Maternal health care in Aceh Province: cluster analysis results

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Abstract: This study aims to establish a group with percentage data of maternal health services in 23 districts / municipalities of Aceh Province. The method used to form groups is by median clustering method. The cluster result of the method will be compared to obtain optimal clusters on maternal health services percentage data. The steps in the cluster analysis are to determine the size of the similarity or inconsistency between data, the process of clustering with the distance matrix and agglomeration schedule, to improve the distance matrix by the median clustering method, to determine the number of clusters and their members, to interpret the cluster result, and to set the grouping boundary to describe characteristics of pregnant women's health services in each cluster. The result obtained is the comparison of standard deviation value, the minimum standard deviation value is owned by 4 clusters. The first cluster: there is 1 district / municipality; the second cluster: there are 9 districts / municipalities; the third cluster: there is 1 district / municipality and in fourth cluster: there are 12 districts / municipalities.

1. Introduction

Pregnancy and childbirth are a natural process for a mother's life in a productive age. This process can not be disturbed either physiologically or psychologically because it can have bad effects and risks for both, mother and baby. Death is one of the biggest risks often faced by mothers during pregnancy and childbirth [1].

Indonesia as a developing country has a life expectancy of pregnant women who are still relatively low. Pregnant women experience many health problems while being pregnant such as bleeding during childbirth, prolonged labor, and others. Aceh is one of the observed areas that still have bad health status of pregnant women. This condition occurs because health services to pregnant women are considered still not optimal. In general, the maternal mortality rate (MMR) in Aceh in 2010 was 193 per 100,000 KH.

The Ministry of Health set a target of 80% of obstetric complications for 2015 [2]. When compared with the results in 2013, the percentage of obstetric care handling is 47.6% and the remaining 33.4% are obstetric complications that are not handled. The cause of maternal death indirectly is due to delay; recognize alarms in pregnancy, reach facilities for delivery, obtain health services, and also lack of maternity access to quality healthcare [3]. This is also due to the spread of health services for pregnant women has not been evenly distributed in all regions in Aceh Province. Maternal health should be improved so that the tendency of death of pregnant women can decrease gradually. The government seeks to reduce maternal mortality by targeting the number of maternal deaths to be reached by 102 per 100,000 KH by 2015 [4].
This study proposes an effective step in looking at areas in Aceh Province where the high degree of awareness patterns of pregnant women needs to be studied and analyzed. It is hoped that the grouping of maternal health service indicators can be obtained, which is needed for the health department in making policy and planning.

Cluster analysis is a method for classifying observational data and relatively many variables, such that the data reduced by the cluster method will be easy to analyze.

The cluster analysis algorithm works by dividing data into a number of clusters to analyze similarity or dissimilarity factors attached to the data set. The cluster analysis method in this research is median clustering. The optimal grouping method will be obtained through the smallest standard deviation. Then, the optimal group is given a characteristic based on the average value in the cluster to get the rank of districts / municipality in Aceh Province which has the maternal health services.

2. Literature Review

Pregnancy is a natural process that occurs in women, beginning with the stage of conception followed by the development of the fetus in the womb [4]. The normal duration of pregnancy is 280 days (40 weeks or 9 months 7 days) in the counting from the first menstruation to the last menstrual (starting from conception) for 6 months, the third quarter from month 7 to 9 months [1].

Utilization of health services by pregnant women is basically a manifestation of one form of behavior in the field of health to prevent and cope with diseases or disorders that can endanger health [5]. Pregnancy surveillance is useful for knowing the general health of mother, fetal health, and their relationships then appropriate delivery planning can be planned [6].

According to Health Department [2] the coverage of health services for maternal health are as follows: Coverage of delivery assistance by health personnel; Coverage of childbirth services; Tetanus Toxoid Immunization (TT) of pregnant women. For administration of tetanus toxoid vaccine in pregnant women there are 5 doses with certain interval (started at or before pregnancy) that is: TT2 injection, TT3, TT4, TT5 and TT2+. Coverage of pregnant women who received the first iron tablets (Fe1) and the second iron tablets (Fe2); Coverage of postpartum women receiving vitamin A capsules; Handling of obstetric complications; Coverage of K-1 and K-4 Services.

Cluster analysis is included in multivariate, but the concept of variat in this technique is different from the concept of variation of other multivariate techniques. In other techniques, variat is defined as a linear combination of variables. While in cluster analysis, variat is defined as a number of variables (considered as characteristics) used to compare an object with another object. Thus, in the cluster analysis, no empirical value search was conducted as in other multivariate techniques [7]. Cluster variables in the cluster analysis are determined by the researchers themselves according to the purpose of the clustering [8].

