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Anemia in Pregnancy and Low Birth Weight Before and During the COVID-19 Pandemic in Kalijambe

Anemia pada Kehamilan dan Berat Bayi Lahir Rendah Sebelum dan Selama Pandemi COVID-19 di Kalijambe

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ABSTRACT

Pregnant women and infants were a vulnerable group during the COVID-19 pandemic. This research aimed to determine anemia in pregnancy and Low Birth Weight (LBW) before and during the COVID-19 pandemic and analyze their associated factors. This was a cross-sectional study used secondary data from maternal and child health records in Kalijambe Public health center, Sragen. A total of 1169 birth records from the period of 2019-2020 were collected. The chi-square and logistic regression were used to analyze the differences and significant associated factors. The prevalence of anemia in pregnancy increased from 38.33% in 2019 to 49.21% in 2020 ($p=0.013$). However, the LBW proportion decreased from 7.26% in 2019 to 6.02% in 2020 ($p=0.415$). Mother who suffered from chronic energy deficiency marked by Mid-Upper Arm Circumference (MUAC) < 23.5 cm was higher risk of anemia (aOR 1.86;95%CI 1.13-3.08). Considering the gestational age when the hemoglobin (Hb) test, anemia was more likely to be found at the second (aOR 2.59;95%CI 1.37-4.86) and third trimester (aOR 6.97;95%CI 3.98-12.20). High-risk pregnancy had higher odds of LBW (aOR 8.57;95%CI 1.65-44.37), while anemia showed no effect on LBW (aOR 1.80;95% CI 0.34-9.45). These results were adjusted for mothers' age, parity, abortus, infection during pregnancy, high-risk pregnancy, MUAC, preterm birth, and gestational age. COVID-19 pandemic increased the prevalence of anemia in pregnancy but had no impact on LBW. Several factors for anemia and LBW were significantly associated. This finding suggests the need for early risk detection and routine, standardized, and comprehensive antenatal care.

ABSTRAK

Wanita hamil dan bayi merupakan kelompok rentan selama pandemi COVID-19. Penelitian ini bertujuan untuk mengetahui anemia pada kehamilan dan Berat Bayi Lahir Rendah (BBLR) sebelum dan selama pandemi serta menganalisis faktor yang memengaruhinya. Penelitian ini merupakan penelitian potong lintang dengan menggunakan data sekunder Kesehatan Ibu dan Anak (KIA) di Puskesmas Kalijambe, Sragen. Sebanyak 1169 catatan kelahiran pada tahun 2019 dan 2020 diikutkan dalam penelitian. Data dianalisis menggunakan uji chi square dan regresi logistik untuk mengetahui perbedaan dan faktor yang memengaruhinya. Prevalensi anemia meningkat dari 38,33% pada tahun 2019 menjadi 49,21% pada tahun 2020 ($p=0,013$). Namun, prevalensi BBLR menurun dari 7,26% pada 2019 menjadi 6,02% pada tahun 2020 ($p=0,415$). Ibu hamil yang mengalami kurang energi kronis dengan Lingkar Lengan Atas (LILA) < 23,5 cm berisiko lebih tinggi mengalami anemia (aOR 1.86;95%CI 1.13-3.08). Dilihat dari usia kehamilan saat pemeriksaan hemoglobin (Hb), anemia lebih banyak ditemukan pada trimester kedua (aOR 2.59;95%CI 1.37-4.86) dan ketiga (aOR 6.97;95%CI 3.98-12.20). Kehamilan risiko tinggi cenderung melahirkan bayi dengan BBLR (aOR 8.57;95%CI 1.65-44.37), sedangkan anemia tidak berhubungan dengan BBLR (aOR 1.80;95%CI 0.34-9.45). Hasil ini disesuaikan dengan usia ibu, paritas, riwayat abortus, infeksi selama kehamilan, kehamilan risiko tinggi, LILA, kelahiran prematur, dan usia kehamilan. Pandemi COVID-19 meningkatkan prevalensi anemia pada kehamilan tetapi tidak berdampak pada

BBLR. Beberapa faktor yang memengaruhinya telah teridentifikasi. Hasil penelitian ini, menunjukkan perlunya deteksi dini risiko dan perawatan antenatal care secara rutin, terstandarisasi dan komprehensif.

INTRODUCTION

The COVID-19 pandemic has impacted vulnerable groups such as pregnant women and infants. Several factors may associate with the increased severity of COVID-19 in pregnancy. There are Physiological and anatomic changes, hormonal imbalance, alterations in immune systems, and increased expression of ACE2.¹ A previous study reported the increase in severe maternal morbidity, mortality, and neonatal complications, especially for those who had comorbid before the pregnancy.² The COVID-19 confirmed that mother with high-risk pregnancies (either preexisting chronic medical conditions in pregnancy or obstetrical disorders occurring in pregnancy) was found to have more adverse maternal outcomes such as severe respiratory symptoms, invasive mechanical ventilation, and admission to ICU.³ Even though no major complications, severe maternal morbidity, and perinatal deaths were reported in a systematic review with 108 pregnancies.⁴

Another concern is the COVID-19 pandemic created a stressful environment that prevented pregnant mothers from getting routine Antenatal Care (ANC). There were fourteen deaths of women during pregnancy and postpartum in West Sumatra province in only two months (March to May 2020). This maternal mortality occurred due to the inability to access proper health care, such as suspicion of being infected from COVID-19, and limited healthcare personnel and facility.⁵ Similar findings were reported in two midwife clinics in 2020; 26.67% of pregnant women did not get their routine ANC in Jakarta,⁶ and 20.00% did not access the 4th ANC in andung.⁷ A previous study that used demographic and health survey data from 10 countries showed inadequate ANC, delayed conception, and maternal age had greater potential effect on birth weight.⁸ Despite being stressed during the COVID-19 pandemic, the lockdown phases in Austria seems to have no significant negative effect on extremely preterm birth rates and newborn weight among non-infected mothers.⁹ During the period of January-April 2020, where Ireland applied lockdown due to COVID-

19, the number of Very Low Birth Weight (VLBW) and Extremely Low Birth Weight (ELBW) decreased compared to the same periods for the last two decades.¹⁰ However, the pathway was still poorly understood rather than socio-environmental and behavior modifiers in pregnancy.¹⁰

Anemia in pregnancy and Low Birth Weight (LBW) are major indicators for maternal and infant outcomes. A study of 66 confirmed pregnant women showed laboratory changes that included increased levels of Lactate Dehydrogenase (LDH), creatinine, D-dimer, and C-Reactive Protein (CRP), anemia, and leukopenia. Low erythrocytes and lymphocytes levels were the main predictors of severe COVID-19 in pregnant women.¹¹ Anemia was found as a maternal adverse outcome due to COVID-19 as well as decreased fetal movement, intrauterine fetal distress, Premature Rupture of Membrane (PROM), preterm labor, and Multiple Organ Dysfunction Syndrome (MODS). Meanwhile, the neonatal outcomes were still birth, prematurity, asphyxia, fetal distress, LBW, Small for Gestational Age (SGA), Large for Gestational Age (LGA), MODS, disseminated intravascular coagulation, and neonatal death.¹² A previous study revealed that maternal anemia was more likely to have LBW than non-anemic mothers.^{13,14}

Anemia in pregnancy is an indirect cause of maternal death in Indonesia, reaching 305/100.000 live births,¹⁵ and determinant for LBW.^{15,16} However, there is still limited evidence investigating the impact of the COVID-19 pandemic on these indicators in this country, and their associated factor has not been clarified. Therefore, this study aimed to examine the anemia in pregnancy and LBW before and during the first year of COVID-19 pandemic and analyze their significant associated factors.

MATERIAL AND METHOD

A cross-sectional study used secondary data from maternal and child records at the Kalijambe Public Health Centre, a primary government owned the health care facility that provided personal and public health programs. The

District of Kalijambe is inhabited by 48.693 residents,¹⁷ located in the southwest area of Sragen Regency, Central Java Province, Indonesia. The prevalence of LBW in Sragen Regency in 2019 was 677 from 14.056 births (4.81%) and 704 from 13.426 births (5.24%) in 2020.¹⁸ A total of 1169 births from 2019 (before pandemic) to 2020 (pandemic) were collected. Since Indonesia had officially declared the first COVID-19 case in March 2020, a previous study showed the possibility of an undetected case at the beginning of the year 2020.¹⁹ Anemia in pregnancy was defined as hemoglobin (Hb) level below 11 g/dl (analyzed using hemato analyzer from venous blood sample at any gestational age). In addition, LBW was recorded if the baby's birth weight was less than 2500 grams (babies' birth weight was recorded by a midwife/health worker, defined as the first weight measured within hours after delivery). The mother's age was then categorized based on optimal pregnancy and delivery age (20-35 years old). Parity showed the number of child delivered, assigned as primipara, second para, and multipara (3 or more children). Preterm birth/PTB was defined as birth at gestational age less than 37 weeks. Mid Upper Arm Circumference (MUAC) was suitable for macro nutritional status for pregnant women, divided into less than 23.5 cm that indicated chronic energy deficiency.²⁰ History of abortion represented the number of Mothers' Abortion. In addition, being infected during pregnancy was recorded as well as a high-risk pregnancy. High-risk pregnancy was defined as pregnancy with at least one of the following conditions; such as severe preeclampsia, PROM, head-pelvic disproportion, PTB, placental abruption, ever Caesarean section, poor obstetrical history, proteinuria, hyperthyroid, butt or foot presentation, hypertension, placenta previa, vacuum extraction, Gemelli, and less than two years of pregnancy interval.

This study used the chi-squared test and fisher exact test to analyze the proportional difference of anemia in pregnancy, LBW, and related factors before and during the first year in pandemic. This analysis included all collected data. However, due to incomplete data, several variables had different total cases included in the analysis, such as mother ages (1140 cases), PTB (494 cases), parity (1154 cases), MUAC (532 cases), anemia in pregnancy (509 cases),

gestational age (484 cases), and baby's birth weight (1090 cases). Furthermore, this study involved 401 cases to analyze the characteristic of anemia in pregnancy and 221 cases for LBW. In order to investigate which factors influenced anemia in pregnancy and LBW, a binomial logistic regression was applied. This study was ethically approved by the Committee of Ethics for Health Research, Faculty of Medicine Universitas Islam Indonesia No. 24/Ka.Kom.Et/70/KE/VI/2021.

RESULTS

From 1169 births data collected in the Kalijambe district, 623 were born in 2019 (before the pandemic) and 546 babies in 2020 (first year of the pandemic). Table 1 showed the characteristic of birth in those years based on maternal demography and reproductive health conditions, and the infant's characteristics.

Based on Table 1, the majority of babies were delivered from mothers at optimal productive ages at 20-35 years old (83.68%), and a similar proportion was found between two years ($p=0.861$). Majority of babies were delivered a term (93.12%). Even though PTB increased during the pandemic, there was no significant different ($p=0.920$). In terms of parity, it was distributed equally in two years ($p=0.963$). Almost one-third of pregnant women who delivered babies were multipara, and there were no significant differences between the two years. Most of the mothers (74.25%) had adequate nutritional status marked by $MUAC \geq 23.5$ cm, and there were no differences in maternal nutritional status before and after pandemic ($p=0.791$).

On the other hand, the prevalence of anemia in pregnancy increased from 38.33% (97 of 253) in 2019 to 49.21% (126 of 256) in 2020, and it was a significant difference ($p=0.013$). A statistical difference was found following the gestational age when the blood test was taken ($p=0.000$). The majority of blood test was taken in the third trimester (44.83%), which the highest proportion (27.27%) was in 2020. Even though 93.30% of babies were born at the normal birth weight (≥ 2500 grams), the prevalence of LBW in Kalijambe was 7.26% (43 of 592) in 2019 and 6.02% (30 of 498) in 2020. However, there were no significant differences in their proportion ($p=0.415$). The majority of Mothers had no history of Abortion (91.27%) and no

high-risk pregnancy (89.56%), and there were no significant differences before and during the pandemic. However, even though almost no

mother was reported infection during pregnancy, there were 2 cases of COVID-19 infection in pregnant women in 2020 (Table 1).

Table 1. Characteristic of Birth Before and During the First Year of COVID-19 Pandemic

Characteristic	Year of Birth						p-value
	2019 (Before Pandemic)		2020 (First Year of the Pandemic)		Total		
	n	%	n	%	n	%	
Mother's Age (Years)							
< 20	17	1.49	12	1.05	29	2.54	0.861
20-35	511	44.82	443	38.86	954	83.68	
> 35	85	7.46	72	6.32	157	13.77	
Total	613	53.77	527	46.23	1140	100	
Pre-Term Birth							
Yes (< 37 weeks)	15	3.04	19	3.85	34	6.88	0.920
No (≥ 37 weeks)	207	41.90	253	51.21	460	93.12	
Total	222	44.94	272	55.06	494	100	
Parity							
Primipara	189	16.38	165	14.30	354	30.68	0.963
Second para	232	20.10	209	18.11	441	38.21	
Multipara	192	16.64	167	14.47	359	31.11	
Total	613	53.12	541	46.88	1154	100	
Mid Upper Arm Circumference							
< 23.5 cm	70	13.16	67	12.59	137	25.75	0.791
≥ 23.5 cm	207	38.91	188	35.34	395	74.25	
Total	277	52.07	255	47.93	532	100	
Anemia in pregnancy							
Yes (Hb < 11 g/dl)	97	19.06	126	24.75	223	43.81	0.013
No (Hb ≥ 11 g/dl)	156	30.65	130	25.54	286	56.19	
Total	253	49.71	256	50.29	509	100	
Gestational Age When Took Blood Test							
1 st trimester	85	17.56	61	12.60	146	30.17	0.000
2 nd trimester	68	14.05	53	10.95	121	25.00	
3 rd trimester	85	17.56	132	27.27	217	44.83	
Total	238	49.17	246	50.83	484	100	
Baby's Birth Weight							
Low Birth Weight (< 2500 gram)	43	3.94	30	2.52	73	6.70	0.415
Normal Birth Weight (≥ 2500 gram)	549	50.37	468	39.33	1017	93.30	
Total	592	54.31	498	41.85	1090	100	
Ever Abortus							
Never	567	48.50	500	42.77	1067	91.27	0.301
1x	39	3.34	38	3.25	77	6.59	
2x and more	17	1.45	8	0.68	25	2.14	
Total	623	53.29	546	46.71	1169	100	
Infection During Pregnancy							
No infection	620	53.04	538	46.02	1158	99.06	N/A
HbsAg+	3	0.26	3	0.26	6	0.51	
HIV+	0	0.00	3	0.26	3	0.26	
COVID-19+	0	0.00	2	0.17	2	0.17	
Total	623	53.29	546	46.71	1169	100	
High-Risk Pregnancy							
Yes	73	6.24	49	4.19	122	10.44	0.126
No	550	47.05	497	42.51	1047	89.56	
Total	623	53.29	546	46.71	1169	100	

Source: Secondary Data of Public Health Centre Kalijambe, 2019-2020

Anemia in Pregnancy, Low Birth Weight and Their Characteristics

Table 2 showed cross tabulation among maternal demography, productive characteristic with anemia in pregnancy and LBW. There were 401 cases included in the analysis of anemia in pregnancy; 172 (42.89%) had anemia. The proportion of anemia in pregnancy was higher for mothers who took a blood test in the third trimester (60.86%, 112 of 184) and was associated significantly with anemia in pregnancy ($p=0.000$). The other factors, such as mothers' age, parity, MUAC, abortus, high-risk pregnancy,

and infection during pregnancy, did not associate with anemia in pregnancy.

Based on table 2, total of 221 cases were included in the analysis; 11 (4.98%) babies had LBW. There were significant differences in the proportion of high-risk pregnancy ($p=0.007$), gestational age when taking a blood test for Hb ($p=0.041$), and PTB ($p=0.007$) among babies with low and normal birth weight. In contrast, mothers' age, parity, MUAC, infection during pregnancy, abortus, and anemia showed no association with LBW.

