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Risk Factors of Infant Diarrhea and Under-five Children Diarrhea

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Abstract

BACKGROUND: Infant and under-five children diarrhea in Indonesia is a health problem that seriously impacts death.

AIM: The main objective of this study was to determine the most significant factors that influence infant and under-five children diarrhea between the years 2012 and 2017.

METHODS: This study used data from the Indonesia Demographic and Health Survey of 2012 and 2017 with a cross-sectional design. We modeled the infant and under-five of age children diarrhea as categorical dependent variable (diarrhea vs. no diarrhea of the infant and under-five of age children). At the same time, 14 covariates are used as an independent variable using $\chi 2$ statistic and multiple logistic regression (MLR).

FINDINGS: For infant diarrhea, television as an information resources showed the highest positive coefficient (OR = 1.966; β = 3.35; and p = 0.001) significant covariate for 2012. Higher mother education was negative correlation (β = –2.31 and p = 0.021) for infant diarrhea in 2017. For under-five children diarrhea, reading newspaper and magazine < 1 a week showed positive coefficients (OR = 1.059; β = 2.62; and p = 0.009) for 2012. Sex of household head female showed the highest positive coefficient (OR = 1.387; β = 2.82; and p = 0.005) for under-five children diarrhea in 2017.

CONCLUSIONS: The finding has important policy implications for infant and under-five of age diarrhea intervention programs. Thus, activities focus on the proper hygienic toilet, improving health information from newspapers, magazines, and TV.

Introduction

Indonesia is globally, with a population of 264 million spread across 34 provinces and 17,000 islands (Trading Economics. Indonesia – Economic Indicators [Trading Economics Website]., 2018) [1]. Infant and under-five mortality is critical in developing countries such as Indonesia. The infant mortality rate and the under-five mortality rate are the indicators included in the 2015–2019 Medium-Term National Development Plan (RPJMN) (National Population and Family Planning Board (BKKBN), Statistics Indonesia (BPS), Ministry of Health (Kemenkes), 2017) [2]. Diarrhea diseases remain among the most common causes of mortality and morbidity in children, particularly in low- and middle-income countries (Liu *et al*., 2015) [3]. Diarrheal is the second leading cause of death in children and is responsible for killing around 525,000 children every year (World Health Organization, 2017) [4]. Diarrhea accounts for an estimated 3.6% of the global disease burden, as expressed in disability-adjusted life years (Murray *et al*., 2012) [5].

Several factors affect the occurrence of diarrhea; these include a child of age, maternal education, household income, environmental sanitation, water availability, and quality (Anteneh *et al*., 2017; Azage *et al*., 2016; Tambe *et al*., 2015) [6], [7], [8]. Living in rural areas was associated with diarrhea disease (Workie *et al*., 2019) [9]. Shine *et al*., 2020 [10] showed an inverse relationship between birth order and diarrhea in children. Low maternal education and poor sanitation were significant predictors of diarrheal disease occurrence in children under 5 years (Gunsa *et al*., 2018; Melese *et al*., 2019) [11], [12].

The main objectives: (i) To determine the covariates that influence infant and under-five diarrhea using $\chi 2$ and multiple logistic regression (MLR), (ii) to compare infant and under-five children diarrhea between in 2012 and 2017, especially reading infant 12 versus infant 17 and under-five 12 against under-five 17,

and (iii) understanding the diarrhea risk factors for infant and under-five children.

Materials and Methods

Input IDHS data

The data sets used in this study were derived from the 2012 and 2017 surveys. The IDHS data set consisted of 16652 respondents, taken from 2012 and 15963 respondents, and taken from 2017. In 2012, 517 infant diarrhea and 1914 under 5 years of age diarrhea were among these. In 2017, 475 infant diarrhea and 1788 under 5 years of age had diarrhea. The sampling techniques, survey design, survey instruments, measuring system, and quality control have been discussed (IDHS data source: https://dhsprogram.com/data/dataset/Indonesia_Standard-DHS_2017.cfm?flag=0).

Methodological approach

Our methodology is based on the application of bivariate analysis, namely, $\chi 2$ test, to examine various predictors and response variables using a single population. We used the STATA 15 software system for our research. The methodology used MLR, where the goal was to determine which predictor variables influence (a) infant diarrhea and (b) under-five diarrhea. The main predictor variables are the type of place, gender of the child, mother's age, mother's and father's education, sex of household head, wealth index, birth order, type of toilet facility, radio, TV, newspaper or magazine, and province (Table 1).

