Clustering of Provinces in Indonesia based on Maternal Health Indicators

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Abstract

Indonesian health issues that deserved top priority was maternal and child health because it determines the quality of the human resources of future generations. The objective of this research is to analyze the clustering of provinces in Indonesia based on maternal health indicators. This cross-sectional study was conducted in 34 provinces using secondary data from the Basic Health Research and Statistics Indonesia. Analysis of provincial clustering used FUZZY C-MEANS. Analysis produces six clusters. Cluster 2 has a high mean value of maternal health indicators that exceeded the Indonesian target, consisting of the provinces of DKI Jakarta, DI Yogyakarta, and East Nusa Tenggara. Cluster 2 was formed by the value equation variable Age of first mating, Ownership of maternal and child health monitoring book, Vitamin A Provision, K4, postpartum visits, Iron supplementation tablets consumption and Childbirth delivery in health facilities. Indicators of ownership of the maternal and child health monitoring book for pregnant women had met Indonesia target in all clusters. Meanwhile, the active participation of family planning program indicator was still below the Indonesia target in all clusters.

Keywords: *maternal health, indicator, cluster, fuzzy-c-means.*

Background

The Maternal Mortality Rate (MMR) and Infant Mortality Rate (IMR), the reduction in the prevalence of stunting, as well as the control of infectious diseases and non-communicable diseases are priority health programs in the Indonesian for 2015-2019 (1).

In developing countries, including Indonesia, maternal mortality is still a major problem. The Indonesia maternal mortality rate in 2018/2019 is 305 per 1000 live births, meaning there are 38 mothers die every day due to illness/ complications related to pregnancy and childbirth. Compared to this, there are 830 mothers die every day in the world because of the same thing. The maternal mortality rate in Indonesia is second highest in ASEAN after Laos. Third place and so are the Philippines, Myanmar, Cambodia, Vietnam and Malaysia (2).

Labor complication is one of major maternal death cause in Indonesia. Based on 2018 Basic Health Research (Riskesdas), the proportion of childbirth complications in women aged 10-54 years in Indonesia was 23.2 percent (3). Based on 2018 National Social Economic Survey (*Susenas*), it was stated that women in Indonesia who had health complaints the last one month were 45.24 percent (4).

Indonesia's health problems that need top priority is Maternal and Child Health (MCH) because it greatly determines the quality of human resources (HR) in future generations. The high maternal and child mortality rates reflect MCH services that urgently need improvement,

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both in terms of range and quality of services [5].

So far, research conducted related to maternal health was still rarely done. Existing research on maternal mortality and related factors. Research conducted by Nurrizka and Wahyono (2018) on Maternal Mortality Disparities in Indonesia stated that there was still a disparity in maternal mortality that involved an intermediate factor between districts/ cities in Indonesia, with the highest risk of maternal mortality occured in Eastern Indonesia. This study used secondary data from Statistics Indonesia and the Ministry of Health as many as 8 variables, including health variables and demographic variables in 2013 [6].

Research conducted by Mukti and Wibowo (2017) on the Mapping of Maternal and Children Health Areas in East Java Province in 2014 used secondary data on 2014 maternal and children health programs in the East Java Provincial Health Office. This study applied a non-hierarchical cluster analysis method or K-Means Cluster. Eight variables were analyzed, ranging from maternal health service coverage, complications of labor and neonatal health service [5].

Based on the description above, research that has been done related to maternal health area mapping was still limited in one particular province, none of which has been done at the national level. Researcher is interested in analyzing the clustering of provinces in Indonesia based on maternal health indicators and using more health variables.

Cluster analysis produces information that differentiate cluster having maternal health indicators that perform beyond Indonesia's target and which do not. Indonesian government can employ this cluster analysis to arrange more precise monitoring and evaluation of health program, by prioritizing programs according to the needs of each region.

Methods

This research is cross sectional study that applies Fuzzy-C Means analysis which was conducted in 34 provinces. The research uses data from three sources, namely the National Health Research (Riskesdas) 2018 [3], Welfare Statistics in Indonesia 2018 and Profile of Maternal and Child Health 2018 [4,7].