Table 2. Anemia in Pregnancy, Low Birth Weight and Their Characteristics

Characteristic	Anemia in Pregnancy			<i>p</i> -value	Birth Weight			<i>p</i> -value
	Yes n = 172	No n = 229	Total n = 401		Low n = 11	Normal n = 210	Total n = 221	
Mother's Age (Years)³								
< 20	7	4	11		3	40	43	
20-35	134	189	323	0.286 ¹	8	170	178	0.451 ²
> 35	31	36	67					
Parity³								
Primipara	53	61	114		6	59	65	
Second para	71	92	163	0.468 ¹	5	151	156	0.086 ²
Multipara	48	76	124					
Mid Upper Arm Circumference (Cm)								
< 23.5 Cm	53	52	105		4	48	52	
≥ 23.5 Cm	119	177	296	0.068 ¹	7	162	169	0.291 ²
Infection During Pregnancy								
Yes	2	1	3		1	0	1	
No	170	228	398	0.404 ¹	10	210	220	0.050 ²
High-Risk Pregnancy								
Yes	21	25	46		5	24	29	
No	151	204	355	0.688 ¹	6	186	192	0.007 ²
Ever Abortus³								
Never	159	208	367		11	191	202	
1 x	10	19	29	0.481 ¹	0	19	19	0.605 ²
2 x and more	3	2	5					
Gestational Age When Took Blood Test³								
1 st trimester	24	97	121		5	38	43	
2 nd trimester	36	60	96	0.000 ¹	6	172	178	0.041 ²
3 rd trimester	112	72	184					
Anemia in Pregnancy								
Yes (Hb <11 g/dl)					4	93	97	
No (Hb ≥ 11 gr/dl)					7	117	124	0.759 ²
Pre-Term Birth								
Yes (< 37 weeks)					3	6	9	
No (≥ 37 weeks)					8	204	212	0.007 ²

Source: Secondary Data of Public Health Centre Kalijambe, 2019-2020

¹Chi squared test

²Fisher Exact test

³for birth weight analysis, there are only two group for mother's age (non optimum < 20 years & > 35 years vs optimum 20-35 years); parity (primipara vs second & multipara); ever abortus (never vs 1 x & more); and gestational age (1st trimester vs 2nd & 3rd trimester)

Factor Influencing Anemia in Pregnancy and Low Birth Weight

Table 3 provided binomial logistic regression analysis of anemia in pregnancy and LBW. Based on table 3, pregnant women with smaller MUAC were more likely to have anemia than their counterparts (aOR 1.86; 95% CI 1.13-3.08).

Mothers who took a blood test in the third trimester were 6.9 times (95% CI 3.98-12.20) higher to have anemia in pregnancy compared to those who took in the first trimester. This was consistent for the second trimester (aOR 2.59 with 95% CI 1.37-4.86). Whereas mothers' age, parity, abortus, high-risk pregnancy, and infection during pregnancy were not significantly influenced on anemia in pregnancy.

A baby with LBW was more likely to be born from a mother with high-risk pregnancy (aOR 8.57 with 95%CI 1.65-44.37). In addition, mothers who took a blood test for Hb at second and third trimesters had lower odds of LBW than the first trimester (aOR 0.15 with 95% CI 0.02-0.86). Meanwhile, anemia in pregnancy had 1.8 times more risk of having LBW, with no statistically significant (95% CI 0.34-9.45). Furthermore, mothers' age, parity, abortus, infection during pregnancy, MUAC, and PTB did not significantly influence baby's birth weight.

Table 3. Factor Influencing Anemia in Pregnancy and Low Birth Weight

Factor Predictor	Anemia in Pregnancy (n=401)			Low Birth Weight (n=221)		
	Adjusted Odd Ratio	95% C.I.for aOR		Adjusted Odd Ratio	95% C.I.for aOR	
		Lower	Upper		Lower	Upper
Mother's Age (Years)³						
< 20 ¹						
20-35 ²	0.401	0.101	1.590			
> 35	0.546	0.123	2.416	2.010	0.410	9.856
Parity³						
Primipara ¹						
Second para	1.261	0.730	2.177	0.219 [†]	0.041	1.180
Multipara	0.928	0.492	1.748			
Ever Abortus³						
Never ¹						
1 x	0.877	0.359	2.141	0.000	0.000	-
2 x and more	1.842	0.236	14.392			
High-Risk Pregnancy						
Yes	1.062	0.536	2.105	8.573 [*]	1.656	44.371
No ¹						
Infection During Pregnancy						
Yes	3.661	0.292	45.947	N/A	0.000	
No ¹						
Mid-Upper Arm Circumference (Cm)						
< 23.5 Cm	1.866 [*]	1.130	3.080	2.053	0.434	9.700
≥ 23.5 Cm ¹						
Gestational Age When Took Blood Test³						
1 st trimester ¹						
2 nd trimester	2.590 ^{**}	1.379	4.863	0.158 [*]	0.029	0.869
3 rd trimester	6.978 ^{***}	3.989	12.204			
Pre-Term Birth						
Yes (< 37 weeks)				5.427 [†]	0.889	33.123
No (≥ 37 weeks) ¹						
Anemia in Pregnancy						
Yes (Hb < 11 g/dl)				1.804	0.344	9.457
No (Hb ≥ 11 g/dl) ¹						

Source: Secondary Data of Public Health Centre Kalijambe, 2019-2020

¹Reference group for binomial logistic regression analysis for anemia in pregnancy and LBW

²Reference group for Mother's age at LBW analysis was optimum age (20-35 yr)

³For LBW analysis, there are only two group for mother's age (non optimum < 20 years & > 35 years vs optimum 20-35 years); parity (primipara vs second & multipara); ever abortus (never vs 1x & more); and gestational age (1st trimester vs 2nd trimester & 3rd trimester)

[†]p<0.1, ^{*}p<0.05, ^{**}p<0.01, ^{***}p<0.001

DISCUSSION

Anemia in Pregnancy and Low Birth Weight Before and After Pandemic COVID-19

A total of 509 cases included in the analysis showed that the prevalence of anemia in pregnancy was 38.33% in 2019 and 49.21% in 2020. According to WHO, this prevalence indicates moderate to severe public health problems.²¹ This prevalence was similar to Indonesia Basic Health Research Report in 2018 (48.90%).²² However, this result was higher than global prevalence (36.90%).²³ Prevalence of anemia in pregnancy increased significantly during the COVID-19 pandemic ($p=0.013$). This condition was related to gestational age when taking a blood test for Hb. There was a higher proportion of Hb test at third trimester during pandemic (27.27%) than a year before (17.56%) with $p=0.000$. At the beginning of the pandemic, Kalijambe Public health center provided online classes for pregnant women (after being stopped for a while) and ANC services by preparing PPE for health workers, hand hygiene facilities and normal working hours. However, due to limited PPE, delivery is only served at public health center which used to be partially performed at the midwife clinic. The first ANC visit (K1) in 2019 and 2020 was similar (100%) but slightly decreased in the fourth ANC visit (K4) in 2020 (87.74%) compared to 2019 (88.61%). The government issued guidelines for the care of pregnant women during the COVID-19 pandemic, such as 6 times ANC, iron tablets as needed and online classes for pregnant women, especially in the red zone.²⁴ However, it has not been well-implemented due to lack of socialization. Disruption in maternal services during pandemic were reported worldwide, such as declining the first ANC and facilities-based deliveries.²⁵ Two models from UNICEF in South Asian countries revealed the direct and indirect impact of COVID-19 on health, economic and food security. Therefore, the provision of basic health services and nutritional intervention during pregnancy and infancy is urgently needed.²⁶ Rapid and massive socialization of the new guidelines through online and offline platforms is required to minimize information gaps.

Factors Influencing Anemia in Pregnancy

Regardless of the year of birth, 401 cases were

included in further analysis. Gestational age when taking blood tests was consistently associated with anemia. The second and third trimesters were more likely to have Hb levels less than 11 g/dl with aOR and 95% CI were 2.59; 1.37-4.86 and 6.97; 3.98-12.2 respectively. Similar findings in Ethiopia revealed second trimester (aOR 3.09, 95%CI 1.41-6.79) and third trimester (aOR 3.68, 95% CI 1.67-8.08) had higher odds to have anemia in pregnancy.²⁷ A Nation wide cross-sectional study in China showed the prevalence of anemia and Iron Deficiency Anemia (IDA) increased by gestational month, peaking at the eighth gestational month (24.00% for anemia and 17.80% for IDA).²⁸ According to WHO, mostly pregnant women suffered from IDA.²³ During pregnancy, the iron intake necessity is 0.8 mg/day in the first trimester and 3-6mg/day in the third trimester. This increasing is required for oxygen consumption for mother and fetal metabolism, fetal growth, expand the plasma volume, produce a greater quantity of red blood cells, and compensate for blood loss at delivery.²⁹

Indonesia, every pregnant woman is tested for hemoglobin (Hb) level at least 1x during pregnancy, usually at the first trimester. However, it varies in terms of gestational age. There will be an evaluation test in the third trimester if the previous showed anemia. Despite Hb level, every pregnant woman is given 90 Iron-Folic Acids (IFA) tablets during the pregnancy. However, considering the numerous gastrointestinal side effects that often lead to poor compliance.²⁹ Education and monitoring through interaction with health care staff increase the compliance of IFA in Kediri,³⁰ and reduce the prevalence of anemia toward pregnancy in Aceh.³¹ To these findings, it is necessary to have an early blood test in the first trimester and Re-evaluation in the third trimester. This procedure should become a nationwide standard; otherwise, there would be an underestimated prevalence of anemia if only done in the first trimester. Stewart T *et al.* recommends initial measurement of Hb and serum ferritin in the first trimester; to start oral tablets when Hb < 12 mg/dl and Normal serum ferritin or low (<30 mcg/dl); recheck in 28 weeks, unless initial Hb <10 mg/dl; and consider intravenous iron administration because of intolerance to oral tablet or persistent iron deficie-

ncy in 34 weeks and Hb < 7 mg/dl.³² Another strategy is needed to combat anemia, such as education, IFA supplements, modify dietary and iron-rich food fortification.

After being adjusted for several factors, maternal nutritional status had a significant effect on anemia. Mothers, who suffered from chronic energy deficiency marked by MUAC below 23.5 cm, was a higher risk of anemia (aOR 1.86; 95%CI 1.13-3.08). A previous study in Ethiopia found a similarity that mothers with anemia had a higher odds of low MUAC with OR 1.28(1.09-1.49).³³ This result reinforces the importance of early detection and early intervention with health education and a specific nutrition program before becoming pregnant.

Factors Influencing Low Birth Weight

Out of 1090 cases included in the analysis, the prevalence of LBW in Kalijambe was 7.26% in 2019 and 6.02% in 2020. However, this proportion was lower than the overall percentage globally (15.00-20.00%) and in South Asia countries (28.00%).³⁴ Compared to national data from 25 provinces (111.827 babies), the proportion of LBW was 3.40%. Moreover, according to Indonesia Basic Health Research in 2018, reported 6.2% LBW, from only 56.6% of babies that had birth weight recorded.²² The prevalence of LBW varied based on geographical area. For example, a hospital-based survey that involved 91 respondents in Palu, Central Sulawesi Province found 40.70% LBW and 72.50% maternal anemia.³⁵

The Prevalence of LBW reduced during the pandemic as well as PTB (n=494). However, it was not statistically significant with $p=0.415$ and $p=0.920$. the previous study showed similar findings in Austria,⁹ and Ireland.¹⁰ In addition, a study from the United States reported a significant (25%) lower odds of PTB during the COVID-19 pandemic compared with a similar pre-pandemic period in the peer-reviewed literature. Several hypotheses are declared for the positive effect of COVID-19 as a consequence of work from home such as less stress and anxiety, no shift work, no long hours, and less physical work, better support from partner and family, better nutrition, more exercise, better hygiene, fewer social interaction, fewer infection, less smoking,

fewer car accident, less air pollution, government financial assistance, and fewer medical intervention.³⁶

There were 221 cases regardless of the year of birth included in further analysis of LBW. Pre-term birth ($p=0.007$) was associated with LBW in bivariate analysis. However, after adjusting other factors, this variable became not significant. High-risk pregnancy was consistent and had a higher odd of LBW with aOR 8.57 and 95% CI 1.65-44.37. A previous case control. Study in Nepal found comorbidity during pregnancy was a risk factor for LBW (aOR 2.4 and 95% CI 1.3-4.5).³⁷ In addition, there was multi factorial nature of LBW such as PTB and SGA.³⁴ Since high-risk pregnancy was a determinant for maternal and infant morbidity and mortality especially during the COVID-19 pandemic, it is necessary to increase awareness of high-risk pregnancy through routine ANC and provide adequate care.

Anemia in pregnancy had a higher odd of LBW; however, it was not statistically significant (aOR 1.8; 95% CI 0.34-9.45). At the same time, mothers who had a blood test in the second and third trimester were less likely to have LBW (aOR 0.15; 95% CI 0.029-0.86). This result was similar to previous study in Tanzania that involved 442 participants, it is found that there was no association between anemia and LBW, PTB, or stillbirths.²¹ A prospective cohort study of 164 pregnant women who had their 4th ANC in Lampung showed no relationship between anemia and LBW.³⁸ Moreover, mothers' age, parity, abortus, MUAC, and infection during pregnancy showed no association with LBW.

To the best of our knowledge, this research is one of the limited studies examining the pandemic's impact on anemia in pregnancy and LBW and their related factors. All births recorded were analyzed. In this research, factors influencing anemia and LBW have been identified with adjustment for mothers' age, parity, abortus, infection during pregnancy, high-risk pregnancy, MUAC, PTB, and gestational age. However, there were several limitations, such as the variation of gestational age at the Hb test. Therefore, gestational age was included in the model. The completeness of data was a big obstacle in this research since several variables have miss-

ed. Consequently, only certain data were included in further analysis (as shown as quite wide of 95% CI for aOR in LBW). Reducing the number of MMR and IMR are the indicators of Sustainable Development Goals, and good quality MCH data are required. Since there is limited healthcare staff in public health center and, increasing burden during the COVID-19 pandemic (tracing, testing, treatment, and vaccination), it is necessary to have a friendly user and Innovative database management based on IT.

CONCLUSION AND RECOMMENDATION

The prevalence of anemia in pregnancy increased during the COVID-19 pandemic and becomes severe public health concern. However, the pandemic has no effect on LBW. Older gestational age and low MUAC were more likely to have anemia in pregnancy. In addition, High-risk pregnancy had a higher odd of LBW. Anemia in pregnancy showed no effect on LBW since gestational age had confounded this relationship. This finding suggests the need for early risk detection (first trimester) and a routine, standardized, comprehensive antenatal care. Several strategies should be implemented from health education (using online platforms and social media), supporting compliance of IFA supplementation and iron-rich food fortification, specific nutritional program, providing adequate care, and strengthening MCH database managerial to achieve the desired outcome for mother and infant.

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Application of Clean and Healthy Lifestyle in Household Management of Coastal Communities

Penerapan Perilaku Hidup Bersih dan Sehat dalam Tataan Rumah Tangga pada Masyarakat Wilayah Pesisir

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ABSTRACT

The coastal area needs special attention regarding the health management for the people living there. Wowo Tamboli Village, Kolaka Regency, Southeast Sulawesi is one of the coastal areas that need attention in terms of health, especially for people who live in unhealthy houses. This study aimed to investigate the application of clean and healthy lifestyle in household management of coastal community. This type of research was descriptive with a total sampling technique of 354 households. The research instrument used a questionnaire consists of respondents characteristic and ten indicators of clean and healthy lifestyle. The results showed that the community had properly implemented clean and health lifestyle on indicators of exclusive breastfeeding, using clean water, washing hands with clean water and soap, eradicating house larvae, eating fruits and vegetables every day, and doing physical activity every day. However, it was still found that the head of the family has not fully implemented a clean and healthy lifestyle because the birth process was still assisted by traditional birth attendants (3.40%), who did not weigh the infant and toddler because of distance from health services (2.50%) and there were community members who still smoke in the house (25.40%). The application of a clean and healthy lifestyle in households is good in 7 indicators. However, 3 indicators are still lack of application.

ABSTRAK

Wilayah pesisir perlu mendapatkan perhatian khusus dalam pengelolaan kesehatan masyarakat yang bermukim di wilayah tersebut. Desa Wowo Tamboli Kabupaten Kolaka Sulawesi Tenggara merupakan salah satu wilayah pesisir yang perlu mendapatkan perhatian dari segi kesehatan terutama bagi masyarakat yang tinggal di rumah yang tidak sehat. Penelitian ini bertujuan untuk mengetahui penerapan perilaku hidup bersih dan sehat dalam tataan rumah tangga pada masyarakat wilayah pesisir. Jenis penelitian ini adalah deskriptif dengan teknik total sampling sebanyak 354 rumah tangga. Instrumen penelitian menggunakan kuesioner yang berisi tentang karakteristik responden dan sepuluh indikator perilaku hidup bersih dan sehat. Hasil penelitian menunjukkan bahwa masyarakat telah menerapkan perilaku hidup bersih dan sehat dengan baik pada indikator memberikan ASI eksklusif, penggunaan air bersih, mencuci tangan dengan air bersih dan sabun, pemberantasan jentik rumah, makan buah dan sayur setiap hari, dan melakukan aktivitas fisik setiap hari. Namun, masih ditemukan kepala keluarga yang belum sepenuhnya menerapkan perilaku hidup bersih dan sehat karena proses persalinan masih ditolong oleh dukun beranak (3,40%), tidak menimbang bayi dan balita karena jarak yang jauh dari pelayanan kesehatan (2,50%), dan masih terdapat masyarakat yang masih merokok dalam rumah (25,40%). Penerapan perilaku hidup bersih dan sehat dalam rumah tangga sudah baik pada tujuh indikator. Namun, tiga indikator masih kurang penerapannya.

