Pavlinac, Tickell, & Walson, 2015; Ullah et al., 2019).

Approximately 88% of diarrhea-related deaths are caused by water that is unsuitable for consumption and inadequate sanitation and hygiene. These factors that cause diarrhea germs are easy to spread from one person to another. Diarrhea germs can spread from a person's stools to someone else's mouth. These germs are usually spread through contaminated water, food, or objects. Water can be contaminated by humans and animals defecating in or near sources of water for drinking and plant irrigation (Centers for Disease Control and Prevention, 2017). Risk of death in childhood diarrhea is increasing following by moderate-to-severe diarrhea (MSD) that caused by pathogens (Levine et al., 2020). The aetiology of diarrhea must be identified accurately and quickly, but traditional methods are time-consuming and fail to identify difficult-to-culture microorganisms. In an average of up to 40% of cases of diarrhea, the aetiological cause cannot be determined (Ugboko, Nwinyi, Oranusi, & Oyewale, 2020). Additionally, diarrhea is reported for approximately 10% at 1–3 days post-oral polio vaccine (OPV) administration (Mediarti, Rosnani, Sukartini, Arifin, & Kurniawati, 2020; Sugawara et al., 2009).

Various programs have been conducted to reduce the incidence of diarrhea by involving the government, non-governmental organizations, healthcare providers and clinical facilities, and communities (Centers for Disease Control and Prevention, 2017). One of the programs conducted, especially in areas that lack access to clean water, is clean water and sanitation, in accordance with the sixth point of the Sustainable Development Goals program; namely, renewable water pumping and desalination can provide effective solutions to provide access to clean drinking water and advance progress toward Sustainable Development Goal 6 (SDG 6) in ensuring the availability and sustainable management of water and sanitation for all (Asia-Pacific, 2017; IntInternational Renewable Energy Agency, 2018).

Unfortunately, children are still suffering from diarrhea. Diarrhea-related morbidity and mortality rates are still high because of the prevalence of risk factors and the lack of access to essential treatment. Risk factors increase the chances that a person will develop a disease. Understanding the importance of different risk factors for different diseases allows targeting those diseases that will make the most impact in reducing the number of deaths. Therefore, the aim of this study was to identify the prevalence and the correlation between individual, environmental and household, health behavior, and source of information factors with diarrhea among under-five children in five Southeast Asian countries based on the National Health Survey.

Materials and methods

Study design

This study used a cross-sectional design conducted in five countries in Southeast Asia.

Data sources and sample

This study utilized data from the Demographic Health Survey (DHS) conducted from 2014 to 2017 and selected five countries from Southeast Asia (Indonesia DHS 2017, Cambodia DHS 2014, Myanmar DHS 2015, the Philippines DHS 2017, and Timor-Leste DHS 2016). We chose these five countries because they had sufficient data on diarrhea among children under 5 years of age. The dataset for selected countries is obtained from the DHS website program (URL: https://www.dhsprogram.com/data/available-datasets.cfm) by submitting an application and can be downloaded after getting approval. Data from DHS Kids Recode are used because information on children under 5 years of age is provided. In addition, data on mothers' information in relation to children were used in this study. Two-stage cluster sampling design has been used by DHS to provide representative estimation information for all enumeration areas (EAs). The first stage is a systematic sampling with probability proportional to the EA size; the second stage is a systematic sampling of equal probability and fixed size across the EAs. This sampling procedure is usually more precise than simple random sampling at both stages (Aliaga & Ren, 2006). DHS used Probability Proportional to Size methodology areas in both rural and urban residences followed by systematic recruitment of 25 households in each counting block. Households were selected randomly in the enumeration areas. Then, data have been weighted based on the number of provinces to obtain the average for each region (Croft, Marshall, & Allen, 2018). To minimize the number of errors made when obtaining the desired information and to maximize validity and reliability, the DHS produced policies for using the questionnaires, which have been translated and printed in all of the major local languages in which the interviews are expected to take place. The validity and reliability test about the questionnaires were conducted by DHS (International, 2007).

A total of 12,447 children under 5 years of age from five countries in Southeast Asia (Indonesia 1807, Cambodia 2650, Myanmar 1717, the Philippines 3669, and Timor-Leste 2614) (Table 1) were included in this study. Children under 5 years of age with selective diarrhea and missing data were excluded from this study.

Dependent variables

According to the World Health Organization, diarrhea is the passage of three or more loose or liquid stools per day or more frequent passage than is normal for the individual. Diarrhea is a symptom of gastrointestinal infection caused by bacteria, viruses, and parasites and is spread through contaminated food or drinking water and lack of proper hygiene (WHO, 2022).

Independents variables

The independent's variables in this study included individual, environmental and household, health behavior, and source of information factors. We constructed these factors based on Bronfenbrenner's ecological systems theory as one of the most accepted explanations regarding the influence of social environments on human development and micro- to macro-system (Bronfenbrenner, 1994).

Individual factors include mother's age and educational level, children's gender, and number of living children. Mother's age was classified into three categories (35–39, 25–34, and 15–24 years old). Educational level was divided into high, secondary, primary, and no education (Kementrian Pendidikan dan Kebudayaan, 2003). Children's gender

Table 1
Univariate analysis for determinant of diarrhea among under-five children in five Southeast Asia.