Ethical review and consent

The IDHS in 2012 and 2017 obtained ethical permits from the Ministry of Health of Indonesia. All respondent identifiers were deleted from the data and written informed consents were provided by each participant. The ICF International, which is part of the DHS program, approved the use of such data in this study.

Results

Results using χ^2-test: Understanding associations

The χ^2-test shows the association between the selected covariates of infant and under-five diarrhea. Table 2 contains the results of the Chi-square test. The first column of Table 2 represents the attributes of selected covariates sequentially for which the association is to be tested. Based on their respective p-values, in 2012, we say that mother's age, father's education, wealth index, birth order, radio, and province are significant covariates for infant diarrhea. Whereas, type of place, gender of the child, mother's age, mother's and father's education, wealth index, type of toilet facility, source of water, radio, TV, reading newspaper or magazine, and province are also significant covariates for under-five diarrhea.

In 2017, the type of place, mother's age, mother's and father's education, wealth index, type of toilet facility, TV, and reading newspaper or magazine were significant factors for infant diarrhea. Whereas, kind of place, gender of the child, mother's age, mother's and father's education, wealth index, type of toilet facility, TV, and province are also significant factors for under-five diarrhea.

Results using MLR

We create Table 3 to show the logistic effect of the selected covariates on infant and under- five diarrhea. Table 3 have been selecting covariates and odds ratio (OR) which are statistically significant. Using the MLR, television showed the significant covariate (p=0.001) for 2012. The corresponding ORs were 1.966. While age of the mother 30- 39 years (p=0.004) in 2012 and > 40 years (p=0.04) was significant covariates.

The sex of household head female (p-0.005) showed the most significant covariate for 2017. The corresponding OR was 1.387. Then, the second most significant covariate in 2017 was birth order 2-6 years (p= 0.009). The corresponding OR was 1.215. Information resources and reading magazine < 1 a week was significant (p= 0.038) for 2017. The corresponding OR was 1.167. The unprotected main water source (p=0.037) was significant. The corresponding OR was 1.148. While age of the mother > 40 years (p=0.005) was significant.

Discussion

Using the χ^2 test, we have got six significant covariates out of 14 covariates for infant diarrhea in 2012 and eight covariates in 2017. Using the χ^2 test, 12 significant covariates were in 2012 and 10 in 2017. This is shown in Table 2 in online supplementary document, using χ^2 for infants and under-five: 2012 versus 2017.

Table 2 in the Online Supplementary Document indicates that mother's age, birth order, radio, and region are the first four top significant covariates for