INTRODUCTION

Coastal areas are included in areas that are prone to health because they are place for mixing the effects of water, air, and land. Various health problems that arise include environmental health, maternal health, and family planning as well as infant and toddler health. Environmental health includes waste, excreta disposal, housing, wastewater, and garbage. Infant and toddler health includes immunization and nutrition.¹

Clean and healthy lifestyle is a set of behaviors that are practiced consciously based on the learning outcomes of a person, group, or community to be able to independently play an active role in realizing public health.² Clean and healthy lifestyle in household arrangements is an effort to empower members in the household to know, have will and ability to practice clean and healthy lifestyles and play an active role in the health movement.³

Riset Kesehatan Dasar (Riskesdas) data in 2018 noted that 10.7% of Indonesian population did not consume fruit or vegetable in one week. Proportion of Defecation behaviour to use the latrine is 88.2%, proportion of the population who has the correct behaviour in washing their hands using soap with flowing water is 49.8%, proportion of the population who still smokes in the building or room is 80.6% and proportion of the population with less activities is 33.5%. The population of Southeast Sulawesi which does not consume fruit or vegetables in one week is 11.1%, the population who defecates in the toilet is 87.3%, the population with correct behaviour in washing their hands is 42.3%, the population who smokes in the building or room is 92.1% and residents who do less physical activities is 35.5%.⁴

Many factors are associated with clean and healthy lifestyle in household settings. A study explains that the factors of knowledge, attitudes, habits, roles of health workers and informal leaders are related to clean and healthy lifestyle and the most dominant is the attitude factor.⁵ Environmental diseases due to lack of clean and healthy lifestyles implementation in the community include malaria, diarrhea, tuberculosis, skin diseases, dengue fever, nutritional disorders, Typhoid fever, ARI, and other digestive disorders. The three most common environmental diseases are diarrhea, tuberculosis, and malaria.⁶ Another

study stated that mothers with poor hygiene and healthy lifestyles tend to cause more diarrhea in toddlers.⁷ Previous research assessed the implementation of clean and healthy lifestyle in general without analyzing specifically the implementation of clean and healthy lifestyle on 10 indicators.

The COVID-19 pandemic that has occurred since 2020 requires people to live clean and healthy living behaviours to prevent the spread of COVID-19. Research conducted stated that there is a relationship between clean and healthy living habits to prevent the transmission of Covid-19 in RW.03 Ciganjur Village.⁸ Another study states that one of the Covid-19 prevention efforts carried out by the people of DKI Jakarta Province is a clean and healthy living culture through hand-washing activities, consuming nutritious food, regular exercise, adequate rest, not smoking, avoiding cigarettes, and maintaining environmental cleaning.⁹

Wowa Tamboli Village is one of the coastal areas in Kolaka Regency which is inhabited by 354 families. The results of recording from the Tosiba Health Center in 2019 obtained information that from 287 houses there were 153 which categorized as healthy homes and 95 houses that were categorized as unhealthy. Upper respiratory tract infections, influenza, typhoid fever, and dermatitis occupy the top 10 diseases in Wowa Tamboli village, Kolaka Regency, Southeast Sulawesi and one of the predisposing factors is the lack of PHBS implementation in the community. This condition makes researchers interested to analyzes about Application of Clean and Healthy Life Behaviour in Household Arrangements towards Communities in Coastal Areas. This research is expected to be able to find indicators of achieving clean and healthy lifestyles that have not been implemented by the community in Wowa Tamboli Kolaka Regency, Southeast Sulawesi, and to find the causal factors.

MATERIAL AND METHOD

This research is a quantitative descriptive study with population of 354 families who live in the village of Wowa Tamboli, Kolaka Regency, Southeast Sulawesi which is a coastal area. The sampling technique used was total sampling and the respondents were mothers or fathers who were the head of the household around 354 people.¹⁰ The variable in this study is the application

of clean and healthy lifestyle in the household which will be assessed based on 10 indicators, namely assisted delivery by health workers, exclusive breastfeeding, weighing infants and toddlers, using clean water, washing hands with clean water and soap, using healthy latrines, eradicating larvae at home, eating fruit and vegetables every day, doing physical activity every day, and do not smoke in the house.¹¹

This research was conducted from June to August 2021. Data collection is done primary and secondary. Primary data was obtained by observing or visiting the respondent's house who has home address in Wowa Tamboli Village, as well as conducting direct interviews with respondents based on a questionnaire list of research variables that had been compiled based on the research objectives. Secondary data was obtained from the medical records of Tosiba Health Center regarding the number of heads of families, data on healthy houses, and diseases that often occur in coastal areas. Data analysis was carried out descriptively to describe application distribution of 10 PHBS indicators in household arrangements in Wowa Tamboli Village using computer programs. This research has obtained *Ethical Clearance* No. 72/KEPK-IAKMI/VI/2021 from Ethic Health Research Commission (KEPK) Regional Committee IAKMI Southeast Sulawesi on Juni 3, 2021.

RESULTS

This section will explain the results of research that has been carried out regarding the characteristics of respondent and the application of clean and healthy lifestyle based on 10 indicators. Table 1 shows the characteristics of the heads of families who are respondents of the study. The results of data collection showed that the male head of family was dominated by 307 people (86.70%), the most family heads with the last education background were elementary school Around 188 people (53.10%), most of family heads worked as farmers with a total of 168 people (47.70%) and the average income of head of the family < 1,000,000 around 212 people (59.90 %).

Table 1. Characteristics of Respondents

Characteristics	n=354	%
Gender		
Male	307	86.70
Female	47	13.30
Education		
College	13	3.60
Senior High School	71	20.10
Junior High School	59	16.70
Primary School	188	53.10
No School	23	6.50
Profession		
Laborer	3	0.80
Honoror	4	1.10
Housewife	33	9.30
Employee	6	1.70
Village Head	1	0.30
Fisherman	60	16.90
Trader	5	1.40
Pensionary	2	0.60
Farmer	168	47.70
Government Employees	5	1.40
Carpenter	5	1.40
Entrepreneur	62	17.50
Income		
< 1.000.000	212	59.90
1.000.000 – 2.000.000	126	35.60
> 2.000.000 – 3.000.000	12	3.40
> 3.000.000	4	1.10

Source: Primary Data, 2021

Tabel 2 shows about Application of Clean and Healthy Lifestyle. There were 241 families (68.10%) who gave birth assisted by health workers and 12 people who don't (3.40%). There were 251 families (70.90%) who gave exclusive breastfeeding to infants and toddlers and 2 people who don't (0.60%). There were 244 families (68.93%) who weighed infants and toddlers, while 9 people (2.54 %) don't weighed infants and toddlers. All families in Wowa Tamboli village use clean water (100%). All families practice hand-washing technique using clean water and soap (100%). There were 321 (90.70%) healthy latrines and 33 (9.30%) families who did not have a latrine and used the river behind their house as a place to defecate. All families did house larvae eradication by actively cleaning water reservoirs 2 times a week. There were 351 families (99.10%) who consumed fruits and vegetables every day and there were 3 families

(0.90%) who did' not consume fruits and vegetables every day. There were 352 (99.40%) heads of families who did actively physical activity every day and there were 2 families (0.60%) who did not do physical activity. Families with members who did not smoke in the house around 264 people (74.60%) and there were 90 families (25.40%) who still smoke in the house.

Table 2. Application of Clean and Healthy Lifestyle in Household Arrangements in Coastal Area Communities in Wowa Tamboli Village

Indicator of Clean and Healthy Lifestyle	n=354	%
Childbirth Assisted by Health Worker		
Yes	241	68.10
No	12	3.40
Exclusive Breastfeeding		
Yes	251	70.90
No	2	0.60
Don't have Babies and Toddlers	101	28.50
Weighing Infants and Toddlers		
Yes	244	68.93
No	9	2.54
Don't have Babies and Toddlers	101	28.53
Use Clean Water		
Yes	354	100
No	0	0
Wash Hands Using Clean Water and Soap		
Yes	354	100
No	0	0
Use a Healthy Latrine		
Yes	321	90.70
No	33	9.30
Get Rid of Mosquitoes		
Yes	354	100
No	0	0
Eat Fruit and Vegetables Every Day		
Yes	351	99.10
No	3	0.90
Do Physical Activity Every Day		
Yes	352	99.40
No	2	0.60
No Smoking in the House		
Yes	90	25.40
No	264	74.60

Source: Primary Data, 2021

DISCUSSION

Childbirth Assisted by Health Worker

The results of this study found 12 families whose births were not assisted by health workers. Since 2015, the emphasis on safe delivery has been assisted by health workers in health care facilities. The health workers in question are midwifery specialists, general practitioners and midwives.¹² Deliveries assisted by health workers using safe, clean, and sterile equipment so that infections and other health hazards can be prevented.¹³ Total of 12 families whose births are still assisted by traditional birth attendants. The reason why they are not helped by health workers is because of the long distance to the health service center and the absence of transportation to reach health services. The results of this study are in line with the study which stated that 10.9% of respondents chose to give birth assisted by a traditional birth attendant which was influenced by the respondent's participation status in the National Health Insurance program.¹⁴

Exclusive Breastfeeding

Most mothers have given exclusive breastfeeding to their children and only 2 mothers have not given exclusive breastfeeding. Exclusive breastfeeding is breastfeeding without other additional food and beverage for infants aged 0 to 6 months. Breast milk contains important anti-infective substances that help babies to fight infection and disease. The most important benefit of breast milk can be seen from its ability to build the body's defense system against infectious diseases, especially digestion.¹⁵ The reason why mothers do not give exclusive breastfeeding is the lack of milk production. The results of this study indicate that the majority of mothers who have infants and toddlers have exclusively breastfed their children. One of factors that can influence exclusive breastfeeding is mother's knowledge. A study explains that knowledge is the most dominant factor associated with exclusive breastfeeding. Mothers who have good knowledge are 13 times more likely to give exclusive breastfeeding compared to mothers who have less knowledge.¹⁶

Weighing Infants and Toddlers

Most of mothers do the weighing to their babies and toddlers every month but still found 9 mothers who do not weigh their children in integrated health center. Weighing infants and toddlers regularly aims to monitor the growth of children and ensure their nutritional status is good. This is very important because the prevalence of stunting in Indonesia is still high in 2017.¹⁷ The basic reasons given by the family were the distance from their house to the health service and unavailability of transportation that they could use to get health services. This is not in line with the study which explains that the accessible factor has no effect on the implementation of PHBS in household arrangements in the working area of Cot Ie Jue Health Center, Bireuen Regency ($p=0.050$). Accessibility is community's affordability to health care places. The easier to reach health services, the better the family will implement clean and healthy lifestyles.¹⁸ The researcher assumes that long distances cause long travel times and high costs to be a consideration for residents to live in remote villages to apply clean and healthy lifestyles specifically on indicators of weighing infants and toddlers.

Use Clean Water

All families in Wowa Tamboli village use clean water. The source of clean water for the community in Wowa Tamboli village comes from wells and water from local drinking water companies. Water is needed by humans for washing, cooking, bathing, and other purposes. Water sources can be obtained from wells, plumbing (regional drinking water companies), purchased from water depots or rivers. Water intended for human consumption must come from clean and safe sources. The category of clean and safe water is free from contamination by germs, free from hazardous and toxic chemical substances, tasteless and odourless and can be used to find domestic and household needs.¹⁹ The results of this study are in line with studies that state the entire population (100%) uses clean water sourced from wells for household purposes such as washing, drinking, cooking, cleaning household furniture, and others.⁶

Wash Hand Using Clean Water and Soap

All families practice hand-washing technique using clean water and soap. This explains that public awareness of the importance of washing

hands with clean water can support clean and healthy lifestyle. Washing hands is an indicator of clean and healthy lifestyle such as fingers which can be a pathway for pathogens, bacteria, and viruses to enter. Washing hands with soap had been shown to reduce diarrhea and acute respiratory infections.²⁰

During the Covid-19 pandemic, the Ministry of Health recommended preventing Covid-19 by implementing health protocols, one of them was to wash hands regularly after touching objects.¹⁴ Various efforts have been made to increase public knowledge about the importance of washing hands to avoid the spread of Covid-19 and other diseases. The community in Wowa Tamboli Village obtained information about proper hand-washing through direct counselling from health workers, socialization banners for preventing the spread of Covid-19, electronic media, and print media. A study explains that there is a strong relationship between knowledge and attitudes with hand-washing in the Pegirian Village community.²¹

Use a Healthy Latrine

In this research, it is still that found 33 families did not have a latrine and used the river behind their house as a place to defecate. Healthy latrines are one of the basic sanitation facilities that play an important role in daily life. The availability of healthy latrines can improve the health status of community and prevent the spread of disease. A research result explains that there is a relationship between knowledge about PHBS and the use of healthy latrines in the working area of Mekar Wangi Health Center.²² The researcher's assumption that the people of Wowa Tamboli who do not have healthy latrines are also influenced by economic factors. The people of Wowa Tamboli who do not have latrines have a low income of < 1,000,000 per month so that their families cannot afford to build healthy latrines.

Get Rid of Mosquitoes

Mosquito nests eradication can be done through draining and closing water reservoirs, burying unused goods and avoiding mosquito bites. A larva-free environment can prevent diseases caused by mosquito bites such as dengue fever, chikungunya, malaria, and elephantiasis.²³ All families did house larvae eradication by actively cleaning water reservoirs

2 times a week. In addition, the community received abate powder from environmental health workers at the Tosiba Health Center to eradicate mosquito larvae. The public health center has also assigned a cadre of larvae monitors in each village to do inspections, monitoring, and eradication of mosquito larvae, especially *Aedes Aegypti* and *Aedes Albopictus*. These cadres routinely provide counseling to the community regarding the eradication of mosquito larvae. A study stated that there was a significant relationship between the role of larva monitoring cadres in eradicating mosquito nests, periodic larva monitoring and providing counseling and efforts to prevent dengue hemorrhagic fever in the working area of Tebet Timur Village in 2019.²⁴ The other study explains that there is a significant relationship among people's knowledge, behavior and the existence of mosquito larvae.²⁵

Eat Fruit and Vegetables Every Day

The active chemicals and nutrients contained in fruits and vegetables are called phytochemicals and phytonutrients that are useful for preventing disease, treating and healing. Fruits and vegetables are also a source of fiber, antioxidants, vitamins and minerals.²⁶ Most families have consumed vegetables and fruit every day and only 3 families do not consume fruits and vegetables every day because they have less income so they cannot buy fruits for consumption every day. The majority of people in Wowa Tamboli village work as farmer (47.70%) who use their gardens to plant vegetables. This result is in line with the study which explains that the indicators of clean and healthy lifestyle are occupied by the consumption of vegetables and fruit because of the easy access for people to get vegetables and fruit. People's access to the market is relatively far so that people can get vegetables from their own gardens. In addition, there are mobile vegetable traders who enter the village in relatively affordable prices.²⁷

Physical Activity Every Day

One of the activities in *Gerakan Masyarakat Hidup Sehat (GERMAS)* program is physical activity. Physical activity is carried out in the form of sports activities and working activities that involve at least 30 minutes of physical activity every day to reduce stress and stimulate

the brain to be happier and relaxed.²⁸ Most families have been doing physical activity every day and only 2 families do not do physical activity because of their old age so that they are limited to doing activities. A study explains that there are elderly respondents who do not do physical activity because there is no one to accompany them so they tend to be lazy to move. Physical activity in question is an activity that can sweat. Physical activity is needed by the elderly to stay healthy.²⁹

Smoking in the House

In this research, it is still found that 90 families members still smoke in the house. Smoking can damage the immune system. Smoking habits can cause various diseases, especially lung infections such as bronchitis and pneumonia.³⁰ The reason they smoke in the house is because of the habit they have been doing for a long time. Another reason that they forget smoking in the house can harm the health of other family members, especially the growth and development of toddlers. The results of this study are supported by studies that state there is a relationship between readiness and social environment related to the smoking behavior of the head of family. The fact obtained in the field is that the head of family knows about the dangers of smoking but still smokes in the house.³¹

CONCLUSION AND RECOMMENDATION

In general, the people in Wowa Tamboli Village have properly implemented clean and healthy behaviour on indicators of exclusive breastfeeding, using clean water, washing hands with clean water and soap, eradicating house larvae, eating fruits and vegetables every day, and doing physical activity every day. However, there are still households that have not fully implemented clean and healthy lifestyle because the birthing process is still assisted by traditional birth attendants (3.40%), not weighing babies and toddlers because of the long distance from health services (2.54%) and there are community members who still smoke in the house because they forget or it has become a habit (25.40%). Suggestions for further research to analyze the impact that occurs due to the application of clean and healthy lifestyle that has not been optimal.