Riskesdas is a community-based health research that its indicators represent both national level and district/ city level. Conducted once every five years, Riskesdas considered having appropriate interval to assess the development of public health status, risk factors, and the progress of health development efforts.

The Statistics Indonesia (*BPS*) collects data on demographic, education, health, fertility and family planning, housing, information and communication technology, crime, and social protection. These data are presented at the national and provincial levels thus allowing comparisons between regions.

FUZZY C-MEANS was applied to analyze the data. Research conducted by Maheswari (2018), Rahayu (2018), and Wang (2018) shows that cluster analysis using factor analysis results can improve clustering results by providing shorter time data processing. Factor analysis is considered for this study due to its stable clustering characteristics [8–10].

The steps of the analysis are:

1. Perform data adequacy test and correlation test.

2. Perform factor analysis.

3. Perform grouping using FUZZY C-MEANS.

4. Determine the optimal number of clusters using Pseudo F-Statistics.

5. Compare the performance of the method using ICD rate.

The highest Pseudo F indicates optimum number of groups created from data available, meaning the group is highly homogeneous while the intergroup diversity is highly heterogeneous [11]. The selection of the best clustering method can be done by choosing the smallest icd rate. The value of icd rate describes the disperse level in the cluster [12].

Results and Discussion

Before clusters is formed, factor analysis is carried out to change the independent variables that correlate with other variables into new variable that is not interrelated.

This new variable is called the principal component [13]. The first step in conducting a cluster analysis is to check the adequacy of the data using the Kaiser-Meyer-Olkin (KMO) value. In this analysis the KMO value is 0.707 (> 0.5), indicating that the amount of data used is sufficient to be calculated.

The next step to do is a Barlett test to find out the correlation between variables. This test yields p-value = 0,000 ($< \alpha = 0.05$), resulting in a decision to reject H_0. It is concluded that there is a correlation between maternal health indicator variables in Indonesia.

Determination of the optimal clusters number is based on the highest Pseudo F-Statistics value. This shows that two optimal clusters are formed. On the other hand, FUZZY C-MEANS method with factor analysis produces the highest Pseudo F-Statistics value of 12.537, which forms six optimal clusters (Table 1).

Table 1. Pseudo F-Statistics with FUZZY C-MEANS method

Number of Clusters	With Factor Analysis
2	7.547577
3	8.742597
4	12.30961
5	11.39988
6	12.5317

Table 2. Clusters of factor analysis using the FUZZY C-MEANS method

Cluster	Member of Clusters	Number of Members
1	South Sumatra, Bengkulu, Bangka Belitung Islands, Central Kalimantan, Central Sulawesi, Southeast Sulawesi	6
2	DKI Jakarta, Yogyakarta, East Nusa Tenggara	3
3	Jambi, Lampung, West Java, Central Java, East Java Timur, Banten, West Nusa Tenggara, West Kalimantan, South Kalimantan, East Kalimantan	10
4	Maluku, North Maluku, Papua	3
5	North Sumatra, West Sumatra, Riau, Riau Islands, Bali	5
6	Aceh, North Kalimantan, North Sulawesi, South Sulawesi, Gorontalo, West Sulawesi, West Papua	7

Cluster Interpretation

FUZZY C-MEANS method with factor analysis is a good method for grouping provinces based on maternal health indicators. Interpretation of results uses the mean value (centroid) of each variable in each cluster. The mean values of all clusters are shown in Table 3.

Table 3. Average value of the maternal health indicator for each cluster

Variable	Average					
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
X1 = First age of mating **	63.02	80.18	61.84	73.99	77.83	68.71
X2 = Normal birth weight newborn **	81.75	80.45	82.76	53.78	86.65	78.92
X3 = Ownership of maternal and child health monitoring book *	69.93	79.90	79.77	62.47	65.08	74.56
X4 = Vitamin A provision *	53.98	63.30	59.71	50.83	49.48	61.00
X5 = Mothers having health insurance **	67.41	77.41	61.36	69.26	63.31	80.69
X6 = K1 *	77.93	86.30	86.86	71.13	87.26	75.93
X7 = K4 *	62.72	79.57	74.94	49.10	72.76	58.84
X8 = Postpartum visits *	58.84	52.40	40.28	24.30	31.08	29.94
X9 = Iron supplementation tablets consumption *	23.10	57.00	39.03	23.57	37.68	18.26
X10 = Childbirth delivery in health facilities **	65.20	90.89	81.63	42.72	85.63	79.11
X11 = Birth attendant by health professional **	90.92	93.94	93.37	67.05	96.51	92.56
X12 = Active participant of family planning program **	58.81	47.22	58.43	37.11	49.14	48.71
Average	64.47	74.05	68.33	52.11	66.87	63.94