AQ10 **Table 1: Background characteristics of child diarrhea in 2012 and 2017***

Study number	Covariates	2012 (a)				2017 (b)			
		Infant		Under 5 years		Infant		Under 5 years	
		No diarrhea (2925)	Diarrhea (517)	No diarrhea (11296)	Diarrhea (1914)	No diarrhea (2905)	Diarrhea (475)	No diarrhea (10795)	Diarrhea (1788)
1	Type of place								
	Urban	1335 (45.64)	224 (43.3)	5306 (46.97)	774 (40.44)	1453 (50.02)	205 (43.16)	5417 (50.18)	821 (45.92)
	Rural	1590 (54.36)	293 (56.67)	5990 (53.03)	1140 (59.56)	1452 (49.98)	270 (56.84)	5378 (49.82)	967 (54.08)
2	Gender of child								
	Male	1527 (52.21)	267 (51.64)	5689 (50.36)	1123 (58.67)	1485 (51.12)	260 (54.74)	5474 (50.71)	975 (54.53)
	Female	1398 (47.79)	250 (48.36)	5607 (49.64)	791 (41.33)	1420 (48.88)	215 (45.26)	5321 (49.29)	813 (45.47)
3	Age of the mother								
	<20	209 (7.15)	61 (11.80)	189 (1.67)	62 (3.24)	145 (4.99)	40 (8.42)	124 (1.15)	35 (1.96)
	20–29	1497 (51.18)	301 (58.22)	5017 (44.41)	998 (52.14)	1389 (47.81)	226 (47.58)	4052 (37.54)	817 (45.69)
	30–39	1101 (37.64)	138 (26.69)	4966 (43.96)	716 (37.41)	1212 (41.72)	182 (38.32)	5354 (49.60)	772 (43.18)
	>40	118 (4.03)	17 (3.29)	1124 (9.95)	138 (7.21)	159 (5.47)	27 (5.68)	1265 (11.72)	164 (9.17)
4	Mother's education								
	Primary	903 (30.87)	159 (30.75)	3746 (33.16)	749 (39.13)	643 (22.13)	133 (28.00)	2833 (26.24)	525 (29.36)
	Secondary	1572 (53.74)	298 (57.64)	5990 (53.03)	979 (51.15)	1643 (56.56)	282 (59.37)	6020 (55.77)	1006 (56.26)
	Higher	450 (15.38)	60 (11.61)	1560 (13.81)	186 (9.72)	619 (21.31)	60 (12.63)	1942 (17.99)	257 (14.37)
5	Father's education								
	Primary	923 (31.56)	180 (34.82)	3613 (31.98)	733 (38.30)	708 (24.37)	152 (32.00)	2997 (27.76)	555 (31.04)
	Secondary	1587 (54.26)	293 (56.67)	6165 (54.58)	1020 (53.29)	1674 (57.62)	272 (57.26)	6137 (56.85)	1025 (57.33)
	Higher	415 (14.19)	44 (8.51)	1518 (13.44)	161 (8.41)	523 (18.00)	51 (10.74)	1661 (15.39)	208 (11.63)
6	Sex of household head								
	Male	2697 (92.21)	472 (91.3)	10475 (92.73)	1772 (92.58)	2638 (90.81)	434 (91.37)	9970 (92.36)	1635 (91.44)
	Female	228 (7.79)	45 (8.70)	821 (7.27)	142 (7.42)	267 (9.19)	41 (8.63)	825 (7.64)	153 (8.56)
7	Wealth index								
	Poorest	840 (28.72)	153 (29.59)	3260 (28.86)	696 (36.36)	730 (25.13)	142 (29.89)	2831 (26.23)	549 (30.70)
	Poorer	617 (21.09)	109 (21.08)	2190 (19.39)	428 (22.36)	577 (19.86)	106 (22.32)	2075 (19.22)	379 (21.20)
	Middle	499 (17.06)	105 (20.31)	2077 (18.39)	332 (17.35)	538 (18.52)	94 (19.79)	2014 (18.66)	331 (18.51)
	Richer	520 (17.78)	99 (19.15)	1925 (17.04)	274 (14.32)	529 (18.21)	84 (17.68)	1922 (17.80)	306 (17.11)
	Richest	449 (15.35)	51 (9.86)	1844 (16.32)	184 (9.61)	531 (18.28)	49 (10.32)	1953 (18.09)	223 (12.47)
8	Birth order (years)								
	1	1028 (35.15)	241 (46.62)	3973 (35.17)	711 (37.15)	888 (30.57)	164 (34.53)	3422 (31.70)	585 (32.72)
	2–6	1822 (62.29)	265 (51.26)	7009 (62.05)	1148 (59.98)	1970 (67.81)	306 (64.42)	7132 (66.07)	1173 (65.60)
	7 and above	75 (2.56)	11 (2.13)	314 (2.78)	55 (2.87)	47 (1.62)	5 (1.05)	241 (2.23)	30 (1.68)
9	Type of toilet facility								
	Hygienic	1713 (58.56)	299 (57.83)	9167 (81.15)	1448 (75.65)	2053 (70.67)	296 (62.32)	7527 (69.73)	1111 (62.14)
	Unhygienic	1212 (41.44)	218 (42.17)	2129 (18.85)	466 (24.35)	852 (29.33)	179 (37.68)	3268 (30.27)	677 (37.86)
10	Main source of water								
	Protected	2310 (78.97)	390 (75.44)	9565 (84.68)	1545 (80.72)	2484 (85.51)	396 (83.37)	9204 (85.26)	1474 (82.44)
	Unprotected	615 (21.03)	127 (24.56)	1731 (15.32)	369 (19.28)	421 (14.49)	79 (16.63)	1591 (14.74)	314 (17.56)
11	Information resources (radio)								
	No	2105 (71.97)	409 (79.11)	8299 (73.47)	1477 (77.17)	2440 (83.99)	407 (85.68)	9071 (84.03)	1516 (84.79)
	Yes	820 (28.03)	108 (20.89)	2997 (26.53)	437 (22.83)	465 (16.01)	68 (14.32)	1724 (15.97)	272 (15.21)
12	Information resources (TV)								