Variable	Diarrhea % (95%CI)				
	Indonesia (DHS 2017)	Cambodia (DHS 2014)	Myanmar (DHS 2015)	Philippines (DHS 2017)	Timor-Leste (DHS 2016)
N	1,807	2,640	1,717	3,669	2,614
Diarrhea					
No	81.79 (0.79–0.83)	83.71 (0.82–0.85)	84.57 (0.82–0.86)	91.61 (0.90–0.92)	87.30 (0.85–0.88)
Yes	18.21 (0.16–0.20)	16.29 (0.14–0.17)	15.43 (0.13–0.17)	8.39 (0.07–0.09)	12.70 (0.11–0.14)
Individual Factors					
Mother Age					
35–49 years old	23.57 (0.21–0.25)	11.02 (0.09–0.12)	22.83 (0.20–0.24)	20.66 (0.19–0.22)	17.94 (0.16–0.19)
25–34 years old	52.74 (0.50–0.55)	52.88 (0.50–0.54)	51.31 (0.48–0.53)	47.83 (0.46–0.49)	54.36 (0.52–0.56)
15–24 years old	23.69 (0.21–0.25)	36.10 (0.34–0.37)	25.86 (0.23–0.27)	31.51 (0.30–0.33)	27.70 (0.26–0.29)
Education Level					
High education	23.19 (0.21–0.25)	4.55 (0.03–0.05)	7.45 (0.06–0.08)	29.63 (0.28–0.31)	8.91 (0.07–0.10)
Secondary education	55.06 (0.53–0.57)	35.34 (0.33–0.37)	34.36 (0.32–0.36)	49.28 (0.47–0.50)	51.19 (0.49–0.53)
Primary education	20.42 (0.18–0.22)	47.42 (0.45–0.49)	42.81 (0.40–0.45)	19.43 (0.18–0.20)	17.37 (0.15–0.18)
No education	1.33 (0.01–0.02)	12.69 (0.11–0.14)	15.38 (0.13–0.17)	1.66 (0.01–0.02)	22.53 (0.20–0.24)
Children's gender					
Female	46.32 (0.44–0.48)	49.81 (0.47–0.51)	46.30 (0.43–0.48)	47.83 (0.46–0.49)	47.93 (0.46–0.49)
Male	53.68 (0.51–0.55)	50.19 (0.48–0.52)	53.70 (0.51–0.56)	52.17 (0.50–0.53)	52.07 (0.50–0.53)
Number of living children					
9–12	0.17 (0–0.005)	0.11 (0.01–0.02)	0.58 (0–0.1)	1.44 (0.01–0.02)	1.42 (0.10–0.19)
5–8	6.25 (0.05–0.07)	4.62 (0.03–0.05)	10.13 (0.08–0.11)	12.86 (0.11–0.13)	21.69 (0.20–0.23)
1–4	93.58 (0.92–0.94)	95.27 (0.94–0.96)	89.28 (0.87–0.90)	85.69 (0.84–0.86)	76.89 (0.75–0.78)
Environmental and Household Factors					
Wealth index					
Poorest	29.05 (0.27–0.31)	23.33 (0.21–0.24)	26.79 (0.24–0.28)	35.54 (0.34–0.37)	18.94 (0.17–0.20)
Poorer	17.71 (0.16–0.19)	18.67 (0.17–0.20)	22.31 (0.20–0.24)	23.68 (0.22–0.25)	20.73 (0.19–0.22)
Middle	17.04 (0.15–0.18)	15.64 (0.14–0.17)	19.39 (0.17–0.21)	17.33 (0.16–0.18)	21.23 (0.19–0.22)
Richer	18.43 (0.16–0.20)	17.31 (0.15–0.18)	17.94 (0.16–0.19)	13.82 (0.12–0.14)	22.30 (0.20–0.23)
Richest	17.76 (0.16–0.19)	25.04 (0.23–0.26)	13.57 (0.12–0.15)	9.62 (0.08–0.10)	16.79 (0.15–0.18)
Residence					
Urban	47.70 (0.45–0.50)	27.50 (0.25–0.29)	23.01 (0.21–0.25)	32.35 (0.30–0.33)	29.15 (0.27–0.30)
Rural	52.30 (0.49–0.54)	72.50 (0.70–0.74)	76.99 (0.74–0.78)	67.65 (0.66–0.69)	70.85 (0.69–0.72)
Source of drinking water					
Improved	84.56 (0.82–0.86)	57.65 (0.55–0.59)	78.33 (0.76–0.80)	91.50 (0.90–0.92)	80.95 (0.79–0.82)