The main purpose of cluster analysis is to place a set of objects into two or more clusters based on similarities of objects on the basis of various characteristics. Characteristics of objects in a cluster have a high degree of similarity, while the characteristics between objects on a cluster with other clusters have a low level of similarity [7].

The steps used in the cluster analysis are measuring similarities or dissimilarities between objects using squared euclidean distance, selecting a cluster analysis procedure, selecting the best method with standard deviation. A good clustering method has a minimum standard deviation value in the cluster (Sw) and the maximum standard deviation value between clusters (Sb), and the determination of the clustering boundary [9].

The clustering limits for each variable follow the following procedure [10]: (1) specifies the value of the data for each variable; (2) Setting aside an outlier data, then calculate the maximum and minimum values of the data that has been removed the outlier values; (3) Range = maximum – minimum; (4) Class width (y) = \( \frac{\text{Range}}{3} \); (5) The boundaries for each cluster with the following formula:

- Low = \( x \leq (\text{min} + y) \)
- Medium = \( (\text{min} + y) < x < (\text{min} + 2y) \)
- High = \( x \geq (\text{min} + 2y) \)
3. Methods

3.1. Data
The data in this study was obtained from Aceh Health Profile 2014. It is an indicator of maternal health care in every district / city in Aceh Province. The dependent variable used is 23 districts / cities in Aceh province, while the independent variable is an indicator of health services. These variables can be seen as follows: Y Variables: Simeulu, Aceh Selatan, Aceh Tenggara, Aceh Timur, Aceh Tengah, Aceh Barat, Aceh Besar, Pidie, Bireuen, Aceh Utara, Gayo Lues, Aceh Tamiang, Nagan Raya, Aceh Jaya, Bener Meriah, Pidie Jaya, Kota Banda Aceh, Kota Sabang, Kota Langsa, Kota Lhokseumawe, Kota Subulussalam
X Variables:
\[ Y_1 \text{: Percentage of deliveries assisted by health personnel} \]
\[ Y_2 \text{: Percentage of childbirth services} \]
\[ Y_3 \text{: Percentage of pregnant women get TT-1} \]
\[ Y_4 \text{: Percentage of pregnant women get TT-2} \]
\[ Y_5 \text{: Percentage of pregnant women get TT-3} \]
\[ Y_6 \text{: Percentage of pregnant women get TT-4} \]
\[ Y_7 \text{: Percentage of pregnant women get TT-5} \]
\[ Y_8 \text{: Percentage of pregnant women get TT2+} \]
\[ Y_9 \text{: Percentage of pregnant women get } F_e \text{ 30 tablet} \]
\[ Y_{10} \text{: Percentage of pregnant women get } F_e \text{ 90 tablet} \]
\[ Y_11 \text{: Percentage of postpartum women receiving vitamin A capsules} \]
\[ Y_{12} \text{: Percentage of obstetric complications handling} \]
\[ Y_{13} \text{: Percentage of visitation services of first pregnant women (K-1)} \]
\[ Y_{14} \text{: Percentage of visits to pregnant women at least 4 times (K-4)} \]

3.2. Analysis
The procedures in cluster analysis are as follows:
1. Calculate the size of similarities and dissimilarities between two objects using median clustering method along with the Squared Euclidean Distance formula.
2. Improved the distance matrix using the median clustering method. The calculation of the distance matrix correction is done until all objects are combined.
3. Forming clusters of 2, 3, 4 and 5 clusters.
4. Establish optimal cluster method and number based on standard deviations in the cluster, standard deviations between clusters and ratios.
5. Define cluster members, Interprete optimal cluster.
6. Provide specific features to describe cluster content based on the average value in each cluster by using clustering limits.

4. Results and discussion

4.1. Result
Cluster analysis will create clusters on objects based on their similarity characteristics. Characteristics of objects in a cluster have a high level of similarity, while the characteristics between objects on a cluster with other clusters have a low level of similarity. The size of the similarity of each object (district / city) is calculated using the formula Squared Euclidean Distance. Subsequently, the median clustering method distance matrix values and other results have been summarized in the following tables:
Table 1. Median clustering method distance matrix

| District/City | Simeulu | Aceh Singkil | Aceh Selatan | ... | Subulussalam |
|---------------|---------|--------------|--------------|-----|--------------|
| Simeulu       | 0       | 20423,4      | 6538,5       | ... | 27572,08     |
| Aceh Singkil  | 20423,4 | 0            | 5712,7       | ... | 2082,6       |
| Aceh Selatan  | 6538,5  | 5712,7       | 0            | ... | 8823,8       |
| Aceh Tenggara | 25078,6 | 4849,3       | 7846,19      | ... | 3617,63      |
| ...           | ...     | ...          | ...          | ... | ...          |
| Subulussalam  | 27572,0 | 2082,6       | 8823,8       | ... | 0            |