Source: *Ministry of Health (Riskesdas) 2018; **Statistics Indonesia (BPS) 2018

Table 3 shows that cluster 2 has the highest average and cluster 4 has the lowest. Cluster 1 has the highest average percentage of active participants of family planning program. The variable with the highest percentage is delivery with the help of health professional, and the variable with the lowest percentage is iron supplementation tablet consumption. Cluster 2 has seven variables with the highest average compared to other clusters which are age of first mating, having maternal and child health monitoring book, vitamin A provision, K4, postpartum visits, iron supplementation tablets consumption, and childbirth delivery at health facilities. The normal birth weight of newborn and active participants of family planning program variables in this cluster show inferior performance compared to other five clusters.

Cluster 3 has two variables with the lowest percentage compared to other clusters, which are age of first mating and national insurance health participant. Other variables in this cluster have a good average percentage. Cluster 4 have the lowest average percentage of maternal health indicators among other clusters. Cluster 4 has eight variables with the lowest average percentage of normal birth weight newborn, having maternal and child health monitoring book, K1, K4, postpartum visits, childbirth delivery at health facility, giving birth with the help of health professional, and active participant of family planning program. The indicator of maternal health with the highest mean in cluster 4 is the age of first mating. Whereas the lowest is iron supplementation tablets consumption.

Cluster 5 has two variables with the highest average percentage than other clusters, that are normal birth weight infant and giving birth with the help of health professional. The provision of vitamin A in this cluster is the variable with the lowest average percentage among all clusters. Indicators of maternal health with the highest mean in cluster 5 is giving birth with the help of health professional, the lowest is postpartum visits. Cluster 6 has the variable with the highest and lowest average percentage of the other clusters, which is national health insurance participation of mother and the iron supplementation tablets consumption, respectively. The variable of iron supplementation tablet consumption is indicator with the lowest mean value in cluster 6. While indicator with the highest mean value is childbirth delivery with the help of health professional.

Provinces with a low average indicator of maternal health are cluster 4 consisting of Maluku, North Maluku and Papua. Provinces with the highest average maternal health indicators are cluster 2, which consists of DKI Jakarta, Yogyakarta and East Nusa Tenggara.

The results shows that the childbirth delivery assisted by health professionals variable is the maternal health indicator with highest mean, almost 100 percent (90.96%). According to Nurhapipa and Seprina's research in Center of Public Health (Puskesmas) XIII Koto Kampar I Riau (2015), the factors of affordability, family support and attitudes determined the mothers' choice of childbirth delivery attendants type. When mothers had limited access to health facilities, then the chances of mothers choosing traditional childbirth delivery attendants ("dukun") were fifteen times greater than those who had better access. While lack of family support gave four times greater chance to choose traditional childbirth delivery attendants (14).

The results of Zahtamal, Tuti Restuastuti and Fifia Chandra's study (2011) showed that 81.1 percent of health service providers contributed to good maternal health practices, although it was statistically insignificant. Better maternal health practices were more likely influenced by the ease of accessing health services. Substandard maternal health practices were experienced 2.5 times greater by respondents with limited health services access (15).

The Number of pregnant mothers receiving iron supplementation tablets (*TTD*) are still lower (31.96%) than expected number, which was 98% according to The Indonesian National Strategic Plan 2015-2019. Dewantoro and Muniroh's (2017) mentioned that limited supply of iron supplementation tablets in Center of Public Health led to low number of iron supplementation tablets utilization. Each Center of Public Health had a

distinct amount of funds spent to meet the needs of the iron supplementation tablets depending on the size of the capitation funds. Thus contributed to pregnant mothers' compliance on consuming iron supplementation tablets [16].