Not improved	15.44 (0.13–0.17)	42.35 (0.40–0.44)	21.67 (0.19–0.23)	8.50 (0.07–0.09)	19.05 (0.17–0.20)
Type of toilet					
Improved	78.58 (0.76–0.80)	52.35 (0.50–0.54)	4.48 (0.03–0.05)	73.21 (0.71–0.74)	18.71 (0.17–0.20)
Not improved	21.42 (0.19–0.23)	47.65 (0.45–0.49)	95.52 (0.94–0.96)	26.79 (0.25–0.28)	81.29 (0.79–0.82)
Health Behavior Factors					
Health facility visit					
No	32.15 (0.30–0.34)	37.01 (0.35–0.38)	42.57 (0.40–0.44)	21.23 (0.19–0.22)	31.83 (0.30–0.33)
Yes	67.85 (0.65–0.69)	62.99 (0.61–0.64)	57.43 (0.55–0.59)	78.77 (0.77–0.80)	68.17 (0.66–0.69)
Disposal of stools					
Toilet	40.56 (0.38–0.42)	26.25 (0.24–0.27)	40.24 (0.37–0.42)	13.71 (0.12–0.14)	24.87 (0.23–0.26)
Drain/ditch	13.95 (0.12–0.15)	7.65 (0.06–0.08)	32.96 (0.30–0.35)	9.59 (0.08–0.10)	5.39 (0.04–0.06)
Garbage	40.34 (0.38–0.42)	12.54 (0.11–0.13)	9.20 (0.07–0.10)	65.66 (0.64–0.67)	18.13 (0.16–0.19)
Buried or left in open	5.15 (0.04–0.06)	53.56 (0.51–0.55)	17.59 (0.15–0.19)	11.04 (0.10–0.12)	51.61 (0.49–0.53)
Breastfeeding					
No	32.65 (0.30–0.34)	25.57 (0.23–0.27)	17.59 (0.10–0.13)	28.10 (0.26–0.29)	26.51 (0.24–0.28)
Yes	67.35 (0.65–0.69)	74.43 (0.72–0.76)	87.94 (0.86–0.89)	71.90 (0.70–0.73)	73.49 (0.71–0.75)
Baby postnatal check					
No	35.31 (0.33–0.37)	17.95 (0.16–0.19)	53.58 (0.51–0.55)	25.59 (0.24–0.27)	79.69 (0.78–0.81)
Yes	64.69 (0.62–0.66)	82.05 (0.80–0.83)	46.42 (0.44–0.48)	74.41 (0.72–0.75)	20.31 (0.18–0.21)
History of ate any solid, semi-solid, or soft foods)					
No	14.72 (0.13–0.16)	24.24 (0.22–0.25)	25.22 (0.23–0.27)	27.75 (0.26–0.29)	34.20 (0.32–0.36)
Yes	85.28 (0.83–0.86	75.76 (0.74–0.77)	74.78 (0.72–0.76)	72.25 (0.70–0.73)	65.80 (0.63–0.67)
Measles vaccine					
No	42.22 (0.39–0.44)	52.58 (0.50–0.54)	54.51 (0.52–0.56)	52.98 (0.51–0.54)	53.37 (0.51–0.55)
Yes	57.78 (0.55–0.60)	47.42 (0.45–0.49)	45.49 (0.43–0.47)	47.02 (0.45–0.48)	46.63 (0.44–0.48)
Source of Information Factors					
Television					
No	6.20 (0.05–0.07)	30.87 (0.29–0.32)	30.05 (0.27–0.32)	11.50 (0.10–0.12)	46.48 (0.44–0.48)
Yes	93.80 (0.92–0.94)	69.13 (0.67–0.70)	69.95 (0.67–0.72)	88.50 (0.87–0.89)	53.52 (0.51–0.55)
Newspaper					
No	54.51 (0.52–0.56)	69.13 (0.75–0.78)	65.75 (0.63–0.67)	56.72 (0.55–0.58)	80.76 (0.79–0.82)
Yes	45.49 (0.43–0.47)	23.48 (0.21–0.25)	34.25 (0.32–0.36)	43.28 (0.41–0.44)	19.24 (0.17–0.20)
Radio					
No	59.55 (0.57–0.61)	47.35 (0.45–0.49)	62.20 (0.59–0.64)	33.63 (0.32–0.35)	63.81 (0.61–0.65)
Yes	59.55 (0.38–0.42)	52.65 (0.50–0.54)	37.80 (0.35–0.40)	66.37 (0.64–0.67)	36.19 (0.34–0.38)