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Bowtie Method: Study of Occupational Health and Safety Risks in Cement Production Process

Metode Bowtie: Studi Risiko Keselamatan dan Kesehatan Kerja pada Proses Produksi Semen

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ABSTRACT

The kiln area is an area that has a very complex hazard potential in the cement production process. This study aimed to assess the risks of occupational safety and health during the production process in the kiln area of PT. X uses the bowtie method. This study used a qualitative descriptive design. The informants used were three managers of the clinker production department, one safety manager, and one field operator. Research data were collected through interviews and observations. The data were analyzed qualitatively using the bowtie method. The study results stated that hot dust could be dangerous if it comes out of the system caused by positive pressure, such as the Induced Draft Fan (IDF) turning off, causing losses such as burns to workers. Heat can be dangerous if it experiences a significant increase due to excess fuel, causing losses, such as health-related illnesses. Preventive controls were carried out such as routine inspections. Mitigation controls were carried out such as light signals. Escalation factors can thwart hot dust and heat control, such as the deformation of raw meals. Escalation factor control, such as the implementation of work instructions. PT. X has carried out control in the kiln area, but additional controls are needed.

ABSTRAK

Area kiln merupakan area yang memiliki potensi bahaya yang sangat kompleks dalam proses produksi semen. Penelitian ini bertujuan untuk mengkaji risiko keselamatan dan kesehatan kerja selama proses produksi di area kiln PT. X menggunakan metode bowtie. Penelitian ini menggunakan desain deskriptif kualitatif. Informan yang digunakan adalah tiga orang manajer departemen produksi klinker, satu orang manajer keselamatan, dan satu orang operator lapangan. Data penelitian dikumpulkan melalui wawancara dan observasi. Data dianalisis secara kualitatif menggunakan metode bowtie. Hasil penelitian menyatakan bahwa debu panas dapat membahayakan jika keluar dari sistem yang disebabkan oleh tekanan positif, seperti Induced Draft Fan (IDF) mati, sehingga menyebabkan kerugian seperti luka bakar pada pekerja. Panas dapat membahayakan jika mengalami peningkatan signifikan karena kelebihan bahan bakar sehingga menyebabkan kerugian, seperti health related illness. Pengendalian preventif yang dilakukan seperti inspeksi rutin. Pengendalian mitigasi yang dilakukan seperti sinyal lampu. Faktor eskalasi dapat menggagalkan pengendalian dari debu panas dan kontrol panas, seperti deformasi raw meal. Pengendalian faktor eskalasi, seperti penerapan instruksi kerja. PT. X telah melakukan pengendalian di area kiln, tetapi perlu adanya penambahan pengendalian.

INTRODUCTION

Improving infrastructure in developing the economy and basic services is one of the agendas of the *Rencana Pembangunan Jangka Menengah Daerah (RPJPD) 2015-2024*. Infrastructure improvements are carried out on dams, irrigation, toll roads, new roads, bridges, flyovers or underpasses, drinking water channels, sanitation and slings, slum cultivation, and housing. The increasing in infrastructure is directly proportional to the increasing demand for cement used as a basic building material, so cement factories must ensure that the production process remains normal to meet demand.¹

One aspect that can ensure the production process can run optimally is to ensure the safety and health of workers. Occupational safety and health are very important to be applied in the production process so that workers can avoid the risk of accident and occupational disease so that the production process continues and workplace productivity can be achieved optimally.²

Cement plant, where the production process happens, has a variety of potential hazards that can affect Workers' Healthy and Safety as well as the surrounding environment.³ Potential hazards and risks that can arise from these hazards in the form of dust which can cause respiratory disorders, noise which, can cause hearing loss, toxic gases (CO, CO₂, NO_x, SO₂), electrical hazard, kiln thermal load hazard, fire, and work accidents due to material handling.³⁻⁵

Several studies have shown the statistics of accidents in the cement industry, including research by Sah, et al in cement industries of Nepal showed that in 2017 until 2018 where 305 accidents consists of 291 minor accidents and 14 major accidents.⁶ The research of Fresenbet, et al conducted at two cement factories in West Shoa Zonal Capital Ambo, Ethiopia on October 15-December 15, 2020 showed that there were 48.9% of workers who reported experiencing workplace injuries during the last 12 months.⁷

Workers in cement factory are at risk of being exposed to occupational hazards that cause workplace injuries, death, and health problems such as allergies, damage to workers' hearing, and respiratory problems.⁸ The cement production process is divided into two stages, namely

1) the crushing, mixing and roasting of raw materials (silica, calcium carbonate, oxides of alumina and iron), 2) milling of clinker. Cement production goes through a series of processes such as crushing, raw material handling, grinding clinker, blending, packing and shipping of the final product of cement clinker. During all these processes, health and safety hazards are unavoidable for workers.⁸

The kiln area, one of the areas where clinker is produced, has the most potential hazards. Potential hazards in the form of dust, toxic gases, high heat radiation, noise, heavy workload, and additional materials.^{5,8} To minimize losses such as accidents, health problems, environmental damage and other material losses, due to existing hazards, risk analysis is needed. One method that can be used to assess or analyze occupational safety and health risks in the cement industry is the bowtie method.

Bowtie method is a method used to analyze and describe risk paths from causes to impacts with simple diagrams.⁹ This method is also recommended by ISO 31000 because it can be used to determine the cause and effect of hazard so that control can be carried out against the hazard.¹⁰ In Ardi's research (2020), this method is used as a risk analysis based on causality so that the results of significant risk and high risk are obtained for workers.¹¹

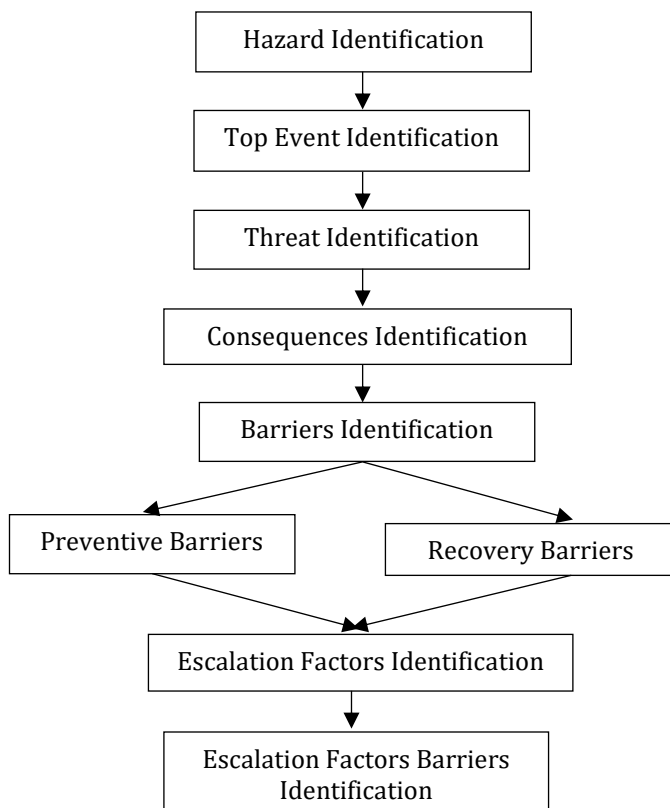
The analysis of bowtie method starts from the top event, which is an event that releases danger. Then the causes and consequences of the incident will be determined so that control measures (barriers) can be found to reduce the likelihood of the incident and the severity of the consequences of incident. Therefore, the purpose of this study is to analyze any possible risks of work accidents that can occur, identify the source of causes, impacts, and controls on the risk of work accidents at PT. X.

MATERIAL AND METHOD

The design used in this study is descriptive with qualitative design. This research was conducted on kiln areas in one of the biggest cement industries in Indonesia. The informants in this study consisted of three managers of the clinker production department, one safety manager, and one field operator, who were selected based

on purposive sampling. Data collection was collected by interviews, observations, and document review. Processed data is displayed into bowtie diagrams and narratives.

Analysis of occupational safety and health risks in the kiln area using the bowtie method. The bowtie method is a qualitative analysis to show causal relationships in high-risk scenarios. Risk analysis begins with the determination of high risk in the kiln area through hazard identification data that has been made by the company and then consults it to informants. Afterward, the identification of a top event which is the first state when the hazard is not controlled, identification of the threat (potential cause) and its impact to determine the losses of the top event, and identification of preventive control and control barriers so as not to cause or aggravate the impact. Next, identification of escalation factors (circumstances that can reduce the effectiveness of preventive controls and barriers) and identification of barriers to escalation factors to prevent escalation factors from occurring. The research flow using the bowtie approach is shown in the figure below (Figure 1).



Source: Secondary Data, 2015¹²

Figure 1. Risk Analysis with the Bowtie Method

RESULTS

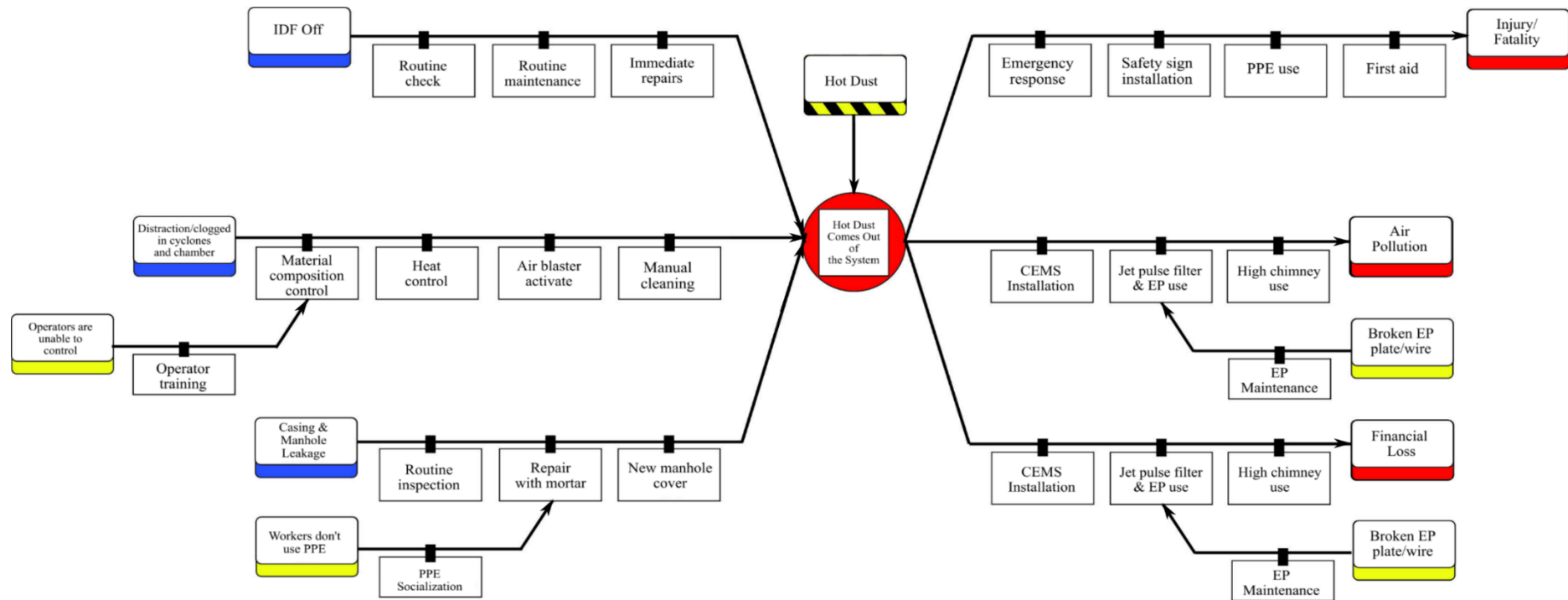
Identification of potential hazards is conducted at each stage of the production process in the kiln area by taking into account activities, materials, or situations that may cause harm or disease due to work. The hazard analyzed in this study is that hazard with a high level of risk as part of normal production process in the kiln area. Based on the results of hazard identification that refers to the data of Hazard Identification, Risk Assessment, and Risk Control (HIRARC), direct observation, and interviews with informants, it is found that potential hazards that have a high level of risk in the kiln area of PT. X is hot dust and a hot working climate. Then, the analysis was carried out by using the Bowtie method, see Figures 2 and 3.

Hot dust which gets out of the system is a hazard with a top event. IDF failure, blockage in the cyclone and chamber area, and explosion due to incomplete combustion are three threats that can cause dust to be discharged from the system. A few steps may be done to prevent hot dust from escaping the system when the IDF fails, including routine checks, routine maintenance, and immediate repairs. Many measures can be taken to prevent hot dust from escaping the system when a dead-end arises in the cyclone and chamber area, including material composition control, hot control, air blaster active, and manual cleaning.

Material composition control can fail if the operator is unable to control it. However, this can be avoided by operator training. When casing and manhole leaks occur, a few steps may be done to prevent hot dust from entering the system, including routine inspections, mortar repairs, and the installation of new manhole covers. When workers do not utilize PPE, mortar repairs can fail, but this can be avoided by socializing PPE. When heated dust escapes the system, it can cause injury/fatality, air pollution, and financial loss, among other things. Before inflicting injury/fatality, various safeguards can be done before inflicting injury/fatality, including emergency response, safety sign installation, PPE use, and first aid. Before producing air pollution and financial losses, numerous safeguards can be taken before producing air pollution and financial losses, including the installation

of CEMS, the use of jet pulse filters and ESP, and the use of high chimneys. Jet pulse filters and ESP can fail due to a broken ESP plate / wire,

although ESP maintenance can prevent this (Figure 2).



Caption:

- : Top Event
- : Hazard
- : The Sequence of Events
- : Threats
- : Consequences
- : Escalation Factors
- : Escalation Factors Barriers

Source: Primary Data, 2020

Figure 2. Bowtie Diagram of Hot Dust

Heat is a hazard that has a high probability of occurrence, especially increased heat. Excess fuel and less material are two risks that might cause heat to rise. When there is a surplus of fuel, a Pfister can be used to reduce the heat before it becomes unbearable. Bearing failure can cause Pfister to fail, however this can be avoided with proper maintenance training. When the material is insufficient, some steps can be taken to prevent the heat from rising, such as regulating the material. Material control can fail if operators are unable to control it, although this can be avoided with proper operator training. Three things can happen when the increased heat such as tool malfunction, heat-related illness, and clinker production disruption. Numerous safeguards can be performed before causing a tool malfunction, including fuel descent and inching kiln. Control with fuel descent can fail to owe to bearing failure, however maintenance training can help prevent this. Several precautions can be taken before causing heat-related illness, including working on the job instruction, PPE use, and first aid. Before disrupting clinker production, numerous safeguards can be taken, including fuel descent, air blaster activation, and hand cleaning. Control with fuel descent can fail to owe to bearing failure, however maintenance training can help prevent this (Figure 3).

Hot dust is one of the cement forming materials that can be dangerous if it goes outside the system. Hot dust can get outside the system in case of a control failure from the operator which causes the pressure to become unstable and stretched between the constituent components of the system, making a pathway for hot dust to come out of the system. Meanwhile, a hot working climate occurs because the temperature at work increases due to the uncontrollable release of hot dust. In addition, heat can also increase as a result of the excessive burning of coal. Based on the research results, it is determined that the top event of hot dust is its release from the system and the top event of the hot working climate due to the increasing of uncontrollable heat temperature.

Sudden positive pressure is a potential cause (threat) of the hot dust release from the system. Positive pressure occurs because the Induced Drive Fan (IDF) is turned off so there is no airspeed to maintain pressure. In addition, disturbances or dead ends in cyclones chambers and ex-

plosions from incomplete combustion can also result in positive pressure. This is determined based on the results of interviews that have been conducted. Meanwhile, the potential causes of increased heat are excess fuel and oxygen and less material.