An interesting finding to be analysed is the low average value on iron supplementation tablets consumption in all clusters. Further finding reveals that the ownership pregnancy monitoring book are quite high in all clusters. This finding is quite contradictory to the fact that maternal and child health monitoring book should be a communications, information and education media on healthy pregnancy issue including information on the importance of iron supplementation [17]. The use of maternal and child health monitoring books are still limited to record medical history of pregnant women and have not been as an educational medium for pregnant women yet, as Sulistingsih reported [18]. According to Kalsum and Yeni, one of the factors that affecting optimum utilization of the maternal and child health monitoring book were number of parity and the active role of health workers [19].

The provincial grouping results presented by images 1 shows cluster 4 (Maluku, North Maluku, and Papua Province) has the lowest mean value of maternal health indicators among others. This finding is consistent with Rahmah Hida N and Tri Yunis MW's (2018) study result on the Maternal Death Disparity in Indonesia, which stated the high maternal death toll found in the district/city located in Eastern Indonesia. The provinces with a low maternal health indicator had higher risk on maternal mortality [6]. The result of our research is consistent with Rivan D and Robert K's study finding (2017) on the modeling of the Maternal Mortality Rate in Indonesia using GWPR. The study showed that the eastern Indonesia region had the smallest number of K4 visits (maternal visit on third semester) in comparison to other districts, leading to lack of sufficient health observation of pregnant women in the area, followed by increasing risk of maternal mortality [20].

The results of this research is also consistent with Syafrina and Sumertajaya's study finding (2019) on Regency and City Clustering in Indonesia and also Fuzzy K Radala's study finding that state most of the regencies and cities on Java Island are situated in cluster 2, which is upper middle class of Indonesian Human Development Index (HDI). The lower middle-class Indonesian HDI category is mostly occupied by Eastern Indonesia regencies and cities, whilst West Papua Province has the lowest Indonesian HDI. In contrast, some parts of Special Region of Jakarta, West Sumatra, and North Sumatra managed to reach high Indonesian HDI [21].

Family planning programme participation rate is one of the indicators of maternal health. The highest of active family planning programme participants (58.81%) is in cluster 1 which consist of six provinces. Based on the 2017 Indonesian Demographic and Health Survey (SDKI) 2017, active participation rate of family planning programme, both traditional and modern method, of the majority of the provinces in the cluster 1 (except Southeast Sulawesi 35.2%) are beyond Indonesia's National average (46%). However, this is still below the national's target set in 2019 which is 66%. Family planning programme is not entirely successful as measured through Contraceptive Prevalence Rate (CPR). The family planning program's achievement in 2017 reached 63 percent, which was increased by 1.1 percent compared to 61.9 percent in 2012 [22].

The Indonesian Demographic and Health Survey showed that the proportion of unmet need was increasing from 9,1% in 2007 and 11,4% in 2012. These also depict shortage on contraception supply contributes to The family planning program's underperformed condition. This condition should be important because it causes unexpected pregnancy to trigger abortion that escalates the risk of maternal mortality. Nurul Huda F., Ratno Widoyo and Fauziyah Elytha (2016) found that lacking of husband's support in participating birth control, raising the risk of unmet need to be 2.2 times [23].

Cluster 2 has the highest average value on all 7 maternal health indicators, amongst all clusters. This also indicates provinces in cluster 2 perform better in implementing health programs amongst all provinces in Indonesia. Cluster 2 consists of three provinces which have similarities on value of the variables. The average value of childbirth delivery at a health service facility (90.89%) on clusters 2 has exceeded the national target of 2018 (82%) [24]. Indonesian Demographic and Health Survey 2017 mentioned that most provinces in the clusters 2 (except East Nusa Tenggara) performed beyond national target, which was 79.4%, on childbirth delivery at health service facilities program. Similarly, healthcare staff-attended childbirth delivery average values in cluster 2 (except East Nusa Tenggara) exceeded the national average of 90.9% [22].