	No	563 (19.25)	84 (16.25)	1997 (17.68)	431 (22.52)	391 (13.46)	82 (17.26)	1385 (12.83)	283 (15.83)
	Yes	2362 (80.75)	433 (83.75)	9299 (82.32)	1483 (77.48)	2514 (86.54)	393 (82.74)	9410 (87.17)	1505 (84.17)
13	Reading newspaper or magazine								
	Not at all	1524 (52.10)	248 (47.97)	5797 (51.32)	1011 (52.82)	1598 (55.01)	311 (66.95)	6268 (58.06)	1028 (57.49)
	<1 a week	1042 (35.62)	204 (39.46)	4017 (35.56)	719 (37.57)	1018 (35.04)	124 (26.11)	3471 (32.15)	611 (34.17)
	≥1 a week	359 (12.27)	65 (12.57)	1482 (13.12)	184 (9.61)	289 (9.95)	33 (6.95)	1056 (9.78)	149 (8.33)
14	Province								
	Aceh	102 (3.49)	17 (2.9)	361 (3.20)	66 (3.45)	164 (5.65)	24 (5.05)	577 (5.35)	107 (5.98)
	North sumatra	118 (4.03)	26 (5.03)	535 (4.74)	81 (4.23)	159 (5.47)	38 (8.00)	580 (5.37)	120 (6.71)
	West sumatra	90 (3.08)	17 (3.29)	331 (2.93)	55 (2.87)	70 (2.41)	11 (2.32)	235 (2.18)	41 (2.29)
	Riau	93 (3.18)	22 (4.26)	408 (3.61)	83 (4.34)	67 (2.31)	15 (3.16)	250 (2.32)	44 (2.46)
	Jambi	82 (2.80)	14 (2.71)	255 (2.26)	49 (2.56)	43 (1.48)	4 (0.84)	145 (1.34)	23 (1.29)
	South sumatra	83 (2.84)	11 (2.13)	379 (3.36)	46 (2.40)	80 (2.75)	12 (2.53)	247 (2.29)	45 (2.52)
	Bengkulu	53 (1.81)	19 (3.68)	212 (1.88)	41 (2.14)	36 (1.24)	13 (2.74)	170 (1.57)	32 (1.79)
	Lampung	76 (2.60)	19 (3.68)	326 (2.89)	46 (2.40)	68 (2.34)	15 (3.16)	256 (2.37)	49 (2.74)
	Bangka belitung	90 (3.08)	18 (3.68)	289 (2.56)	32 (1.67)	45 (1.55)	3 (0.63)	177 (1.64)	18 (1.01)
	Riau islands	65 (2.22)	10 (1.93)	301 (2.66)	33 (1.72)	59 (2.03)	10 (2.11)	227 (2.10)	26 (1.45)
	Jakarta	145 (4.96)	27 (5.22)	497 (4.40)	76 (3.97)	97 (3.34)	17 (3.58)	341 (3.16)	51 (2.85)
	West java	119 (4.07)	26 (5.03)	528 (4.67)	70 (3.66)	272 (9.36)	46 (9.68)	1053 (9.75)	182 (10.18)
	Central java	109 (3.73)	19 (3.68)	404 (3.58)	64 (3.34)	186 (6.40)	28 (5.89)	676 (6.26)	93 (5.20)
	Yogyakarta	82 (2.80)	5 (0.97)	300 (2.66)	25 (1.31)	37 (1.27)	2 (0.42)	118 (1.09)	8 (0.45)
	East java	124 (4.24)	22 (4.26)	409 (3.62)	65 (3.40)	172 (5.92)	36 (7.58)	702 (6.50)	85 (4.75)
	Banten	123 (4.21)	29 (5.61)	467 (4.13)	84 (4.39)	92 (3.17)	15 (3.16)	356 (3.30)	41 (2.29)
	Bali	81 (2.77)	10 (1.93)	333 (2.95)	37 (1.93)	33 (1.14)	0 (0.00)	177 (1.64)	24 (1.34)
	West nusa tenggara	83 (2.84)	11 (2.13)	333 (2.95)	59 (3.08)	80 (2.75)	15 (3.16)	299 (2.77)	61 (3.41)
	East nusa tenggara	79 (2.70)	18 (3.48)	342 (3.03)	71 (3.71)	155 (5.34)	19 (4.00)	601 (5.57)	97 (5.43)
	West kalimantan	83 (2.84)	21 (4.06)	311 (2.75)	99 (5.17)	67 (2.31)	5 (1.05)	229 (2.12)	30 (1.68)
	Central kalimantan	73 (2.50)	12 (2.32)	256 (2.27)	56 (2.93)	38 (1.31)	5 (1.05)	135 (1.25)	29 (1.62)
	South kalimantan	78 (2.67)	14 (2.71)	289 (2.56)	59 (3.08)	39 (1.34)	6 (1.26)	154 (1.43)	38 (2.13)
	East kalimantan	63 (2.15)	16 (3.09)	286 (2.53)	46 (2.40)	61 (2.10)	12 (2.53)	296 (2.74)	65 (3.64)
	North kalimantan	81 (2.77)	10 (1.93)	297 (2.63)	46 (2.40)	48 (1.65)	10 (2.11)	159 (1.47)	31 (1.73)
	North sulawesi	61 (2.09)	15 (2.90)	288 (2.55)	62 (3.24)	23 (0.79)	3 (0.63)	109 (1.01)	20 (1.12)
	Central sulawesi	106 (3.62)	23 (4.45)	385 (3.41)	101 (5.28)	73 (2.51)	15 (3.16)	263 (2.44)	40 (2.24)
	South sulawesi	64 (2.19)	12 (2.32)	341 (3.02)	62 (3.24)	105 (3.61)	20 (4.21)	346 (3.21)	69 (3.86)
	South-east sulawesi	62 (2.12)	15 (2.90)	239 (2.12)	61 (3.19)	100 (3.44)	18 (3.79)	361 (3.34)	67 (3.75)
	Gorontalo	80 (2.74)	21 (4.06)	309 (2.74)	73 (3.81)	38 (1.31)	4 (0.84)	121 (1.12)	30 (1.68)
	West sulawesi	101 (3.45)	3 (0.58)	375 (3.32)	44 (2.30)	105 (3.61)	17 (3.58)	368 (3.41)	67 (3.75)
	Maluku	86 (2.94)	10 (1.93)	323 (2.86)	52 (2.72)	142 (4.89)	14 (2.95)	509 (4.72)	63 (3.52)
	North maluku	102 (3.49)	7 (1.35)	313 (2.77)	36 (1.88)	58 (2.00)	12 (2.53)	230 (2.13)	55 (3.08)
	West papua	88 (3.01)	6 (1.16)	274 (2.43)	34 (1.78)	40 (1.38)	5 (1.05)	147 (1.36)	16 (0.89)
	Papua					53 (1.82)	6 (1.26)	181 (1.68)	21 (1.17)