was classified into male and female, and the number of living children was divided into 1–4 children, 5–8 children, and 9–12 children. Environmental and household factors include wealth index, residence, source of water, and type of toilet. The wealth index was classified into poorest to richest (Vyas & Kumaranayake, 2006). The place of respondent's residence was classified as rural and urban. Source of drinking water and type of toilet was classified as improved and not improved. Health behavior factors include health facility visit to Public Health Care (PHC) during sixth month, stool disposal, breastfeeding, baby's postnatal check, child's food history, and measles vaccination. We included measles vaccine because some previous studies presented the correlation between measles vaccine and diarrhea (Bawankule, Singh, Kumar, & Shetye, 2017; Kurniawati & Martini, 2016). Health facility visit to PHC during six last month was classified into two categories as yes and no. Stool disposal was classified as toilet, drain or ditch, garbage, and buried or left in the open. Mothers who breastfeeding, baby postnatal check-in six-week, children who have history of ate any solid, semi-solid, or soft foods, and the measles vaccine were divided into category yes and no. Source of information factors included television, newspaper, and radio, which were divided into yes and no.

Data analysis

We used STATA/MP version 16.1 to analyze the data. We analyzed five countries in Southeast Asia and estimated each country's overall and country-level weighted prevalence rate and their 95% confidence interval (CI). Binary logistic regression was performed to analyze the association between diarrhea among under-five children in each country. We present an adjusted odds ratio (aOR) with 95%CI. A *P*-value <0.05 was considered statistically significant.

Ethical consideration

Each of the five countries performed and approved the Ethical consideration. We registered and requested access to the dataset of DHS on their website (URL: https://www.dhsprogram.com/data/available-datasets.cfm) and received approval to access and download the DHS data file of the five Southeast Asian countries. DHS obtained written informed consent from each individual.

Results

Prevalence of diarrhea among under-five children

A total of 12,447 under-five children were included in the study (Table 1). Overall, in five Southeast Asian countries, the prevalence of diarrhea is known from 8.39% in the Philippines to 18.21% in Indonesia. From individual factors, we found that more than half of the total number of Southeast Asian mothers were aged 25–34 years (Indonesia 52.74%; Cambodia 52.88%; Myanmar 51.31%; the Philippines 47.83%; and Timor-Leste 54.36%). The most mother with secondary education level was in Indonesia 55.06%, Philippines 49.28%, and Timor-Leste 51.19%. Most of primary education level was in Cambodia and Myanmar. The higher education was placed in Myanmar 29.63% and conversely in Timor-Leste 22.53%. In five Southeast Asian countries, most of the children's gender was male and the number of living children was 1–4. In the environmental and household factors, the poorest wealth index was in Indonesia 29.05%, followed by Myanmar (26.79%) and the Philippines (35.54%). However, the most of wealth index in Cambodia was at richest level 15.04% and Timor-Leste was at richer level 22.30%. The prevalence of diarrhea among under-five children was higher in rural areas in most countries (ranging from 52.30% in Indonesia to 76.99% in Myanmar). However, the most gaps residence was lower in Indonesia (urban vs rural: 47.70% vs 52.30%). In most of the five Southeast Asian countries, the water source was improved. However, in Myanmar (95.52%) and Timor-Leste (81.29%), the type of toilet was not improved. Conversely, in Indonesia (78.58%), Cambodia (52.35%), and the Philippines (73.21%), the type of toilet was improved.

In the health behavior factors, most of the respondents routinely visit their health facilities. We found that most stools in Indonesia were disposed in the toilet (40.56%) and garbage (40.34%), those in Myanmar were disposed in the toilet (40.24%), and those in the Philippines were disposed in the garbage 65.66%. Most stools in Cambodia (53.56%) and Timor-Leste (51.61%) were buried or left in the open. The most of breastfeeding and history of children ate any solid, semi-solid, or soft foods were in the five countries. The postnatal check was in Indonesia 64.69%, Cambodia 82.05%, and Philippines 74.41%, except Myanmar 53.58% and Timor-Leste79.69%. The measles vaccination rate was highest in Indonesia (57.78%). Conversely, in the fourth countries. The source of information factors, the most information was from television and the lower was from newspaper in the five countries. Meanwhile, the higher information from radio was in Indonesia 59.55%, Cambodia 52.65%, and the Philippines 66.37%. Conversely, in Myanmar 62.20%, and Timor-Leste 63.81% (Table 1).

Determinants of diarrhea among under-five children

Several factors are related to diarrhea among under-five children in several countries in Southeast Asia (Table 2). In terms of individual factors among these population, mothers aged 15–24 years in Indonesia (aOR: 1.52; 95% CI: 1.04–2.23), Cambodia (aOR: 1.56; 95% CI: 1.00–2.43), the Philippines (aOR: 2.41; 95% CI: 1.60–3.64), and Timor-Leste (aOR: 1.60; 95% CI: 1.02–2.50) had a higher risk of having children with diarrhea than older mothers. A male child in Timor-Leste (aOR: 1.23; 95% CI: 0.97–1.56) was more likely to have diarrhea. In the number of living children, 5–8 children in Cambodia (aOR: 1.60; 95% CI: 0.94–2.73) were more likely to have diarrhea, and 1–4 children in Timor-Leste (aOR: 0.38; 95% CI: 0.14–1.03) were less likely to have diarrhea.

In terms of environmental and household factors among these population, we found that in richer family in Myanmar (aOR: 0.50; 95% CI: 0.30–0.83) and richest family in Philippines (aOR: 0.53; 95% CI: 0.29–0.98) were lower chance of their child having diarrhea compare with lower wealth index family. Mother in Timor-Leste who lived in rural area (aOR: 0.76; 95% CI: 0.56–1.03) was less likely to be diarrhea (Table 2).