The *visit 1* (K1) or minimum once visit to health care facilities during first trimester of pregnancy is one of the maternal health indicators that reaches the highest average value (86.30%) in cluster 2, which is also exceeds the national target of 2018 (85%) [24]. Indonesian Demographic and Health Survey 2017 showed that provinces in cluster 2 (except East Nusa Tenggara) performed better than the national average of K1, which was 97.5%. Likewise, average value for *visit 4 (*K4) or minimum four times visit to health care facilities during pregnancy (once in the first trimester, once in second semester and twice in third trimester of pregnancy) in cluster 2, which was 79.57%, performed beyond the national target 2018 (78%) [24]. According to Indonesian Demographic and Health Survey 2017, most provinces in cluster 2 (except East Nusa Tenggara) implemented K4 above the national target 2017 (77.4%) [22].

Analysis results show the mean value of the KMS ownership in cluster 2 is higher than other clusters, surpassed the targeted achievement rate by General Directorate of Family Health, 50% (25). The analysis indicated that the average value of the postpartum women received vitamin A in cluster 2 is higher than the other clusters. Despite this, the results of the Nutritional Status Monitoring (*PSG)* (2017) nationally is still high at 53.5% [26].

Analysis results show that clusters 3 had satisfying mean value of most maternal health indicators, but still have the lowest average on indicator of the first mating age and mother having National Health Insurance. Cluster 3 consists of 10 provinces dominated by provinces situated in West Indonesian region. Over the past three years, many of the pregnant women in Indonesia's western region have rarely utilize the NHI scheme as they prefer pay for medical service. On the other hand, most women in Central and Eastern Indonesia area had higher utilization rate of NHI [27]. Desra and Idris's study (2019) on the mass-level Determinant in West Sumatra province indicated that the mother's age had a significant influence on infant mortality in West Sumatra. The older the mother's age, the higher risk for infant mortality. Furthermore, first mating age also plays significant role in infant mortality rate issue [28].

Cluster 4 has the lowest average value of eight maternal health indicators. Normal birth weight leads to optimum growth and healthy generation. The low percentage of normal birth weight infants increase the risk of infant mortality and health disorders. Indonesian Demographic and Health Survey (SDKI) 2017 showed provinces in cluster 4 (Maluku 67%, North Maluku 68.3%, Papua 52.4%) had much lower normal birth weight infants number than national average (87.5%). The ownership of toddlers growth chart and milestones card (*KMS)* in cluster 4 is the lowest amongst others. Through this *KMS,* children's growth are monitored every months. According to SDKI 2017, Papua, which is grouped in Cluster 4, had the lowest average in ownership of KMS (67.2%) among all provinces in Indonesia [22].

The childbirth delivery assisted by health professionals variable has the highest average amongst all variables. The results of Alhidayati and Asmuliyanti (2016) study showed that the coverage of childbirth delivery assisted by health professionals in Hulu-Riau Center of Public Health (Puskesmas) was 79.86%, while the rest 20.14% assisted by non health professionals.

The percentage of iron supplementation tablet consumption is the lowest amongst all variables in cluster 5, also the lowest compared to all provinces in Indonesia. Contrary to Nutritional Status Monitoring (*PSG)* 2017 results, provinces grouped in cluster 6 which got sufficient amount of iron supplementation tablets was only 31.3%. While the rest 16.5% did not get any iron supplementation tablets and the other 52.2% only got less than 90 iron supplementation tablets [26]. This clustering analysis can be employed by the central government to conduct more targeted monitoring and evaluation, by providing special programs with the requirements of each cluster. Out of the 12 variables analyzed, the iron supplementation program needs even greater effort to increase the participation level of pregnant women across the clusters. The enactment of maternal iron supplementation means improving the maternal mortality rate due to bleeding as well as reducing the neonatal mortality rate [30–32].

Conclusion

The Indonesian provincial group based on Maternal Health Indicators using FUZZY C-MEANS Clustering produces six clusters, which is found with high, medium and low in average value of maternal health indicators. Indicator for ownership of pregnancy monitoring book has met national targets in all clusters. Indicator for active family planning participation is still below the national target on all clusters. Cluster 2 which consist of the Special Region of Jakarta, Special Region of Yogyakarta and East Nusa Tenggara is a cluster with high average maternal health indicators and perform beyond the national target. Meanwhile, the clusters of the Maluku, North Maluku and Papua provinces are clusters with low average maternal health indicators and many indicators under the national target. Other clusters have maternal health indicators with medium and varied average values.

Additional Informations

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