infant diarrhea in 2012. The lower importance covariate is the wealth index. On the other hand, the Online Supplementary Document shows that mother's and father's education, wealth index, type of toilet, and reading newspaper or magazine are the first five top importance covariates for infant diarrhea in 2017.

AQ10 **Table 2: Association of infant diarrhea and under 5 years diarrhea to the selected covariates by χ^2-test for 2012 and 2017***

Number	Covariates	2012				2017			
		Infant diarrhea		Under 5 years diarrhea		Infant diarrhea		Under 5 years diarrhea	
		χ^2-test	p-value	χ^2-test	p-value	χ^2-test	p-value	χ^2-test	p-value
1	Type of place	0.949	0.330	28.123	0.000	7.686	0.006	11.153	0.001
2	Gender of child	0.055	0.814	45.253	0.000	2.139	0.144	8.966	0.003
3	Age of the mother	31.552	0.000	71.805	0.000	9.959	0.019	56.065	0.000
4	Mother's education	5.464	0.065	38.978	0.000	21.983	0.000	17.137	0.000
5	Father's education	12.546	0.002	52.854	0.000	22.039	0.000	20.448	0.000
6	Sex of household head	0.497	0.481	0.055	0.814	0.154	0.694	1.790	0.181
7	Wealth index	12.322	0.015	94.371	0.000	20.310	0.000	42.969	0.000
8	Birth order (years)	24.832	0.000	2.988	0.224	3.601	0.165	2.740	0.254
9	Type of toilet facility	0.096	0.756	31.359	0.000	13.444	0.000	14.267	0.000
10	Main source of water	3.254	0.071	19.148	0.000	1.482	0.223	3.991	0.046
11	Information resources (radio)	11.388	0.001	11.645	0.001	0.879	0.348	0.660	0.417
12	Information resources (TV)	2.591	0.107	25.551	0.000	4.907	0.027	11.987	0.001
13	Information resources (reading newspaper or magazine)	3.274	0.195	18.505	0.000	23.776	0.000	5.375	0.068
14	Region	63.032	0.001	130.091	0.000	39.872	0.191	77.082	0.000

Table 3: Multiple logistic regression estimates for the effect of the selected covariates on infant diarrhea and under-five diarrhea in 2012 and 2017