In health behavior factors, it was known that mothers who routinely visit their health facilities in the last 6 months have higher risk of having children with diarrhea in Indonesia (aOR: 1.45; 95% CI: 1.10–1.91), Cambodia (aOR: 2.21; 95% CI: 1.73–2.82), and the Philippines (aOR: 1.70; 95% CI: 1.21–2.38). Disposal stools at drain or ditch was more likely to be diarrhea in Indonesia (aOR: 1.67; 95% CI: 1.14–2.45), Cambodia (aOR: 1.76; 95% CI: 1.10–2.80), Myanmar (aOR: 1.40; 95% CI: 1.01–1.94), the Philippines (aOR: 1.79; 95% CI: 1.10–2.90), but less likely in Timor-Leste (aOR: 0.51; 95% CI: 0.25–1.04). Conversely, mothers who breastfeed were less likely have children with diarrhea in Indonesia (aOR: 0.72; 95% CI: 0.55–0.95), Cambodia (aOR: 0.79; 95% CI: 0.61–1.01), and the Philippines (aOR: 0.73; 95% CI: 0.56–0.95). In Timor-Leste (aOR: 1.52; 95% CI: 1.15–1.99) and the Philippines (aOR: 1.29; 95% CI: 0.95–1.74), we found that mother who routinely baby postnatal check was greater odds risk of children having diarrhea. Likewise, children with history of ate any solid, semi-solid, or soft foods were more likely to be diarrhea in Indonesia (aOR: 3.08; 95% CI: 1.89–5.02), Cambodia (aOR: 1.93; 95% CI: 1.41–2.65), Myanmar (aOR: 1.89; 95% CI: 1.28–2.79), the Philippines (aOR: 2.01; 95% CI: 1.42–2.86), and Timor-Leste (aOR: 1.87; 95% CI: 1.37–2.54) (Table 2).

In the source of information factors, numerous factors were more likely to diarrhea in some countries. In Indonesia (aOR: 1.82; 95% CI: 1.00–3.33), information from television was greater odd risk of children having diarrhea. Likewise, information from newspaper was greater odd risk of children having diarrhea in Myanmar (aOR: 1.36; 95% CI: 1.00–1.86) and Timor-Leste (aOR: 1.30; 95% CI: 0.95–1.78) (Table 2).

Table 2
Binary logistic regression analysis for Determinant of Diarrhea among Under-Five Children in Five Southeast Asia.

Variable	Indonesia	Cambodia	Myanmar	Philippines	Timor-Leste
	aOR (95%CI)	aOR (95%CI)	aOR (95%CI)	aOR (95%CI)	aOR (95%CI)
Individual Factors					
Mother age					
35–49 years old	Ref.	Ref.	Ref.	Ref.	Ref.
25–34 years old	0.97 (0.68–1.35)	1.45 (0.96–2.21)*	1.18 (0.81–1.72)	1.40 (0.96–2.04)*	1.02 (0.69–1.51)
15–24 years old	1.52 (1.04–2.23)**	1.56 (1.00–2.43)**	1.13 (0.73–1.76)	2.41 (1.60–3.64)***	1.60 (1.02–2.50)**
Education Level					
High education	Ref.	Ref.	Ref.	Ref.	Ref.
Secondary education	1.05 (0.74–1.49)	1.32 (0.70–2.49)	1.17 (0.61–2.27)	0.98 (0.71–1.34)	1.37 (0.87–2.18)
Primary education	1.09 (0.70–1.69)	1.39 (0.72–2.67)	1.05 (0.53–2.10)	1.12 (0.74–1.69)	1.21 (0.69–2.13)
No education	1.97 (0.67–5.77)	1.37 (0.66–2.83)	0.73 (0.33–1.62)	0.42 (0.09–1.86)	1.20 (.67–2.13)
Children's gender					
Female	Ref.	Ref.	Ref.	Ref.	Ref.
Male	1.04 (0.81–1.34)	1.13 (0.92–1.40)	1.00 (0.76–1.31)	1.01 (0.79–1.28)	1.23 (0.97–1.56)*
Number of living children					
9–12	Ref.	Ref.	Ref.	Ref.	Ref.
5–8	1.41 (0.84–2.38)	1.60 (0.94–2.73)*	0.87 (0.17–4.47)	1.21 (0.40–3.60)	0.53 (0.20–1.37)
1–4	–	–	0.61 (0.12–3.09)	0.70 (0.23–2.11)	0.38 (0.14–1.03)*
Environmental and Household Factors					
Wealth index					
Poorest	Ref.	Ref.	Ref.	Ref.	Ref.
Poorer	1.12 (0.76–1.66)	1.04 (0.75–1.43)	0.91 (0.63–1.32)	0.97 (0.69–1.37)	1.03 (0.67–1.57)
Middle	1.11 (0.72–1.72)	0.93 (0.63–1.38)	0.82 (0.54–1.23)	0.70 (0.46–1.07)	1.19 (0.78–1.83)
Richer	1.02 (0.64–1.61)	1.10 (0.70–1.73)	0.50 (0.30–0.83)***	0.89 (0.56–1.41)	1.35 (0.85–2.15)
Richest	0.83 (0.49–1.39)	1.04 (0.60–1.82)	0.56 (0.29–1.07)*	0.53 (0.29–0.98)**	1.08 (0.62–1.87)
Residence					
Urban	Ref.	Ref.	Ref.	Ref.	Ref.
Rural	1.19 (0.88–1.60)	1.02 (0.73–1.42)	1.07 (0.70–1.62)	0.82 (0.63–1.08)	0.76 (0.56–1.03)*
Source of drinking water					
Improved	Ref.	Ref.	Ref.	Ref.	Ref.
Not improved	1.31 (0.92–1.87)	1.07 (0.84–1.36)	1.21 (0.87–1.67)	0.82 (0.52–1.31)	1.01 (0.73–1.40)
Type of toilet					
Improved	Ref.	Ref.	Ref.	Ref.	Ref.
Not improved	1.21 (0.87–1.67)	1.03 (0.75–1.41)	1.09 (0.50–2.35)	1.07 (0.78–1.46)	1.23 (0.89–1.70)
Health Behavior Factors					
Health facility visit					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	1.45 (1.10–1.91)***	2.21 (1.73–2.82)***	1.21 (0.91–1.60)	1.70 (1.21–2.38)***	1.19 (0.91–1.56)
Disposal of stools					
Toilet	Ref.	Ref.	Ref.	Ref.	Ref.
Drain/ditch	1.67 (1.14–2.45)***	1.76 (1.10–2.80)***	1.40 (1.01–1.94)**	1.79 (1.10–2.90)***	0.51 (0.25–1.04)*
Garbage	1.31 (0.99–1.75)*	1.12 (0.74–1.69)	1.02 (0.61–1.70)	1.27 (0.87–1.86)	1.32 (0.93–1.89)
Buried or left in open	1.62 (0.94–2.79)*	1.36 (0.97–1.91)*	1.05 (0.71–1.55)	1.15 (0.71–1.89)	1.04 (0.77–1.40)
Breastfeeding					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	0.72 (0.55–0.95)**	0.79 (0.61–1.01)*	0.73 (0.49–1.08)	0.73 (0.56–0.95)**	0.81 (0.62–1.06)
Baby postnatal check					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	1.03 (0.79–1.34)	0.96 (0.73–1.27)	0.88 (0.67–1.15)	1.29 (0.95–1.74)*	1.52 (1.15–1.99)***
History of ate any solid, semi-solid, or soft foods)					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	3.08 (1.89–5.02)***	1.93 (1.41–2.65)***	1.89 (1.28–2.79)***	2.01 (1.42–2.86)***	1.87 (1.37–2.54)***
Measles vaccine					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	0.95 (0.72–1.25)	0.89 (0.7–1.14)	1.14 (0.84–1.54)	1.15 (0.88–1.51)	1.23 (0.95–1.60)
Source of Information Factors					
Television					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	1.82 (1.00–3.33)***	0.71 (0.54–0.93)**	0.78 (0.57–1.06)	0.85 (0.57–1.27)	1.09 (0.79–1.49)
Newspaper					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	0.83 (0.61–1.12)	1.07 (0.80–1.44)	1.36 (1.00–1.86)**	1.12 (0.86–1.46)	1.30 (0.95–1.78)*
Radio					
No	Ref.	Ref.	Ref.	Ref.	Ref.
Yes	0.91 (0.68–1.22)	1.04 (0.83–1.30)	0.97 (0.72–1.29)	0.85 (0.65–1.13)	1.20 (0.92–1.58)