"Hot dust is caused by positive pressure, sohot dust can come out of the system. This positive pressure can occur because the fan is off so there is no airspeed to maintain the pressure. Disruption in the cyclone can also cause the same positive pressure if there is an explosion due to imperfect combustion. So, from the CO that reacts, hot dust can come out of the leaking casings." (MAF)

Hot dust and hot working climates can have effects on workers. Hot dust can cause losses in injuries, burns and even death. In addition, air pollution and financial losses can also occur. Meanwhile, heat that continues to increase during the production process can affect the tool, heat related illness, and Clinker production disruption. Based on work accident data of PT. X, it is found that there are field workers exposed to hot dust when making up the closing of check hole where there was a sudden positive pressure. In addition, from the observations it is determined that the heat in the kiln area can reach three meters from the tool assess that workers can experience heat related illness complaints due to heat exposure.

Controlling the hot dust and hot working climate is needed to protect the workers. To avoid the releasing heat dust from the system, it needs routine checks and maintenance on the IDF and immediate repairs to control the IDF to keep it rotating. In addition, to keep the cyclone or chamber area from experiencing interference, material and heat control carried out. When a cyclone or chamber is disrupted, to prevent hot dust from escaping the system, the activation of the air blaster is carried out. If there is a dead-end in the chamber due to dust building up, manual handling will be done to break down the impasse. Observations and document review show that air blasters have been installed at some of kiln area points and maintenance is carried out periodically. In addition, the use of lights, installation of hazard signs, the manufacture of work permits, and the use of personal protective equipment are also carried out to minimize workers exposed to hot dust. Meanwhile, heat is controlled so it does not cause harm by controlling excess fuel and oxygen.

“We control the material composition and combustion heat, and for heat, dust does not come out continuously we activate the air blaster so that air fired into the dead end can also be cornered manually.” (IS)

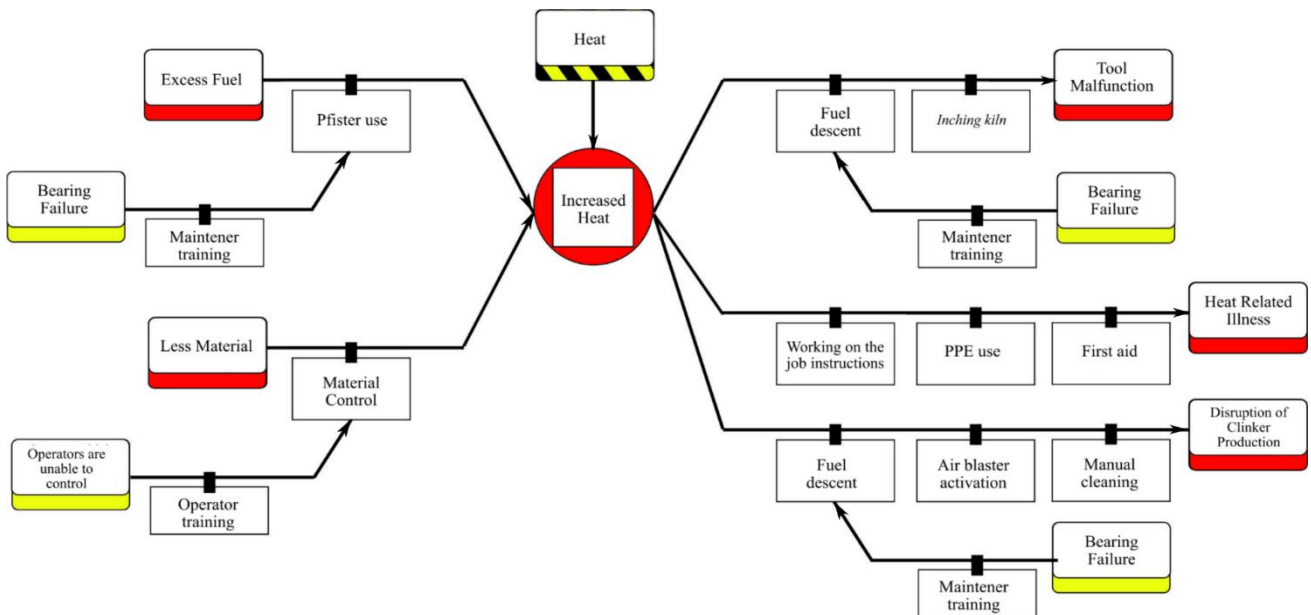
From the results of the study, it is determined that preventive control is carried out to prevent the release of hot dust by preventing incomplete combustion. Therefore, the preventive control is the installation of a gas analyzer to monitor oxygen so that it can be immediately handled if there is an excess, Pfister feeder to regulate fuel, and weigher control by the Central Control Room (CCR) to regulate or control the material.

The results also showed that control barriers were carried out so that hot dust does not cause burns to workers. These are in the form of work permit manufacturing, installation of safety signs, and inspection of K3 object equipment. To reduce the serious impact of burns, workers are required to use PPE and perform first aid. In addition, prevention is also carried out in the form of good housekeeping, safety patrol, and safety education through safety meetings, safety talks, and safety induction. Barrier control to overcome air pollution due to dust and financial losses is the use of Continuous Emissions Moni-

toring System (CEMS), increased dedusting system utilization, such as double jet pulse filters and optimization of inspection and maintenance on Electrostatic Precipitator (ESP) components and baghouses.

Meanwhile, barrier control is carried out so that heat does not damage work equipment, namely fuel reduction and inching kiln. To prevent workers from experiencing a heat related illness, working based on the instructions and use of PPE. To overcome the disruption of clinker production, namely the decreasing of fuel and activation with air blaster.

Controls carried out on hot dust, and hot working climates can fail. The results showed that some controls may fail, such as workers' non-compliance with PPE use due to forgotten or uncomfortable workers, poor material and fuel, slabs or broken ESP wires, and use of Pfister feeder due to damage to seals or bearings. Failure of control can be overcome by controlling the cause of failure. The results showed that the control was carried out by PT. X, in order to determine the cause of failure is working based on work instructions, socialization of the use of PPE, routine maintenance of ESP and the use of bypass pipes.



Caption:

- : Top Event
- ▭ : Escalation Factors
- ▭ : Consequences
- ▭ : Threats
- ▭ : Escalation Factors Barriers
- ▭ : Hazard
- : The Sequence of Events

Source: Primary Data, 2020

Figure 3. Bowtie Diagram of Heat

DISCUSSION

Hot dust and hot working climates are at high risk during the production process in the kiln area. This classification is in accordance with several studies which state that the high potential hazards that exist in the kiln area are dust, hot gases, toxic gases, high heat radiation, noise, and high workloads.^{5,8} Hot dust in the clinker production process consists of dust mixed with hot gases, while the hot working climate is the temperature that increases due to combustion reaches 1800°C in the burning zone.¹³ Based on HIRARC (Hazard Identification, Risk Assessment, and Risk Control) assessment by PT. X, workers have a degree of likelihood (likelihood of exposure) to hot dust and hot working climate in the moderate category, while the severity assessment is assessed to cause disability and even death, very serious impacts on the environment, and losses of up to 100 million.

Hot dust has a high risk if it is outside the system. This can occur because the pressure inside the system is unstable or experiencing the sudden positive pressure that is affected by the operator's ability to control pressure. In addition, heat has a high risk and becomes dangerous when the combustion temperature increases significantly. According to the standard, the heat in the burning zone should be no more than 1800 °C. Based on Brinell's hardness to temperature linkage diagram, the strength of steel can be reduced when the temperature is more than 300°C.¹⁴ During the production process, steel which is the constituent component of the kiln shell has a temperature range between 200°C to 250°C.¹⁴ Therefore, heat can become dangerous when the temperature increases from 100°C to 1800°C in the burning zone without control.

Sudden positive pressure that can make hot dust out of the system is three potential causes: an inactive Induced Draft Fan (IDF), a dead-end in the chamber or cyclone area, and an explosion from imperfect combustion. The IDF serves to dissipate hot gas by dumping combustion residual gas into free air, so when the IDF is off, the fan rotation speed will slow down and make the pressure in the system become high in accordance with Bernoulli's law, pressure is inversely proportional to fastness.

Similar to the IDF, the impasse in the chamber or cyclone area causes the absence of the mate-

rial flow that enters the system until the pressure in the system becomes high. In addition, explosions can occur when imperfect repairs of excess fuel form carbon monoxide. This process is in accordance with Hasnah et al. research, namely imperfect combustion in coal can cause explosions.^{15,16} Increased heat also has three potential causes: excess fuel and oxygen, as well as less material feed. This cause is in line with the research of Rohmawati and Dzulkifih, namely oxygen in large quantities will produce high heat.¹⁷

Hot dust which comes out of the system can cause losses in the form of burns, air pollution and financial losses. Burns suffered by workers can cause injury and even death during complications. This loss is in accordance with research conducted by Karahan and Akosman, namely the risk of serious injury, death, and respiratory problems has the potential to guide kiln area workers.⁸ In addition, hot dust can also cause air pollution and financial losses.

A significant increase in heat can cause losses in the form of tool damage, heat-related illness, and clinker production disorders. The damage to the tool is affected by coating durability and the effectiveness of fireproof brick which is the heat retainer of kiln system, so that when the heat retainer melts then the kiln shell becomes incandescent. This damage is in accordance with research Ammarullah et al. in 2018, namely fireproof stone as kiln insulation can be damaged due to thermal load thus reducing the life of rotary kiln.¹⁸ Heat related illness is experienced by workers who do not pay attention to work instructions when working in areas with a radius very close to the heat source and for a long time in line with Arianto and Prasetyowati in 2019, there is a link between the hot work environment and heat related illness complaints.¹⁹

Because of the large loss of hot dust comes out of the system and the heat that increases, control is carried out on the potential. Controlling to keep the IDF rotating, namely, routine inspection, routine maintenance, and immediate repairs. Control of the chamber or cyclone area deadlocked to control the pattern of operation, activate the air blaster, and corner the dead-end. The activation of air blaster aims to destroy clogging material, so that positive pressure only lasts a short time, according to Putra et al. research in

2018, namely air blaster serves as a tool that can release clumps (coating) material.²⁰ Blast control from combustion is not perfect, namely the installation of a gas analyzer and the use of a pfister feeder. The assumption of coal and excess oxygen, as well as less material bait, namely the use of pfister feeders and weighers in accordance with Rohmawati and Dzulkifli research in 2017, namely the optimization of the combustion process in kilns is influenced by the control of exhaust gases O₂, CO, and NO_x.¹⁷

Pfister feeder (fine coal feeder) is a coal feeder equipped with a heavy flow measuring device. Coal feeder is controlled by a controlling system based on PLC (Programmable Loci Control) and DCS (Distributed Control System). Where the desired setpoint flow rate entered in the dine coal feeder controlling module through the operator work station to get optimal combustion results.²¹

Hot dust that has come out of the system and heat that has increased can be directly controlled so that losses do not occur or do not get worse. Control in hot dust so that there is no burn, namely the use of light signals, installation of hazard signs, and work permits, while to minimize the severity is to use PPE. A momentary outage is a signal which indicates that workers should not be around the kiln area. Work permits are used on jobs related to flames as well as heights, such as patching activities.

The use of Personal Protective Equipment (PPE) can fail when workers do not use it appropriately and completely. This failure can be controlled by giving workers understanding towards the importance of personal protective equipment with socialization in accordance with zahara et al. research in 2017, namely compliance with the use of personal protective equipment has a close relationship with knowledge and behavior.²²

Controlling on hot dust not to cause environmental pollution and financial losses, namely the use of CEMS, ESP, jet pulse filters, and high chimneys. CEMS is a sensor that continuously monitors air quality emission, while ESP and jet pulse filters are served to reduce the severity of dust coming out of the system.²³ In addition, bag filters can reduce dust emissions, and more effective in removing dust than Electrostatic Precipitator (ESP).²⁴

Heat control is used to keep the tool away from the damage, namely lowering the amount of fuel and inching kiln. Decreased amount of fuel through the Pfister feeder includes immediate control, medium inching kiln includes controls performed when the heat is over controlled. Heat control so as not to cause heat related illness, namely the use of refractory bricks and steel coatings, work according to instructions, and the use of personal protective equipment. Refractory bricks and steel coatings act as insulation to reduce heat that creeps into the environment. The refractory bricks used in the kiln area has a high resistance toward temperature.^{25,26} Heat control so it is not causing disruption of clinker production, namely a decrease in the amount of fuel and activation of air blaster. Decreased amount of fuel including immediate control as heat increases. A late drop in fuel can lead to the formation of a large snowman. If a snowman has been formed then the control that can be done, namely the activation of the air blaster.

Controls are carried out to prevent hot dust from escaping the system or heat increases and controls that are undertaken to reduce the severity or prevent losses which can fail or become ineffective. Control of operating patterns can fail when raw meals or coal fed into the system undergoes deformation. This failure can be controlled by the work instructions to control the operating parameters. In addition, the use of Electrostatic Precipitator (ESP) and baghouse filters can prevent any particulate matter escaping the process.^{27,28}

ESP usage can fail when there is a broken building wire that causes electrode and anode to dust to decrease. This failure can be controlled through regular ESP maintenance in accordance with Doddamani's research, namely component repair and replacement and routine maintenance as well as checking can improve ESP efficiency.²⁹ Juarsyah et. al also mentioned by analyzing the Pfister feeder (fine coal feeder) control system in the combustion process against the level of CO gas produced and optimizing the PLC Fine Coal Feeder program to reduce fuel flow automatically before the CO gas level exceeds the protection limit on the ESP, it is expected to minimize interference with the ESP, equipment damage, environmental impact and

operational losses.²¹

CONCLUSION AND RECOMMENDATION

Hot dust comes out of the system and a significant increase in heat are potential hazards with a high risk in the kiln area. Potential causes of such potential hazard become hazardous, namely the inactive IDF, dead-ends in the chamber or cyclone area, and explosions from imperfect combustion, excess fuel and oxygen, and less material feed. The impact of the potential hazard is in the form of burns, air pollution, financial losses of heat-related illness, damage to tools, and disruption of clinker production. Preventive control that can be done are routine inspection and maintenance, immediate repair, control of operating patterns, activation of air blaster, matching, installation of the gas analyzer, the use of Pfister feeder, and weigher, while mitigation control is carried out, namely the use of light signals, installation of safety signs, work permits, use of PPE, CEMS, ESP, jet pulse filter, and high chimney, fuel drop, inching kiln, the use of fire bricks and steel coatings, work according to instructions and activation of air blaster.

The escalation factors are the deformation of a raw meal or coal controlled by the application of work permit, damage to seals or rotary feeder bearings controlled by the installation of bypass pipes, do not use controlling PPE socialization, and damage to ESP components controlled through routine maintenance. Advice is given in the form of risk assessment at each stage of the production process in the kiln area, provision of electrolyte fluid during direct monitoring inching kiln, installation of heat signs, and dissemination of PPE use.

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Environmental Health Risk Analysis of Dust Exposure on Employees in PT. Cassia Co-op Indonesia in Jambi

Analisis Risiko Kesehatan Lingkungan Paparan Debu pada Pekerja di PT. Cassia Co-op Indonesia di Jambi

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ABSTRACT

The dust has a negative impact that can affect workers' health. This study aimed to analyze the environmental health risks of dust exposure on workers at PT. Cassia Co-op Indonesia in Jambi. Descriptive quantitative research was conducted using an *Analisis Risiko Kesehatan Lingkungan (ARKL)* approach, including analysis of hazard identification, dose response, exposure assessment, and risk characteristics. 61 respondents from the production division were selected as samples with a disproportionate stratified random technique. Data was collected using a questionnaire and Total Suspended Particulate (TSP) concentration from company's secondary data. The results of measuring dust levels at 2 (two) points obtained a concentration value that was still below the threshold, but 77% of respondents experienced health problems related to TSP dust. The real-time intake value of TSP exposure of workers was not at risk of health problems ($RQ < 1$) at both measurement points, and the intake lifespan value of TSP exposure was at risk of health problems ($RQ > 1$) for all workers in the 15th year at point 1. It is recommended for companies to conduct regular health checks on workers, provide PPE and apply the standard use of PPE, make rules that prohibit smoking while working, and increase the location and frequency of testing for TSP dust levels in the company.