Number	Covariates	2012					2017				
		Coefficient (β)	*p*	OR	95% CI for OR		Coefficient (β)	*p*	OR	95% CI for OR	
					Lower	Upper				Lower	Upper
A	Infant diarrhea										
1	Type of place										
	Urban	-	-	1.000	-	-	-	-	1.000	-	-
	Rural	−1.39	0.165	0.783	0.554	1.106	1.50	0.133	1.245	0.935	1.659
2	Gender of child										
	Male	-	-	1.000	-	-	-	-	1.000	-	-
	Female	0.78	0.433	1.115	0.849	1.462	−0.63	0.526	0.926	0.731	1.174
3	Age of the mother										
	<20	-	-	1.000	-	-	-	-	1.000	-	-
	20–29	−1.27	0.205	0.729	0.447	1.188	−1.11	0.268	0.768	0.481	1.225
	30–39	−2.88	0.004	0.406	0.220	0.750	−1.46	0.144	0.680	0.405	1.142
	>40	−2.05	0.040	0.415	0.179	0.962	−0.43	0.670	0.860	0.430	1.721
4	Mother's education										
	Primary	-	-	1.000	-	-	-	-	1.000	-	-
	Secondary	0.12	0.905	1.021	0.729	1.427	−1.13	0.257	0.829	0.600	1.146
	Higher	−0.93	0.354	0.769	0.440	1.341	−2.31	0.021	0.517	0.296	0.904
5	Father's education										
	Primary	-	-	1.000	-	-	-	-	1.000	-	-
	Secondary	−0.43	0.665	0.931	0.674	1.286	−0.11	0.914	0.983	0.720	1.344
	Higher	−1.47	0.143	0.651	0.367	1.155	−0.83	0.407	0.793	0.458	1.374
6	Sex of household head										
	Male	-	-	1.000	-	-	-	-	1.000	-	-
	Female	−0.29	0.775	0.933	0.583	1.495	−0.02	0.988	0.997	0.663	1.498
7	Wealth index										
	Poorest	-	-	1.000	-	-	-	-	1.000	-	-
	Poorer	−1.62	0.105	0.676	0.421	1.086	0.39	0.699	1.085	0.716	1.644
	Middle	−0.80	0.424	0.799	0.462	1.384	1.26	0.208	1.341	0.849	2.118
	Richer	−1.54	0.123	0.623	0.340	1.137	1.47	0.141	1.463	0.880	2.430
	Richest	−2.47	0.014	0.409	0.201	0.831	−0.24	0.811	0.926	0.492	1.743
8	Birth order (years)										
	1	-	-	1.000	-	-	-	-	1.000	-	-
	2–6	−1.21	0.226	0.801	0.559	1.147	−1.86	0.062	0.757	0.565	1.015
	7 and above	−0.90	0.370	0.663	0.269	1.630	−1.41	0.158	0.396	0.108	1.431
9	Type of toilet facility										
	Hygienic	-	-	1.000	-	-	-	-	1.000	-	-
	Unhygienic	−0.96	0.337	0.827	0.562	1.218	1.24	0.216	1.211	0.893	1.642
10	Main source of water										
	Protected	-	-	1.000	-	-	-	-	1.000	-	-
	Unprotected	1.42	0.156	1.296	0.905	1.855	−0.44	0.660	0.925	0.653	1.309
11	Radio										
	No	-	-	1.000	-	-	-	-	1.000	-	-
	Yes	−1.71	0.088	0.752	0.542	1.043	−0.55	0.584	0.916	0.668	1.255
12	TV										
	No	-	-	1.000	-	-	-	-	1.000	-	-
	Yes	3.35	0.001	1.966	1.324	2.920	−1.28	0.199	0.768	0.514	1.149
13	Reading newspaper or magazine										
	Not at all	-	-	1.000	-	-	-	-	1.000	-	-
	<1 a week	1.35	0.178	1.246	0.904	1.719	−1.91	0.056	0.758	0.570	1.007
	≥1 a week	0.88	0.380	1.247	0.761	2.042	−0.06	0.954	0.985	0.586	1.652
B	Under-five diarrhea										
1	Type of place										
	Urban	-	-	1.000	-	-	-	-	1.000	-	-
	Rural	0.95	0.345	1.089	0.912	1.300	0.44	0.663	1.037	0.879	1.224
2	Gender of child										
	Male	-	-	1.000	-	-	-	-	1.000	-	-
	Female	−4.71	0.000	0.715	0.622	0.823	−1.34	0.181	0.922	0.818	1.038
3	Age of the mother										
	<20	-	-	1.000	-	-	-	-	1.000	-	-
	20–29	−2.40	0.017	0.587	0.385	0.911	−0.89	0.373	0.789	0.468	1.329
	30–39	−3.88	0.000	0.401	0.258	0.644	−2.19	0.029	0.553	0.325	0.940
	>40	−3.51	0.000	0.374	0.221	0.658	−2.79	0.005	0.454	0.261	0.792
4	Mother's education										
	Primary	-	-	1.000	-	-	-	-	1.000	-	-
	Secondary	0.44	0.657	1.041	0.870	1.247	−1.25	0.210	0.901	0.770	1.068
	Higher	0.27	0.788	1.049	0.738	1.492	−0.84	0.398	0.890	0.683	1.172

(Contd...)