*p<0.1; **p<0.05; ***p<0.01

Discussion

This study presents national-level prevalence data and determinants of diarrhea in children under 5 years in five selected Southeast Asian countries. Diarrhea is still a common health problem in children under 5 years of age in developing countries (Kumar & Subita, 2012). On the basis of the results of this study, the prevalence of diarrhea in five selected countries in Southeast Asia ranged from 8.39% to 18.21%. Particularly in Indonesia, the prevalence of diarrhea is slightly different from the data reported by the National Health Survey at 11.0% (Riskesdas, 2018). This is because the Ministry of Health data is taken from doctor's diagnosis. While many parents do not take their children with diarrhea

to health care facilities (Kakulu, 2012). It is estimated that only 31.0% of Southeast Asians seek care for children with diarrhea (Lamberti, Fischer Walker, & Black, 2012). A systematic study reports that every child under 5 years of age in Southeast Asia has experienced 2.4 episodes of diarrhea in 1 year (Walker, Perin, Aryee, Boschi-Pinto, & Black, 2012), and it is estimated that 64.8%, 34.7%, and 0.5% of Southeast Asian children under 5 years have mild, moderate, and severe diarrhea, respectively (Lamberti et al., 2012). Healthy children are less likely to suffer from severe diarrhea (Walker et al., 2013), so preventing diarrhea requires a healthy lifestyle from birth. Prevention that can be pursued is in the form of improving water quality, sanitation, and hygiene (Cairncross et al., 2010).

In this study, we found that individual factors, environmental and household factors, health behaviors, and sources of information associated with the incidence of diarrhea in five Southeast Asian countries. These findings are related to the ecological theory of Uri Bronfenbrenner (Bronfenbrenner, 1994). The theory mentioned that children's health development is affected by multiple levels of the surrounding environment, from immediate settings of family and school to broad cultural values, laws, and customs. To optimize the children's health, the focus observation is not only on the children themselves but also on a larger environment as well. Bronfenbrenner divided the person's environment into five different systems: microsystem (immediate environment), mesosystem (connections), exosystem (indirect environment), macrosystem (social and cultural values), and chronosystem (changes over time). The most influential level is the microsystem because the closest interaction between individual children and family, and will be influenced by the mesosystem to chronosystem respectively.