ABSTRAK

Debu memberikan dampak negatif yang dapat mempengaruhi kesehatan pekerja. Penelitian ini bertujuan untuk menganalisis risiko kesehatan lingkungan akibat paparan debu pada pekerja di PT. Cassia Co-op Indonesia di Jambi. Penelitian kuantitatif deskriptif dilakukan dengan pendekatan Analisis Risiko Kesehatan Lingkungan (ARKL), meliputi analisis identifikasi bahaya, dosis respon, penilaian pajanan dan karakteristik risiko. Sebanyak 61 responden dari bagian produksi terpilih sebagai sampel dengan teknik disproportionate stratified random. Pengumpulan data menggunakan kuesioner dan konsentrasi Total Suspended Particulate (TSP) dari data sekunder perusahaan. Hasil pengukuran kadar debu di 2 (dua) titik didapatkan nilai konsentrasi yang masih di bawah standar nilai ambang batas, namun sebanyak 77% responden mengalami gangguan kesehatan terkait debu TSP. Nilai intake realtime pajanan TSP pekerja belum berisiko gangguan kesehatan ($RQ < 1$) pada kedua titik pengukuran, dan nilai intake lifespan pajanan TSP berisiko gangguan kesehatan ($RQ > 1$) pada seluruh pekerja pada tahun ke-15 pada titik 1. Disarankan kepada perusahaan untuk melakukan pemeriksaan kesehatan secara berkala pada pekerja, menyediakan APD dan menerapkan standar penggunaan APD, membuat aturan larangan merokok saat bekerja, serta menambah lokasi dan frekuensi pengujian kadar debu TSP di perusahaan.

INTRODUCTION

The growth of the wood processing industry is quite rapidly due to the increase in forest consumption every year, while the process uses energy and natural raw materials on a large scale tends to produce air pollution in the form of dust particles. About 10-13% of the chopped and crushed wood dust particles fly in the air, potentially causes air pollution in the work environment and health problems.¹

Dust in the work environment causes complaints in the throat and nose, such as cough, respiratory problems and other infections up to death.² The World Health Organization (WHO) estimates about 3 million deaths per year from exposure to outdoor air pollution, and about 6.5 million deaths (11.6% of all global deaths) are attributed to indoor and outdoor air pollution. Nearly 90% of deaths from air pollution occur in lower middle income countries, and two-thirds of them occur in Southeast Asia and Western Pacific region.³ Outdoor air pollution is a risk factor for approximately 58% of premature deaths from ischemic heart disease and stroke, 18% of deaths from COPD and Lower Respiratory tract infection, and 6% of deaths from lung cancer.⁴ In Indonesia, about 70% of worker morbidity is caused by exposure to high dust.⁵

The threshold value for wood dust that can be accepted by human is 5 mg/m³ with an exposure duration of < 8 hours/day for 5 working days. Dust concentrations that exceed quality standards will affect health.⁶ A study by Rahman, et al in 2008 showed that the longer humans are in a polluted air environment, the greater the risk of health problems and the number of risk agents entering the body. Timber industry workers who have a working period of > 5 years have a 13.5 times risk of suffering from lung function disorders compared to a working period of 5 years.^{1,7,8}

PT. Cassia Co-op Indonesia is a company in the field of cinnamon processing which located in Sungai Penuh City and Kerinci Regency, Jambi Province. The company is process cinnamon into a broken and clean product, cinnamon stick, essential oils, tea bag cut products, cut and sifted, and powder (cinnamon bark powder),⁹ which through some processing process such as drying, cutting, counting, milling, and sawmills that produce dust as a source of air pollution. This condition causes workers who are active to be very

vulnerable to air pollution due to exposure to dust in the long term.

The results of the initial survey found the condition of wood dust scattered in the workplace while some workers did not appear use respiratory Personal Protective Equipment (PPE) such as masks. The results of the interviews revealed that some workers often had symptoms of health problems such as coughing, shortness of breath, and dizziness. Based on clinical data company throughout 2020, obtained diseases related to dust exposure where from about 511 patients who visited, 195 (38.3%) suffered from ISPA, 68 patients (13.3%) with Bronchitis, 15 patients (2.9%) with Bronchopneumonia, and 6 patients (1.2%) with Asthma. PT Cassia Co-op Indonesia is known to have made efforts in monitoring the work environment, but no analysis has been done to determine the risk of environmental hazards to workers, especially exposure to dust from the process of cinnamon to lead export commodity from Kerinci-Jambi province which is very popular in the international market. This study aims to Analyze the Environmental Health Risk of dust exposure on workers including hazard identification, dose-response analysis, exposure analysis and risk characterization at PT. Cassia Co-op Indonesia in Kerinci-Jambi Province.

MATERIAL AND METHOD

Study design was a quantitative descriptive using the *Analisis Risiko Kesehatan Lingkungan (ARKL)* approach with 4 steps consisting of hazard identification, dose-response analysis, exposure analysis and risk characterization. The samples were exposed to the production employees directly by cinnamon dust timber which processed a total of 61 respondents selected by disproportionate stratified random sampling Technique,¹⁰ and met the inclusion criteria that have worked at least one year. Data were collected by interview using a questionnaire, while the concentration of Total Suspended Particulate (TSP) was taken from secondary data belonging to the company's latest environmental monitoring results using *HVAS* gravimetric method according to SNI 19-7119.3-2005.

RESULTS

Characteristics of Respondents

Age of workers as respondents ranged from 19 to 63 years, an average of 30.3 years (SD =

8.068) and an average bodyweight of 60.52 kg (SD = 8.142). Most of the respondents were male (81.97%), had high school education (75.41%), and did not smoke (44.26%). Based on using of PPE (personal protective equipment), the majority used masks (100%) and gloves (93.44%), while protective glasses were only 41% (Table 1).

Hazard Identification

Hazard identification was carried out by analyzing dust concentration (TSP), dust sources, and health risks from dust exposure (Table 2). TSP dust concentration measurement results at two points are considered to represent the working environment at the production known that TSP levels at one point amounted to 0.54279 mg/m³ higher than point 2 of 0.08962 mg/m³. The TSP level at point 1 was above the quality standard value/QSV (0.23 mg/m³), but both did not exceed the threshold value/TV (5 mg/m³).

Table 1. Characteristics of Workers

Characteristics	n=61	%
Gender		
Male	50	81.97
Female	11	18.03
Education		
Elementary School	2	3.28
Junior High School	2	3.28
Senior High School	46	75.41
College	11	18.03
Smoking Status		
Not Smoking	27	44.26
Mild	17	27.87
Moderate	13	21.31
Weight	4	6.56
Use of PPE		
Mask	61	100
Goggles	25	41.98
Gloves	57	93.44

Source: Primary Data, 2020

Table 2. Measurement of TSP Concentration

Location	Levels (mg/m ³)	QSV (0.23 mg/m ³)	TV (5 mg/m ³)
Point 1	0,54279	> QSV	< TV
Point 2	0,08962	< QSV	< TV

Source: PT. Cassia Co-op Indonesia, 2020

Observation results revealed that airborne dust particles were visible to the naked eye in the production section which wassourced from the cinnamon wood processing process using

special production machines such as cutting, chopping and refining. From the interviews, it is known that generally respondents have experienced health complaints related to exposure to wood dust in their working environment, including coughing (29.5%), coughing up phlegm (19.7%), sneezing (52.5%), shortness of breath (9.8%), chest pain (16.4%), itching in the nose (37.7%), skin irritation (41%), and eye irritation (32.8%).

Dose-Response Analysis

The dose-response analysis used in this study was for non-carcinogenic inhalation exposures expressed by Reference Concentration (RfC). This dose is needed to find a safe value for non-carcinogenic effects or to determine the quantitative value of toxicity in particular risk agent that can cause adverse health effects on the population at risk. The dust reference dose is not available yet in IRIS but it can be derived from the NAAQS with the primary standard for PM10 being 50 g/m³ (annual arithmetic mean), so because 68% TSP is Pm10, the value C = 0.7353 mg/m³. Therefore, the safe concentration (RFC = I), then to the RFC, the following equation applies:

$$RfC = \frac{CxRxt_Exf_EDt}{W_bxt_{avg}}$$

Description:

C = 0,7353mg / m³

R = 0.83 m³/ h

t_E = 24 hours/day

f_E = 350 days/year

D_t = 30 years

t_{avg} = 365 days × 30 years

Then using the substitution with default value of US-EPA exposure, the RfC value is 0.0020 mg/kg/day.

Exposure Analysis

Exposure analysis was described based on workers' activity pattern, inhalation rate, and calculation of TSP intake. The pattern of worker activity is seen from the length of exposure, frequency of exposure, and duration of exposure based on the production division group (Table 3).

Table 3 illustrates that in general, the average length of dust exposure to workers is 8.34 hours/day with the largest average in the division Blending (8.75 hours/day) and the smallest

average in the Grinding and Stick division (8 hours/day). The total average value for the frequency of exposure was 283.39 days/year with the highest average in the KHL Stick division (308.17 days/year) and the lowest in the Stick division (258.67 days/year). The average total exposure duration was 3.64 years with the highest average exposure duration in the Grinding division (6.25 years) and the lowest in the KHL Drying division (1.84 years). This average value is entered into the intake formula so that the TSP intake value and the risk level (RQ) of the population are obtained from 8 divisions. Inhalation rate value (R) is used as the default value for Exposure Factor of US-EPA for adults' inhalation of 20 m³ / day with average body weight 70 kg converted to units of m³/ h to R = 0.83 m³/ O'clock.

Calculation of the TSP intake value was carried out during the study (*realtime*) and is projected for the next 30 years (*lifespan*). The analysis showed that the lowest realtime exposure TSP intake was in the KHL Drying (0.0004 mg/kg/day) in point 2, while the highest was in the Distillation (0.0112 mg/kg/day) in point 1 (Table 4). In lifespan exposure, the projected TSP intake values in point 1 and point 2 from the 5th to the 30th year continue to increase. The TSP intake value in point 1 is projected to exceed the RfC value (0.020 mg/kg/day) or unsafe from the 15th year and above, while in point 2 it is still within the safe limit until the 30th year (Figure 1 & 2).

Table 3. Time, Frequency and Duration of Dust Exposure to Workers

Division	n	Time Exposure (te)		Frequency Exposure (fe)		Duration Exposure (De)	
		Mean	SD	Mean	SD	Mean	SD
		Blending	4	8.75	0.957	260.25	3.500
Crushing	9	8.33	0.707	271.67	22.836	5.56	2.068
Distillation	3	8.33	0.577	264	0	5.67	1.528
Drying	4	8.50	1	268.75	25.500	4	0.816
Grinding	4	8	0	262.50	3.317	6.25	0.957
KHL Drying	19	8.47	0.772	296.53	48.883	1.84	0.898
Stick	12	8.25	0.622	308.17	45.674	1.92	0.669
KHL Stick	6	8	0	258.67	6.314	5.50	1.643
Total	61	8.34	0.68	283.39	39.601	3.64	2.199

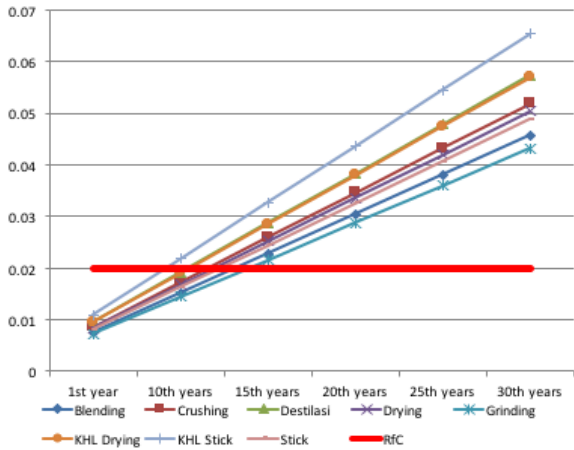
Source: Primary Data, 2020

Table 4. Real Time and Lifespan TSP Intake

TSP Intake (mg/kg/day)	Real Time	Projection (Year)					
		5	10	15	20	25	30
Point 1							
Blending Division	0,0087*	0,0076*	0,0152*	0,0228*	0,0305*	0,0381*	0,0457*
Crushing Division	0,0096*	0,0086^	0,0173^	0,0259^	0,0345^	0,0432^	0,0518^
Destilasi Division	0,0112*	0,0096*	0,0191*	0,0287*	0,0382*	0,0478*	0,0573*
Drying Division	0,0066*	0,0084*	0,0168*	0,0252*	0,0335*	0,0419*	0,0503*
Grinding Division	0,0091*	0,0072*	0,0144*	0,0216*	0,0288*	0,0360*	0,0432*
KHL Drying Division	0,0026^	0,0095*	0,0190*	0,0284*	0,0379*	0,0474*	0,0568*
KHL Stick Division	0,0041*	0,0109*	0,0218*	0,0327*	0,0436*	0,0545*	0,0654*
Stick Division	0,0089*	0,0081*	0,0163*	0,0244*	0,0325*	0,0406*	0,0488*
Point 2							
Blending Division	0,0014*	0,0013*	0,0025*	0,0038*	0,0050*	0,0063*	0,0075*
Crushing Division	0,0016*	0,0014^	0,0029^	0,0043^	0,0057^	0,0071^	0,0086^
Destilasi Division	0,0019*	0,0016*	0,0032*	0,0047*	0,0063*	0,0079*	0,0095*
Drying Division	0,0011*	0,0014*	0,0028*	0,0042*	0,0055*	0,0069*	0,0083*
Grinding Division	0,0015*	0,0012*	0,0024*	0,0036*	0,0048*	0,0060*	0,0071*
KHL Drying Division	0,0004^	0,0016*	0,0031*	0,0047*	0,0063*	0,0078*	0,0094*
KHL Stick Division	0,0007*	0,0018*	0,0036*	0,0054*	0,0072*	0,0090*	0,0108*
Stick Division	0,0015*	0,0013*	0,0027*	0,0040*	0,0054*	0,0067*	0,0081*

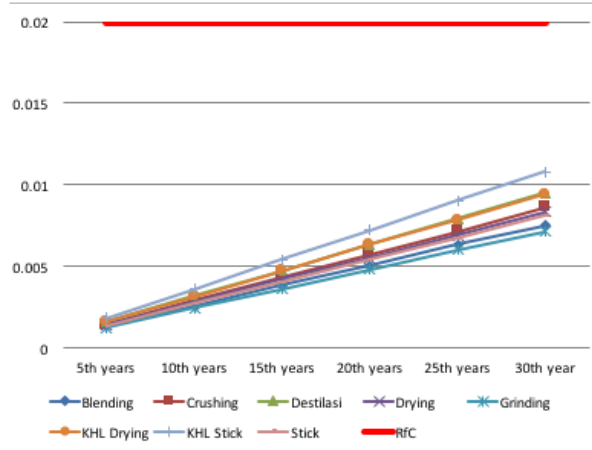
Source: Primary Data, 2020

Description: * = Mean ^ = Median



Source: Primary Data, 2020

Figure 1. Lifespan TSP Intake (Point 1)



Source: Primary Data, 2020

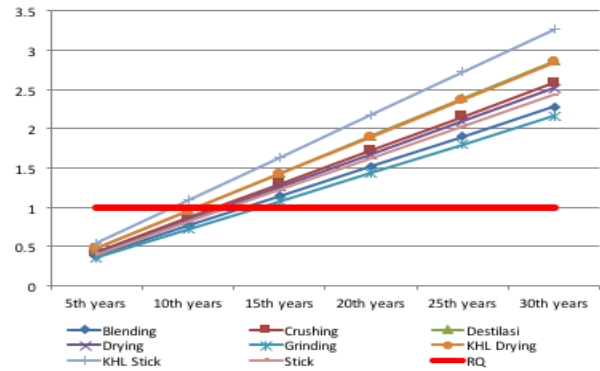
Figure 2. Lifespan TSP Intake (Point 2)

Risk Characteristics

Risk Characteristics are an effort to determine how big the risk level of a risk agent as TSP enters the body. The risk level in this study is only for non-carcinogenic effects which are expressed by the Risk Quotien (RQ) Notation by dividing the value intake TSP with RfC obtained from IRIS.

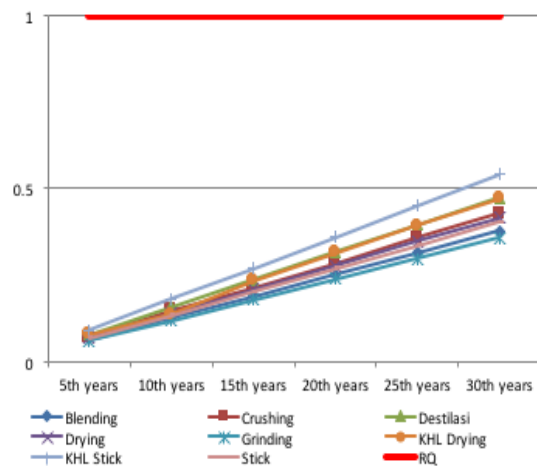
The results of real time risk level analysis in point 1 and point 2 obtained RQ values below the safe limit (RQ<1), in point 1 the lowest was in the KHL Drying division (0.1300) and the highest in the Distillation division (0.5602), while in point 2 the lowest value in the KHL Drying division (0.0215) and the highest in the Distillation division (0.0925) (Table 5).