Table 3: (*Continued*)

Number	Covariates	2012					2017				
		Coefficient (β)	*p*	OR	95% CI for OR		Coefficient (β)	*p*	OR	95% CI for OR	
					Lower	Upper				Lower	Upper
5	Father's education										
	Primary	-	-	1.000	-	-	-	-	1.000	-	-
	Secondary	−0.59	0.555	0.951	0.806	1.122	−0.46	0.647	0.962	0.816	1.134
	Higher	−0.92	0.356	0.855	0.614	1.191	−1.84	0.066	0.766	0.576	1.017
6	Sex of household head										
	Male	-	-	1.000	-	-	-	-	1.000	-	-
	Female	−0.49	0.623	0.934	0.712	1.225	2.82	0.005	1.387	1.105	1.740
7	Wealth index										
	Poorest	-	-	1.000	-	-	-	-	1.000	-	-
	Poorer	−0.21	0.831	0.976	0.783	1.217	1.87	0.116	1.242	0.990	1.559
	Middle	−0.64	0.525	0.922	0.719	1.183	0.88	0.638	1.126	0.863	1.468
	Richer	−1.28	0.201	0.828	0.620	1.106	1.54	0.262	1.266	0.938	1.709
	Richest	−1.54	0.123	0.754	0.527	1.079	0.34	0.868	1.066	0.760	1.496
8	Birth order (years)										
	1	-	-	1.000	-	-	-	-	1.000	-	-
	2–6	1.00	0.319	1.089	0.920	1.290	2.60	0.009	1.215	1.049	1.407
	7 and above	−1.19	0.233	0.752	0.471	1.201	−0.90	0.370	0.781	0.455	1.341
9	Type of toilet facility										
	Hygienic	-	-	1.000	-	-	-	-	1.000	-	-
	Unhygienic	1.06	0.288	1.114	0.913	1.360	1.41	0.157	1.170	0.941	1.456
10	Main source of water										
	Protected	-	-	1.000	-	-	-	-	1.000	-	-
	Unprotected	0.98	0.326	1.112	0.899	1.376	2.09	0.037	1.148	1.008	1.307
11	Information resources (radio)										
	No	-	-	1.000	-	-	-	-	1.000	-	-
	Yes	0.52	0.606	1.048	0.876	1.252	0.93	0.354	1.089	0.909	1.304
12	Information resources (TV)										
	No	-	-	1.000	-	-	-	-	1.000	-	-
	Yes	−0.76	0.455	0.922	0.749	1.134	−1.32	0.188	0.843	0.654	1.086
13	Information resources (reading newspaper or magazine)										
	Not at all	-	-	1.000	-	-	-	-	1.000	-	-
	<1 a week	2.62	0.009	1.059	1.061	1.496	2.07	0.038	1.167	1.008	1.352
	≥1 a week	−0.55	0.583	0.622	0.626	1.305	0.17	0.862	1.022	0.797	1.310

OR: Odds ratio, CI: Confidence interval.

Table 2 in Online Supplementary Document indicates that type of place, gender of the child, mother's age, mother's and father's education, wealth index, type of toilet, source of water, TV, reading newspaper or magazine, and region are the first 11 top importance covariates for under-five diarrhea in 2012. On the other way, mother's age, mother's and father's education, wealth index, type of toilet, and region are the first six top importance covariates for under-five diarrhea in 2017.

Table 3 in the online supplementary document shows that the first top significant covariate is watching TV and it was high importance covariates for infant diarrhea in 2012. We have only one covariate; reading newspapers or magazines was an important covariate for under-five diarrhea in 2012. In 2017, we had three significant covariates for under-five diarrhea in online supplementary document. Among them, the female sex of household head was the highest importance covariates for under-five diarrhea. The lower risk significant factors are: Birth order 2–6 years and reading newspaper and magazine < 1 a week, whereas we had only 11 important covariates out of 14 in 2017.

Television is an important covariate for infant diarrhea in 2012, reading newspaper or magazines as significant covariates for under-five diarrhea in 2012 and 2017. Our studies also found radio associated with diarrhea pada infants and under-five in 2012. Women who read newspapers/magazines were more likely to provide sufficient fluids and food, and those exposed to the TV were more likely to provide zinc supplementation. Since mothers' exposure to newspaper/magazines, TV, and radio showed associations with some recommended practices for treating childhood diarrhea, mass media has the potential to improve diarrhea management practices (Alam *et al*., 2019) [13]. Mass media has disseminated several public messages regarding various social and medical issues. Studies have been conducted to determine whether there is an association between mass media exposure and people's knowledge, practice, and health outcomes (Naugle and Hornik, 2014) [14].