This study found that individual factors associated with the incidence of diarrhea in children under 5 years include younger maternal age. The results of this study are the same as those of previous studies. In Indonesia (Eka Susanti, Novrikasari, & Sunarsih, 2016; Santika et al., 2020) and Cambodia (Pisey & Banchonhattakit, 2020), we found that younger mothers tend to have children suffering from diarrhea and the prevalence of diarhea decreases with increasing maternal age. Women can use the years before becoming a mother to complete their education, build careers, and seek parenting knowledge as a preparation for mature decision making (Duncan, Lee, Rosales-Rueda, & Kalil, 2018). So, when they become mothers, they have more experience to care for and maintain children's health, including feeding and hygiene.

In environmental and household factor variables, children under 5 years from richer households were less likely to have diarrhea especially in Myanmar and the Philippines. The results of this study are supported by previous research in developing countries (Braimoh et al., 2021; Nandi, Megiddo, Ashok, Verma, & Laxminarayan, 2017). Richer households have handwashing soap and stations (Kamm et al., 2014). A meta-analysis study states that hand washing can reduce 47% of the risk of diarrhea (Curtis & Cairncross, 2003). Hygiene practices also contribute to the incidence of diarrhea for children under 5 years; households with less dirty sewerage had lower diarrhea prevalence (Agustina et al., 2013).

Health behavior factors that related to the incidence of diarrhea are health facility visits except ini Timor-Leste, disposal of stool in drain/ditch, breastfeeding except in Myanmar and Timor-Leste, history of eating any solid, semi-solid, or soft foods. Bringing to a health facility is the mother's first response and the cause of the timely provision of aid for children with diarrhea (Degefa, Gebreslassie, Meles, & Jackson, 2018). Mothers in Indonesia prefer to take their children with diarrhea to a general practitioner (Irnawati & Salimo, 2018), and one third of children with diarrhea in Cambodia are taken to private health service centers (Mao, Saint, & Nit, 2005). The choice of health services for children with diarrhea is influenced by the mother's perception of the urgency of signs and symptoms and maternal literacy (Adane, Mengistie, Mulat, Kloos, & Medhin, 2017). Children who visit health facilities suffer more from diarrhea which can be caused by nosocomial diarrhea. Hundreds of patients worldwide suffer from diarrhea caused by hospital-acquired and healthcare-related infections (World Health, 2014). Patients may face some risks of pathogen exposure while in the hospital, such as contact with other patients and healthcare professionals or contamination from the hospital environment (Tietjen, Bossemeyer, & McIntosh, 2003) or inadequate infection control measures such as poor hand washing (Pittet et al., 2008). This incident mostly occurred in children under 1 year (69.7%) than aged 1–6 months (Alrifai, Alsaadi, Mahmood, Ali, & Al-Kaisi, 2009).

Under-five years who are breastfeeding are less likely to suffer from diarrhea. There are studies that reveal that breastfeeding is not in accordance with the recommendations related to the incidence of diarrhea in children (Horta & Victora, 2013; Siregar, Pitriyan, & Walters, 2018). Infants under 6 months who were not exclusively breastfed had 265% chance of incidence of diarrhea (Lamberti, Fischer Walker, Noiman, Victora, & Black, 2011), which decreased to 64% at 7–23 months of age compared with those who were exclusively breastfed (Yofrido et al., 2019). Inadequate breastfeeding increases the risk of diarrhea because breastfeeding provides immunity to the child's digestive system. Breast milk provides immunoglobulin A (IgA) immunity to fight pathogens and protect from infection and contains lactoferrin, as a growth factor for lymphocytes, can destroy pathogens and regulate immune response (Palmeira & Carneiro-Sampaio, 2016).

Stool disposed of in the drain or ditch is significantly associated with diarrhea in children under 5 years. This is in line with previous research in Cambodia (Pisey & Banchonhattakit, 2020), Myanmar (Kamp, 2017), Timor-Leste (Mizumoto et al., 2015), the Philippines (Sangalang et al., 2020), and Indonesia (Cronin, Sebayang, Torlesse, & Nandy, 2016; Krisnana, Pradanie, & Mustika, 2020). Children's stools who are not disposed in the toilet is associated with increased diarrhea (Bawankule, Singh, Kumar, & Pedgaonkar, 2017). Systematic studies of unsafe stool disposal were associated with 23% increased risk of diarrhea in children (Gil, Lanata, Kleinau, & Penny, 2004). Unsafe stool disposal can cause fecal contamination of the environment. Almost 78% of environmental compartments, such as soil, water, and food, were contaminated by *Escherichia coli* (*E. coli*) (Holcomb et al., 2020) and five times more likely to develop diarrhea from *E. coli* (George et al., 2016).

Children under 5 years with a history of semi-solid solid eating tend to be more likely to have diarrhea. This is supported by previous research in developing countries (Gizaw, Woldu, & Bitew, 2017; Mizumoto et al., 2015). In developing countries, solid and semi-solid feedings are used as complementary foods for children (Sheth & Dwivedi, 2006). However, complementary feeding before the end of the exclusive breastfeeding period can increase the risk of diarrhea (World Health, 2009). Moreover, children under 5 years of age are at greater risk of being exposed to food pathogens that can cause diarrhea (Woldt & Moy, 2015), including *E. coli*, *Shigella*, *Salmonella*, *Campylobacter*, *Yersinia*, and *Clostridium* spp. (Akhondi & Simonsen, 2020). Apart from exposure to pathogens that enter through the fecal and oral routes, diarrhea can also be caused by lactose and gluten intolerance (Humphries & Linscott, 2015).