Furthermore, the projected TSP risk level for lifespan exposure was illustrated in Figure 3 & 4. Table 6 explains that in lifespan exposure, the projected RQ value in point 1 and point 2 from the 5th to the 30th year continues to increase. In point 1, projections with an RQ value >1 (risky) occur in the 15th year and above, while at point 2, until the 30th year it is still not risky.



Source: Primary Data, 2020

Figure 3. Lifespan RQ Projection (Point 1)



Source: Primary Data, 2020

Figure 4. Lifespan RQ Projection (Point 2)

Table 5. Realtime TSP Intake

Population Group	RQ (mg/kg/day)	
	Point 1	Point 2
Blending Division	0,4369*	0,0721*
Crushing Division	0,3711*	0,0792*
Distilling Division	0,5602*	0,0925*
Drying Division	0,3295*	0,0544*
Grinding Division	0,4541*	0,0750*
KHL Drying Division	0,1300^	0,0215^
KHL Stick Division	0,2072*	0,0342*
Stick Division	0,4423*	0,0730*

Source: Primary Data, 2020

Description: * = Mean ^ = Median

Table 6. Real Time and Lifespan RQ TSP by Sampling Point

RQ (mg/kg/ day)	Real Time	Projection (Year)					
		5	10	15	20	25	30
Point 1							
Blending Division	0,4369*	0,3806*	0,7612*	1,1418*	1,5225*	1,9031*	2,2837*
Crushing Division	0,3711*	0,4315 [^]	0,8629 [^]	1,2944 [^]	1,7258 [^]	2,1573 [^]	2,5887 [^]
Distilling Division	0,5602*	0,4778*	0,9556*	1,4334*	1,9111*	2,3889*	2,8667*
Drying Division	0,3295*	0,4193*	0,8386*	1,2578*	1,6771*	2,0964*	2,5157*
Grinding Division	0,4541*	0,3601*	0,7202*	1,0803*	1,4405*	1,8006*	2,1607*
KHL Drying Division	0,1300 [^]	0,4740*	0,9480*	1,4221*	1,8961*	2,3701*	2,8441*
KHL Stick Division	0,2072*	0,5450*	1,0901*	1,6351*	2,1801*	2,7251*	3,2702*
Stick Division	0,4423*	0,4062*	0,8125*	1,2187*	1,6250*	2,0312*	2,4374*
Point 2							
Blending Division	0,0721*	0,0628*	0,1257*	0,1885*	0,2514*	0,3142*	0,3771*
Crushing Division	0,0792*	0,0712 [^]	0,1477 [^]	0,2137 [^]	0,2850 [^]	0,3562 [^]	0,4274 [^]
Distilling Division	0,0925*	0,0789*	0,1578*	0,2367*	0,3156*	0,3944*	0,4733*
Drying Division	0,0544*	0,0692*	0,1385*	0,2077*	0,2769*	0,3461*	0,4154*
Grinding Division	0,0750*	0,0595*	0,1189*	0,1784*	0,2378*	0,2973*	0,3568*
KHL Drying Division	0,0215 [^]	0,0783*	0,1365*	0,2348*	0,3131*	0,3913*	0,4696*
KHL Stick Division	0,0342*	0,0900*	0,1800*	0,2700*	0,3600*	0,4500*	0,5399*
Stick Division	0,0730*	0,0671*	0,1342*	0,2012*	0,2683*	0,3354*	0,4024*

Source: Primary Data, 2020

Description: * = Mean [^] = Median

DISCUSSION

Characteristics of Respondents

Age is one of the risk factors in workers that can increase the incidence of acute respiratory infections (ARI).⁶ Increasing age will increase the number of damaged lung alveoli and decrease body resistance, as well as a decreasing in the respiratory system when the age reaches over 30 years.⁶ The average body weight of the respondents was 59 kg, which ranged from 47 to 87 kg. This value is smaller than the US EPA standard adult body weight of 70 kg, but close to the IRIS Asian exposure standard weight of 55 kg. Based on the intake results, it was found that respondents with low body weight had higher intake values than respondents with high body weight. This was in line with research conducted by Sari, which concludes that the lower the body weight, the greater the *intake* received, on the other hand, high body weight is less likely to raise the risk of health problems.¹¹

According to Purba et al, that there is no relationship between gender and pulmonary function disorders, where men and women have the same risk of pulmonary function disorders.¹² From the aspect of education, a good knowledge of health and the environment will be in line with efforts to protect themselves from the effects due to exposure to contaminant.¹³ However, looking at the number of respondents with health problems of 77%, and those who have a

higher education level (High School and Bachelor Degree) of 93.4%, it is suspected that the level of knowledge does not guarantee to avoid symptoms that arise due to exposure to dust.

Smoking is a risk factor for the incidence of ARI. Smoking has a toxic effect that causes irritation to the respiratory tract mucosa, thereby increasing the tendency to ARI.^{6,13} Smoking habit can increase the risk of ARI as much as 2.2 times,⁶ and cause respiratory system disorders such as lung cancer, acute irritant symptoms, chronic respiratory symptoms, chronic obstructive pulmonary disease, and respiratory infections. Smoking will increase the amount of air pollutants that enter the body so that it is riskier to get ARI disease.¹³

The result of this study found about 100% of respondents use mask while working, protective glasses (41%) and gloves (93.4%). Although most respondents have used PPE but still have health complaints, this is due to the use of masks that are not related with the provisions so that dust enters the respiratory tract. In line with the research conducted by Tong R et al, which says that the use of a mask that does not wear a respirator can cause a hazard of air into the respiratory tract.¹⁴ In addition, complaints of skin irritation (41%) require respondents to use gloves when working to prevent direct skin contact with wood dust. In line with the research conducted by Putri F, found no association between

exposure to wood dust with an incidence of irritant contact dermatitis of workers sanding PT X Jepara.¹⁵

Hazard Analysis

The measurement results show that the concentration of TSP in PT. Cassia Co-op Indonesia, in point 1 is 0.54279 mg / m³ above the ambient air quality standard according to PP No. 22 of 2021, but still below the threshold value according to Permenaker No. 5 of 2018, while in point 2 the concentration of TSP is 0.08962 mg/m³ and still safe because it is below the threshold value and quality standard. Although it is said to be safe, one day it can cause health problems related to the length of exposure as proven by the presence of respondents with health complaints such as sneezing, coughing, dizziness, chest pain, and so on. This is in line with the research of Fuadi, et al who concluded that the potential for hazards in the workplace will enter and accumulate in the body influenced by the length of exposure and the continuity of exposure. The longer the exposure, the more dust particles will accumulate in the body, which will cause health problems.⁶

The TSP concentration value in this study is lower than the results of research conducted by Nafisa (2016) with the highest value of 16.987 mg/m³ and the research conducted by Herdianti (2018) with the lowest value of 3.26 mg/m³.^{1,16} This condition is probably because the measurement of TSP concentration is not carried out in all points of original emergence of Dust risk agents, so it is less accurate. Measurements were carried out in two points during the day because the activities in company were densely packed during the day. This is in line with research conducted by Anugrah, which shows that the highest dust concentration results are in the midday.¹⁷

Based on the source of exposure, it is known that the potential source of exposure that produces TSP dust comes from the production activities of cinnamon bark processing, namely the chopping process, cutting process and refining process. Dust can arise due to natural processes or mechanical processes such as cutting, breaking, refining, packing, packaging, and others arising from an object or material either from both organic and Non-organic.^{2,18}

Working environmental conditions such as the presence of dust will affect the productivity and health of workers. Workers who are often exposed to dust will be at risk for health problems in the form of infectious or non-infectious diseases. Health problems can be seen from the perceived complaints/symptoms such as coughing, coughing up phlegm, shortness of breath, skin irritation, eye irritation, itchy nose, shortness of breath, and wheezing.⁶ The results showed that the majority of workers experienced health complaints. According to the research of Purba, et al, which found 58.06% of respondents with respiratory disorders, and the research conducted by Riani where most of the respondents experienced subjective complaints (84.7%) and the most common respiratory complaints were sneezing (80.3%). Sneezing and coughing are two of the most common symptoms felt due to the presence of dust in the ambient air as a non-specific form of body defense when the concentration of pollutants, especially particulates or TSP, is in the threshold.^{12,19}

Dose-Response Analysis

National ambient air quality standard PP no. 22 of 2021 cannot be substituted in the RfC equation because the default value of exposure factor is not known, so the reference dose is taken from the literature of previous studies where the RfC value for TSP is 0.020 mg/kg/day. These results were obtained from the default value of the US-EPA exposure factor and the TSP value taken from the NAAQS primary standard for PM₁₀ was 50 g/m³ (annual arithmetic mean) because 68% TSP was Pm₁₀, then the TSP Primary Standard was 73.53 g / m³ and converted to 0.7352 mg/m³.^{7,20}

Exposure Analysis

The results of the study obtained that the average daily length of exposure for respondents was 8 hours/day which calculated from the reduction between the total working time a day and the rest time. This shows the maximum daily exposure time of workers in the study longer than Undang-Undang Cipta Kerja No. 11/2020 for 8 hours / day or 40 hours / week.²¹ This condition is due to the high production activity that is adjusted to the market demand for cinnamon so that workers choose to fill overtime to increase their income. However, long exposure

while working will affect lung function. The greater the daily exposure value, the greater the risk of health problems. Indriyani et al stated the respondents exposed to TSP over 8 hours/day have a risk to get impaired lung function.⁸

The results of the analysis obtained the value of the exposure frequency of 264 days/year. This result is not in line with the US-EPA's default exposure value for the work environment of 250 days/year. The difference of 14 days is because workers in the Production section at PT. Cassia Co-op Indonesia utilizes holidays overtime for additional income.²⁰

The results of the study found that the duration of exposure (D_t minimum) was 1 year and the maximum duration was 8 years. Based on health complaints, it is known that the workers who have the least complaints are workers with more than 4 years of working, because they are used to air pollution. In the beginning of working, the researcher felt more sensitive and often experienced health complaints, but over time, health complaints decreased. This is in line with research conducted by Riani that health complaints are related to decrease respiratory tract sensitivity so that they are not too sensitive to exposure to pollutants in ambient air. This occurs when the concentration of TSP pollutants in the ambient air is still below the quality standard.¹⁹

The rate of inhalation (R) obtained based on provisions of the US-EPA's IRIS is equal to 20 m³/day and converted to 0,83 m³/h, this value using inhalation adult with average body weight of 70 kg according to the exposure factor in America.²⁰ The inhalation rate value does not use the national exposure factor because there is no default value for the exposure factor in Indonesia.

The highest non-carcinogenic intake for exposure real time in point 1 and point 2 is 0.0112 mg/kg/day and still below the RfC value (0.02 mg/kg/day), but the exposure lifespan in the 15th year projected intake in point 1 has exceeded the RfC, while in point 2 up to 30 years it is still said to be safe. This happens because of the difference in the value of the TSP concentration in each point. The greater the value of the

exposure factor, the greater the intake value.

Risk Characterization

The results of this study obtained the risk level of real time population in point 1 and point 2, a minimum of 0.0215 and a maximum of 0.5602 (RQ<1), meaning that in general respondents are safe from the risk of non-cancer health problems due to exposure to TSP in the air when study was carried out. Based on the lifespan risk level, the projected RQ value in point 1 exceeds the safe limit (RQ>1) in the 15th year for the entire population, meaning that the respondent is still safe in the location for 8 hours/day, 294 days/year for a maximum of 15 years. The next period of exposure to TSP in respondents will be at risk of experiencing non-carcinogenic health problems. This result is different from the Research conducted by Falahdina, which found a high level of real time exposure risk (RQ>1).²² This is probably due to differences in the characteristics and patterns of respondents' activities in the workplace.

This study has limitations because it only predicts the risk level of health problems due to TSP which is non-carcinogenic (RQ), while predicting the level of carcinogenic risk using the value of ECR (Excess Cancer Risk) is not carried out. In addition, the prediction of this risk level is subjective depends on the researcher's perspective and there is no control over other factors so it is possible that the reality of risk is not precisely defined.

CONCLUSION AND RECOMMENDATION

Based on the intake lifespan of TSP exposure, all production workers at PT. Cassia Co-op Indonesia will be at risk of experiencing health problems in its 15th year. Therefore, it is recommended for companies to take control measures to reduce the risk of health problems for workers due to exposure to TSP from cinnamon, including: regular health checks of workers by conducting lung function tests (spirometry), providing complete PPE, especially masks with a respirator and apply the correct use of PPE, make smoking rules while working, add a wet filter at the dust source, and increase the location and frequency of TSP dust level testing in the company.

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The Influence of Covid-19 Preparedness Through Health Care Implementation on Ship Crew

Pengaruh Kesiapsiagaan Covid-19 dengan Penerapan Protokol Kesehatan pada Awak Kapal

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COVID-19

ABSTRACT

An increasing number of people exposed to diseases is caused by uneven public awareness of personal health and the factors that cause the infectious diseases. Meanwhile, the government has limited funds and personnel, which causes an inability to achieve maximum goals in disease prevention. Therefore, this study aims to analyze the relationship between responsiveness, reliability, empathy, assurance, and tangible aspects with patient satisfaction regarding preparedness services at Belawan Port, Medan City in 2020. The quantitative analytic survey was used with a cross-sectional design. The population used was all ship crews presented and worked on the ship when it was anchored at Light I of Belawan Port. The sample consisted of 95 crew members. Analysis of the chi-square test shows the following results: responsiveness ($p=0.001$), reliability ($p=0.001$), assurance ($p=0.002$), empathy ($p=0.001$) and physical aspect ($p=0.060$). The logistic regression test shows the variable that influences the most satisfying service in preparedness service is empathy, with an Exp (B) value of 4.781. The conclusion shows that responsiveness, reliability, assurance, and empathy-related to crew satisfaction, while the physical aspect has no relationship with it. It is recommended to improve the quality of preparedness services for crew members by increasing supervision and inspection, and attention to prevent disease transmission and establish a harmonious relationship between health workers and crew members for customer satisfaction.

ABSTRAK

Meningkatnya jumlah orang yang terpapar penyakit disebabkan oleh kesadaran masyarakat yang tidak merata akan kesehatan pribadi dan faktor-faktor penyebab terjadinya penyakit menular. Sementara itu, keterbatasan dana dan tenaga yang dimiliki pemerintah menyebabkan tidak tercapainya tujuan secara maksimal dalam penanggulangan penyakit. Oleh karena itu, penelitian ini bertujuan untuk menganalisis hubungan antara aspek daya tanggap, kehandalan, kepedulian, jaminan, dan aspek fisik dengan kepuasan pasien terhadap pelayanan kesiapsiagaan di Pelabuhan Belawan Kota Medan Tahun 2020. Desain penelitian menggunakan survei analitik kuantitatif dengan rancangan cross sectional. Populasi yang digunakan adalah seluruh awak kapal yang berada dan bekerja di kapal pada saat sandar di Light I Pelabuhan Belawan. Sampel berjumlah 95 awak kapal. Berdasarkan analisis uji chi square menunjukkan hasil sebagai berikut: daya tanggap ($p=0,001$), kehandalan ($p=0,001$), jaminan ($p=0,002$), kepedulian ($p=0,001$) dan aspek fisik ($p=0,060$). Uji regresi logistik menunjukkan bahwa variabel yang paling berpengaruh terhadap pelayanan yang paling memuaskan dalam pelayanan kesiapsiagaan pada awak kapal adalah kepedulian dengan nilai Exp (B) 4,781. Kesimpulan menunjukkan bahwa daya tanggap, kehandalan, jaminan, kepedulian berhubungan dengan kepuasan awak kapal, sedangkan aspek fisik tidak memiliki hubungan dengan kepuasan awak kapal. Disarankan untuk meningkatkan pengawasan dan pemeriksaan, serta perhatian kualitas pelayanan kesiapsiagaan pada awak kapal dengan meningkatkan pengawasan dan pemeriksaan, serta rasa perhatian untuk mencegah penularan penyakit dan juga dapat menjalin hubungan yang harmonis antara tenaga kesehatan dengan awak kapal demi tercapainya pelayanan yang mampu memuaskan pengguna.