Analysis of Diouf *et al*. (2014) [15] and de Oliveira Borba Vasconcelos *et al*. (2018) [16] shows that a mother's age has a significant risk of diarrhea in children. This study shows that the mother's age significantly influences diarrhea in infants under-five between 2012 and 2017. In our research, χ^2-test indicates a relationship between the gender of a child with under-five diarrhea in 2012 and 2017. From the results of multiple logistic regression, it was found that the sex of toddler girls is lower the risk of diarrhea than boys in 2012. While researching de Oliveira Borba Vasconcelos *et al*. (2018) [16] and Melese *et al*. (2019) [12], there is no relationship between sex and the incidence of diarrhea in infants. Diarrhea in boys under five may be caused by their activities outside the home, playing in the field or playing with dirt in a dirtier condition, while toddler girls play more in the house with cleaner conditions.

Our results from the result of the χ^2-test showed a relationship of type of place with under-five diarrhea in 2012 and 2017. There was a relationship between the type of residence and diarrhea in infants in 2012. Workie *et al*. (2019) [9] found that living in the rural has a higher risk of under-five diarrhea than in the

urban. In contrast, in the study data, de Oliveira Borba Vasconcelos *et al*. (2018) [16], living in cities is more at risk of diarrhea in infants in 1997 and living in villages is more at risk of diarrhea in infants in 2006.

The result of the χ^2-test shows that there is a relationship between a mother's education with infant diarrhea in 2017. There is a relationship between a mother's education with under-five diarrhea in 2012 and 2017. Father's education significantly affected diarrhea in infants and under-five in 2012 and 2017. Results research Mulatya and Ochieng (2020) [17] parents or caregivers with lower education were twice likely to predispose their children to a diagram, which is consistent with other findings. Lower educated parents have limited knowledge and awareness on appropriate child care as they are less likely to access health-care services and messaging than higher educated counterparts. Mother's literacy influences hygienic practices, child feeding, weaning, and sanitation practices, essential factors for childhood diarrhea.

The results of the χ^2-test show that the type of toilet facility was associated with diarrhea in infants in 2012 and under-five in 2012 and 2017. The MLR test shows that hygiene toilets significantly caused diarrhea in under-five in 2017. The results of this study are in line with the findings of de Oliveira Borba Vasconcelos *et al*. (2018) [16] unsanitary hygiene habit significantly caused diarrhea in children in 1997 and 2006. The type of toilet facility had a significant association with diarrheal morbidity. Children from households who have no toilet facilities have 6 times more risk for having diarrhea than children from families who have toilet facilities (Mihrete *et al*., 2014) [18].

The primary water source is associated with diarrhea in the under-five of 2012 and 2017. On the contrary, MLR shows no link between the utilization of different water sources or improved sanitation and diarrhea prevalence. Research result Diouf *et al*. (2014) [15] shows no relationship between water source and diarrhea. Instead, research Otsuka *et al*. (2019) [19] children from households using open containers for water storage were significantly associated with an increased risk of diarrhea. Depending on the etiology, diarrhea diseases can be transmitted through many pathways. Blocking one or two transmission pathways cannot meet the purpose, as sources of infection remain ubiquitous, which may explain the missing effect in our study settings.

The region was associated with diarrhea in infants in 2012 and under-five in 2012 and 2017. West java had the highest diarrhea in infants and under-five diarrhea in 2017, Banten with the highest infant diarrhea in 2012, West Kalimantan with under-five diarrhea the highest in 2012.

Conclusions

In 2012, in Online Supplementary Document, significant covariates were: Mother's age, father's education, wealth index, birth order, radio, and province are significant covariates for infant diarrhea. Whereas, type of place, gender of the child, mother's age, mother's and father's education, wealth index, type of toilet facility, source of water, radio, TV, reading newspaper or magazine, and province are also significant covariates for under-five diarrhea. In 2017, type of place, mother's age, mother's and father's education, wealth index, type of toilet facility, TV, and reading newspaper or magazine are significant factors for infant diarrhea. Whereas, type of place, gender of child, mother's age, mother's and father's education, wealth index, type of toilet facility, TV, and province are also significant factors for under-five diarrhea. This study allows policy makers to make appropriate decisions to reduce infant and under-five diarrhea in Indonesia.

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