Source of information is one of the factors contributing to the incidence of diarrhea where television and newspapers. These media have a significant relationship with diarrhea incidence especially in Indonesia, Myanmar, Timor-Leste. Television and newspaper are the most accessible information and frequently used by people in Southeast Asian countries. The previous studies stated that most of information presented in the television and newspaper are using medical term, uncomplete information, and guideline the treatment of diarreha (Panuju, 2017; Prasanti, 2017). Furthermore, it makes difficult for society to understand about diarrhea. However the quality of source information needs to evaluate by health expert and the information that can be used as a health reference should be from health-based information media. The number of accessible health information-based media is positively related to decision making and health information search (Jesus, 2013).

The treatment of diarrhea is influenced by health behavior in regional differences of Southeast Asian. Indonesia, which has a very large area with various cultures, has different management of diarrhea, such as taking treatment to a traditional healer, herbal leaves, and assuming that diarrhea is not a dangerous disease (Hariani & Ramlah, 2019; Syahrani, Asrina, & Yusriani., 2020). In cambodia, the local society using traditional treatment to overcome diarrhea by using guava leaves and herbal medicine (Iaen, Heang, & Kim, 2017; Nariddh, 2021). In Timor-Leste, the initial treatment of diarrhea using boiled leaves and coconut oil (Zwi et al., 2009). In Myanmar, local society using traditional medical plant and *Saccharomyces boulardii* (a probiotic yeast that has a di-rect antagonistic effect on many pathogens) (Htwe, Yee, Tin, & Vandenplas, 2008; Li et al., 2018). Additionally, the avocado and guava leaves are impletement in Philipinnes to overcome the diarrea (Bersamin et al., 2021). Furthermore, As a health worker specially as nurses, an attitude of respecting the belief in traditional community medicine is needed. However, monitoring and providing understanding to the community on the management of diarrhea is needed to prevent the severity of diarrhea.

Practice implications

Diarrhea management needs collaborative action among the community, leaders, and healthcare workers. Based on Bronfenbrenner's Ecological Systems Theory, at the level of microsystem, nurses can optimize the education programs such as food preparation, cleanness, and food storage regularly, and providing information about initial treatment and MSD symptoms should be well known to community and parents. Then, at the level of the macrosystem, nurses can collaborate with community leaders regarding the environment's cleanness and sanitation control. A monthly intervention to clean the environment and sanitation can be initiated from the small area. Not only social factors but also cultural values, nurses should disseminate information in collaboration with a community leader or PHC regarding the traditional medicine, and local or cultural beliefs to treat diarrhea properly. This information is important because Soultheast Asean Countries have my cultural believes. Furthermore, cross-collaboration among nurses, medical doctors, and sanitarians is needed to tackle childhood diarrhea and minimize the severity.

Recommendations and limitations

There are multiple factors that contribute to the incidence of diarrhea, ranging from individual to sources of information factors. Clearly, multi-factor causes require multi-factor handling as well. Based on the present study, the prioritized recommendation by optimizing health education to modify health behavior from microsystem to macrosystem and government roles to pursue the policy to decrease the prevalence of diarrhea. Additionally, the setting minimum age of marriage for the prospective bride and groom. Expansion of coverage of health services for all residents, promotion and facilitation of exclusive breastfeeding and complementary foods for children according to age. Attention to sources of information is required. The attention is not only to the amount of media and information, but also the quality of accurate information. However, the present study obtained through survey methods and it prone to research bias related to recall and the perceived stigma regarding the variables.

Conclusions

The incidence of diarrhea in five selected countries in Southeast Asia is related to many factors. Significantly, younger maternal age, richer household, frequency of health facility visits, stool disposal in drain or ditch, breastfeeding, history of eating any solid, semi-solid, or soft foods, and sources of information have a significant relationship with the incidence of diarrhea in children under 5 years. Preventive and curative approaches based on those determinants are needed to impliement to decrease the prevalence and the severy of diarrhea. This study can be a valuable information for the government to arrange the policy in handling childhood diarrhea.

CRediT authorship contribution statement

Hidayat Arifin: Conceptualization, Data curation, Formal analysis, Methodology, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Windy Rachmawati:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. **Yulia Kurniawati:** Conceptualization, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Rifky Octavia Pradipta:** Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing. **Ferry Efendi:** Validation, Visualization, Writing – original draft, Writing – review & editing. **Gusmaniarti Gusmaniarti:** Validation, Visualization, Writing – original draft, Writing – review & editing. **Iqbal Pramukti:** Project administration, Resources, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Joel Rey U. Acob:** Methodology, Writing – original draft, Writing – review & editing. **Agoestina Soares:** Methodology, Writing – original draft, Writing – review & editing. **Nyein Moh Moh Myint:** Methodology, Writing – original draft, Writing – review & editing. **Setyowati Setyowati:** Writing – review & editing. **Rosnani Rosnani:** Writing – review & editing. **Devi Mediarti:** Writing – review & editing. **Kuei-Ru Chou:** Writing – review & editing.

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