INTRODUCTION

Deaths caused by an epidemic are a public health threat of international concern. The 2002 severe acute respiratory syndrome (SARS) epidemic caused 800 deaths of estimated 8,000 cases, while the 2009 H1N1 pandemic with 18,500 deaths, the 2012 MERS respiratory syndrome epidemic with 800 deaths of 2,500 cases, the 2014 Ebola outbreak with 28,616 cases, and 11,310 deaths. Based on the WHO (World Health Organization) assessment of 118,000 cases of COVID-19 (Coronavirus Disease 19) which reported globally in 114 countries with more than 90 percent of cases in four countries (China, South Korea, Iran, and Iraq), COVID-19 was determined as a global pandemic on March 11, 2020.¹

The President declared the non-natural disasters caused by the spread of COVID-19 as a national disaster through Presidential Decree No. 12 of 2020. Accelerating COVID-19 national disaster handling was carried out through synergy between all ministries/agencies and local governments.²

The COVID-19 pandemic with its devastating impact on public health and economies worldwide urges the whole world to build and sustain the capacity of every country to prevent, detect and respond to these risks and threats. WHO emphasizes the importance of making substantial for every country to strengthen the core capacity of preparedness in preventing, detecting, responding to public health emergencies, including operational readiness in dealing with the COVID-19 pandemic as mandated by the IHR (International Health Regulations).³

According to the Research Center for the Expertise Agency, the People's Representative Council of the Republic of Indonesia, Indonesia's preparedness steps in facing COVID-19 disaster in 2020 are not optimal. Based on COVID-19 handling acceleration task force report, data on the spread of COVID-19 in Indonesia on June 11, 2020, reached a positive confirmed number of 35,295 people, with 12,636 people recovered and 2,000 died.² With suboptimal preparedness, disasters will cause more significant loss and death.

As stated in the Minister of Health Regulation No. 356 of 2008 and its amendment in the Minister of Health Regulation No.2348 of 2011, the

Port Health Office has duties to prevent the entry and exit of diseases, potential disease outbreaks, epidemiological surveillance, quarantine, environmental health impact control, health services, drug control, food, cosmetics, medical devices and addictive materials as well as safeguarding against new and re-emerging diseases, bioterrorism, biological, chemical and radiation protection in operational of airports, ports and state border crossing posts. According to the IHR mandate, the central capability for country entry is capacity in stable conditions and capacity in public health emergencies of international concern. Activities at the state entrance include detecting, preventing, and responding to COVID-19 at ports, airports, and State Land Border Crossings.⁴ This effort is carried out through the supervision of transportation, people, goods, and the environment from areas/countries affected by COVID-19 and executed by the Ministry of Maritime Affairs and Fisheries and coordinating with related sectors.

Port health office class 1 of Medan as the Technical Implementation Unit of the Ministry of Health also has functions for the implementation, facilitation and advocacy for the preparedness as well as epidemics and disasters management on health sector at operational area of airport and port as the state entry point based on the mandate of Minister of Health Republic of Indonesia Number 356 of 2008. Preparedness at the North Sumatra region's state entrance covers efforts of early detection, prevention and response to COVID-19 at ports and airports.

Based on the recapitulation of PCR and antigen rapid test results MV HI. 03 crew at Pertamina Pangkalan Brandan Hospital. On June 30, 2021, there were 16 crew members who tested positive for antigen test. Meanwhile, with a test through PCR on July 1, 2021, there were 9 positive crew members. On July 3, 2021, there were 10 positive crew members through the PCR test. On July 4, 2021, there were 6 positive crew members through antigen test. On July 5, 2021, Through PCR test, there were 2 positive crew members.

Optimization of disaster preparedness development also covers various aspects of operational readiness in Human Resources, Infrastructure, Fund, and Coordination.⁵ These preparedness efforts are carried out through the supervision of transportation means, people,

goods, and environment from areas/countries affected by COVID-19 which executed by the Ministry of Maritime Affairs and Fisheries and coordinating with related sectors. Therefore, this study aims to analyze the relationship among responsiveness, reliability, empathy, assurance, and tangible aspects with patient satisfaction regarding preparedness services at Belawan Port, Medan City, in 2020. Furthermore, it is also to measure the most influential factors to form the model for preparedness service during COVID-19 disasters in Medan.

MATERIAL AND METHOD

This research is a quantitative study with a cross-sectional approach. Researchers measured variables simultaneously and analyzed the dynamical correlation between risk factors and effects using approaching, observing, or collecting data at one time (Point time Approach). The responsiveness was measured by using six questions related to time during health assessment, document and administration as well as medical and evacuation. The reliability consists of seven questions related to the schedule of services, drugs, health resources, evacuation, quarantine quality. On the other hand, Assurance was measured by using six questions related to the accuracy of health service element given by the health officer. Empathy represented the psychological aspect of health officer caring behavior from four questions.⁶ Lastly, tangible things is related to all facilities required for health disasters preparedness services represented from eight questions.

This research was conducted from October to January 2021. The populations in this study were all ship crews anchored by Light 1. The crews who came and departed through the Port of Belawan were 150,948 people. The average number of crew members arrived and departed each month is 12,579 people. The sampling technique was carried out using purposive sampling. The minimum sample size is determined by using Slovin's Formula, which represented from a large number of total crew arrived mentioned earlier. The total sample counted as minimum as 99,21 or rounding to 100. The sample selection was projected based on the number of origin countries where the ships docked at the Port of Belawan over four months. The five shipping

countries were then projected with a proportional number of 20 respondents per country of origin. but then, during respondent selection were excluded because they had positive COVID-19 cases and enrolled on quarantine protocols. Therefore, 95 crew are last (consider appropriate number) continued to measure during the exact same time. The data were analyzed by using the chi square test for the first step, and the second step using multiple logistic regression to achieve the model for health services preparedness during the COVID-19 disaster.

RESULTS

The characteristics of the sample taken in this study include age and education. Univariate analysis was carried out to see the frequency distribution of respondents' characteristics. Table 1 represented the characteristics of research subject. The crew is mostly adults between ages of 26 and 45. This may correlate with workload because to be a crew member in a challenging working environment requires a very strong and healthy body. While their educations dominated by high school, this circumstance during the minimum requires for ship crew who are high school graduates, and all of them are male workers. Based on their nationalities, more than half are Indonesian who work at foreign ship, followed by Chinese and Burmese. Their origin countries around Southeast Asia.

According to table 2, responsiveness and reliability are reported above 50% in good terms. It means that this responsiveness during COVID-19 is the aspect that crew expected from the health services. During the responsiveness, comes the reliability, it means that how strong do they (the crew) believe the service is trusted. This aspect is common value as good term. Due the percentage of responsiveness and reliability rated as good; their satisfaction also followed. Different form of two aspects, assurance, empathy and tangible things are reported poor, but slightly showed higher percentages. Their common perspective regarding satisfaction is commonly high in good. The chi-square test shows significant relation among responsiveness, reliability, assurance, and empathy in crew satisfaction towards health services. But the tangible aspects are negatively correlated. Further analysis using logistic regression noted as follows:

In this first stage of logistic regression, the variables tested were all independent variables declared to have a p -value <0.25 in the bivariate analysis, namely responsiveness, reliability, assurance, empathy, and physical aspect. The results of the variable analysis with the first stage logistic regression test can be seen in the following Table 3.

The results of the first stage regression analysis showed that two variables have a p -value <0.05 , namely responsiveness (0.025) and empathy (0.042). Meanwhile, reliability, assurance, and physical aspect variables have a p -value >0.05 . For the next stage of the logistic regression test, the variables of reliability, assurance, and physical aspect were no longer used, and variables with a p -value <0.05 were continued to the next stage. Based on the first stage analysis, two variables meet the requirements of p -value <0.05 for the second stage test, namely responsiveness and empathy variables (Table 4).

Table 1. Characteristics of Respondents

Characteristics	n=95	%
Age		
Adolescents (17-25 Years Old)	22	23.2
Adults (26-45 Years Old)	44	46.3
Elderly (46-65 Years Old)	29	30.5
Educations		
Elementary	9	9.5
Middle School	13	13.7
High School	58	42.1
Gender		
Male	95	100
Female	0	0
Nationality		
China	18	18.90
Filiphine	9	9.47
India	7	7.36
Indonesia	49	51.50
Myanmar	10	10.50
Vietnam	6	6.31

Source: Primary Data, 2021

Table 2. Cross Tabulation of Responsiveness, Reliability, Assurance, Empathy, Tangible Aspect and Relationship with Crew Satisfaction at Belawan Port, Medan City

Variable	Crew Satisfaction				Total		<i>p</i> -value
	Less Satisfied		Satisfied		n	%	
	n	%	n	%			
Responsiveness							
Poor	37	29.2	7	14.8	44	46.3	0.001
Good	26	33.8	25	17.2	51	53.7	
Reliability							
Poor	38	29.2	6	14.8	44	46.3	0.001
Good	25	33.8	26	17.2	51	53.7	
Assurance							
Poor	42	34.5	10	17.5	52	54.8	0.002
Good	21	28.5	22	14.5	43	45.2	
Emphaty							
Poor	40	31.2	7	15.8	47	49.5	0.001
Good	23	31.8	25	16.2	48	50.5	
Tangible							
Poor	36	31.2	11	16.8	47	49.5	0.060
Good	27	31.8	21	16.2	48	50.5	

Source: Primary Data, 2021

Table 3. First Stage Multiple Logistic Regression

Variable	<i>p</i> -value	Exp(B)	95%C.I for Exp(B)	
			Lower	Upper
Constant	0.000	0.00		
Responsiveness	0.025	3.617	1.173	11.151
Reliability	0.050	3.159	1.000	9.981
Assurance	0.150	2.241	0.747	6.721
Emphaty	0.042	3.328	1.047	10.557
Tangible	0.073	2.709	0.910	8.068

Source: Primary Data, 2021

From the results of the second stage of regression analysis, it was found that responsiveness has a $p = 0.013 < 0.05$, and empathy has a $p\text{-value}$ of $0.003 < 0.05$. From the analysis above, the most dominant variable with crew satisfaction is empathy with a $p\text{-value}$ of $0.003 < 0.05$ and an Exp (B) value of 4.781, it means that the empathy given by health workers to crew members is 4.781 times more likely to affect crew satisfaction.

DISCUSSION

Responsiveness Aspect

After the Chi-Square test was carried out with confidence level of 95%, significant value of 0.001 was obtained, which means that it is smaller than ($p\text{-value}$) 0.05. Based on the results of this statistical test ($p\text{-value}$), it can be interpreted that poor responsiveness will result in low crew satisfaction with preparedness services, while good responsiveness can increase crew satisfaction.

Responsiveness relates to healthcare workers' ability to help patients and their readiness to serve according to standard procedures that meet patient expectations. The expectations of health service users for the speed of services tend to increase from time to time in line with advances in technology which used by service providers and health information owned by service users. Health services are responsive to the needs of users.⁴ This study shows the dimension of responsiveness related to patient satisfaction concerns with the services provided quickly and responsively, providing appropriate information, providing satisfying responses to user complaints, responsible service, and providing services by following technological developments.

Responsiveness is a strategy to assist and provide appropriate (responses) as well as appropriate services to customers by delivering clear information.⁷ Responsiveness refers to the willingness and ability of service providers (health

services) to assist customers (patients) and respond to their requests promptly. Responsiveness indicates a desire to help consumers and provide services quickly and precisely.⁸

Based on the research results, it can be concluded that the better quality of service provided by the public health center, the higher level of patient satisfaction during the service at the public health center. In other words, the higher the responsiveness provided by the public health center to the patients, the patients' satisfaction will surely increase.

Reliability Aspect

After doing the Chi-Square test with confidence level of 95%, a significant value of 0.000 was obtained, which means that it is smaller than ($p\text{-value}$) 0.05. Based on the results of this statistical test ($p\text{-value}$), it can be interpreted that poor service reliability results in low user satisfaction with health services, while good service reliability results in high satisfaction with health services. It shows that there is a relationship between reliability and crew satisfaction with preparedness services at Belawan Port, Medan city. The ability of Customer service officers is ability to provide services which provided by the expertise and skills possessed by officers in providing or completing services, providing accurate services, providing explanations to patients before services are provided, and providing satisfying services.⁸

The dimension of reliable service quality (Reliability) is ability to provide reliable and accurate service.⁹ Performance must follow patient expectations without errors, including fast and precise patient admission, prompt and precise examination services, correct and precise delivery treatment, fast and precise care services, and scheduled services carried out precisely, such as doctor visits. Service schedules are also required to be carried out appropriately, such as rest periods, straightforward service procedures, and when patients need help, nurses always provide services based on procedures.¹⁰

Table 4. Second Stage Multiple Logistic Regression

Variable	$p\text{-value}$	Exp(B)	95%C.I for Exp(B)	
			Lower	Upper
Constant	0.000	0.995		
Responsiveness	0.013	3.714	1.322	10.428
Emphaty	0.003	4.781	1.721	13.283

Source: Primary Data, 2021

Assurance Aspect

Assurance is related to the ability of security service so that the environmental security of the service provider unit or the facilities used is guaranteed, aiming to make the public feel at ease to get services against the risks that resulted from service implementation besides, employee knowledge and courtesy to instill trust and confidence in customers. Based on research, this dimension includes the factors of friendliness, competence, credibility, and security.

This study shows that the dimensions of assurance concerning friendly health workers, sufficient knowledge and ability to provide full confidence, skilled in providing services, security and trust assurance, and positive personality of health workers related to user satisfaction.⁸

Empathy Aspect

Empathy in providing services by not differentiating people's class or status served is related to the staff's exceptional care and attention to each service user, understanding their needs and providing convenience in calling the hospital at any time if they need some help. Empathy is also related to good communication between doctor and patient as well as personal approach.¹¹

This study shows that the comfort dimension involves good communication between health workers and patients, giving special attention to each patient, meeting patient needs, easy access to information and assistance from health workers, and good attention and response to any complaints are related to patient satisfaction.

Empathy means giving sincere attention and attitude (individually or personally) as well as the convenience that the hospital gives to the patients such as the ease of contacting health services, the ability of employees to communicate with patients, and efforts to understand the patients' wants and needs. A health center is expected to understand and know the patients, understand the patients' specific needs, and have a comfortable operational time.

Empathy in providing services by not differentiating people's class or status served is related to the staff's special care and attention to each service user, understanding their needs, and making it easy to be called back at any time. Empathy is also related to good communication

between doctor and patient as well as personal approach.^{12,13}

This study shows that the comfort dimension which consists of good communication between health workers and patients, giving special attention to each patient, meeting patient needs, by health workers, obtaining information and assistance from health workers, and good attention and response to each complaint. This convenience dimension has a relationship with patient satisfaction.¹⁴

Empathy means giving sincere attention and attitude (individually or personally) as well as the convenience that the hospital gives to the patients, such as the ease of contacting health services, the ability of employees to communicate with patients, and efforts to understand the patients' wants and needs. A health center is expected to understand and know the patients, understand the patients' specific needs, and have a comfortable operational time.¹⁵

According to the results of study, it was found that the empathy for the ship crews was still lack, engaged with respondents' answer that the patients did not get enough attention and proper response to their complaints from the health workers. Also, good communication has not been established between patients and health workers. Patients should get proper care from health workers.¹⁶ Attention is one sign that health workers care about the patient's condition. The preparedness officers at the Belawan Port are less communicative in interacting with the crew, it was dominated by male officers, and appear to be less attentive so that the services provided are not optimal.

Tangible Aspect (Physical Aspect)

The physical aspect related to the quality health services felt directly by its users by providing adequate physical facilities and equipment. The form of service cannot be seen, smelled and touched. Therefore, the physical aspect becomes essential as a measure of service. Patients will use their sense of sight to assess the quality service. The proper physical aspect will affect patient perception. At the same time, this aspect is also one of the sources which influence patient's expectations. With a good physical aspect, the patient's expectations will be higher. Therefore, the hospital needs to know how far

the exact physical aspects are, namely those that still give positive impression on the quality services provided but do not cause patient expectations to be too high. It can meet the needs of patient and provide satisfaction to patient.^{17, 18}

This study shows that health workers appearance, cleanliness and completeness of the available equipment, safe and comfortable waiting room and a large parking area is related to patient satisfaction. Patients feel satisfied if they feel comfortable undergoing treatment.

The research result found that the physical aspects were adequate in terms of location, building, appearance, atmosphere, equipment used and health workers appearance. It certainly makes patients feel safe and comfortable. Patients have had a pleasant experience getting services at the public health center, which have been proven through the desire to come back when they need health services.

CONCLUSION AND RECOMMENDATION

The research results can be concluded as follows: there is a relationship between responsiveness, reliability, and empathy with patient satisfaction. Meanwhile, assurance and tangible things (physical aspects) do not affect on patient satisfaction. Based on the logistic regression test results, the variable that influences the most satisfying is the empathy shown by health workers to patients, which is 4,781 times greater in influencing crew satisfaction with preparedness services at Belawan Port, Medan City in 2020.

The Ministry of Health at Belawan Port is expected to improve the quality of preparedness services in preventing infectious diseases, especially at the State Entry, by conducting strict inspections and establishing good interactions between health workers and ship crews so that ship crews do not feel compelled to carry out health checks.

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