Figure 1. Dendogram median clustering method

Table 2. Member of 2 median clustering method

| Cluster | District/City |
|---------|---------------|
| Cluster I | Simeulu      |
| Cluster II | Aceh Selatan, Aceh Timur, Aceh Besar, Pidie, Bireun, Aceh Utara, Aceh Tamiang, Bener Meriah, Lhokseumawe, Aceh Tenggara, Aceh Barat, Aceh Barat Daya, Gayo Luas, Nagan Raya, Aceh Jaya, Pidie Jaya, Banda Aceh, Sabang, Langsa, Subulussalam |

Table 3. Members of 3 median clustering method

| Cluster | District/City |
|---------|---------------|
| Cluster I | Simeulu      |
| Cluster II | Aceh Singkil, Aceh Tenggara, Aceh Barat, Aceh Barat Daya, Gayo Luas, Nagan Raya, Aceh Jaya, Pidie Jaya, Banda Aceh, Sabang, Langsa, Subulussalam |
| Cluster III | Aceh Selatan, Aceh Timur, Aceh Besar, Pidie, Bireun, Aceh Utara, Aceh Tamiang, Bener Meriah, Lhokseumawe, Aceh Tenggah |
Table 4. Members of 4 median clustering method

| Cluster | District/City                                                                 |
|---------|-----------------------------------------------------------------------------|
| Cluster I | Simeulu                                                                    |
| Cluster II | Aceh Singkil, Aceh Tenggara, Aceh Barat, Aceh Barat Daya, Gayo Lues, Nagan Raya, Aceh Jaya, Pidie Jaya, Banda Aceh, Sabang, Langsa, Subulussalam |
| Cluster III | Aceh Selatan, Aceh Timur, Aceh Besar, Pidie, Bireun, Aceh Utara, Aceh Tamiang, Bener Meriah, Lhokseumawe |
| Cluster IV | Aceh Tengah                                                                |

Table 5. Members of 5 median clustering method

| Cluster | District/City |
|---------|--------------|
| Cluster I | Simeulu |
| Cluster II | Aceh Singkil, Aceh Tenggara, Aceh Barat, Aceh Barat Daya, Nagan Raya, Aceh Jaya, Pidie Jaya, Banda Aceh, Sabang, Langsa, Subulussalam. |
| Cluster III | Aceh Selatan, Pidie. |
| Cluster IV | Aceh Besar, Bireun, Aceh Utara, Aceh Tamiang, Bener Meriah, Lhokseumawe, Aceh Timur. |
| Cluster V | Gayo Lues, Banda Aceh Aceh Tengah |

Table 6. Value of standard deviation ratio of the cluster

| Cluster | Rasio median clustering |
|---------|--------------------------|
| 2 Cluster | 14.67 |
| 3 Cluster | 14.28 |
| 4 Cluster | 10.227 |
| 5 Cluster | 12.66 |

Cluster number 4 is selected because it has the smallest ratio value compared to clusters 2, 3, 4 and 5. The table below will show the sequence of cluster 4 which has an average value in the cluster.

Table 7. Members of cluster formed by median clustering method

| Cluster | District/City |
|---------|--------------|
| Cluster I | Simeulu |
| Cluster II | Simeulu |
| Cluster III | Simeulu |
| Cluster IV | Simeulu |

Interpretation of Median Clustering Methods

After the cluster is formed, cluster members will be explained based on the average number of health services in each district / city as shown in the following graphic figure:
Figure 2. Average graph of each variable in the cluster

Table 8. Clustering Boundary Indicator of Each Cluster

| No | Variable | Outlier | Maximum | Minimum | Range | Y | Low | Medium | High |
|----|----------|---------|---------|---------|-------|---|-----|--------|------|
| 1  | $X_1$   | -       | 100     | 72.1    | 27.9  | 9.3| ≤ 81.4 | 78.5 < x < 90.7 | ≥ 90.7 |
| 2  | $X_2$   | -       | 99.9    | 67.8    | 32.1  | 10.7| ≤ 78.5 | 75.5 < x < 89.2 | ≥ 89.2 |
| 3  | $X_3$   | -       | 97.2    | 10      | 87.2  | 29.0| ≤ 39.06 | 39.06 < x < 68.13 | ≥ 68.13 |
| 4  | $X_4$   | -       | 95      | 11.1    | 83.9  | 27.9| ≤ 39.06 | 39.06 < x < 67.03 | ≥ 67.03 |
| 5  | $X_5$   | -       | 35.9    | 0       | 35.9  | 11.9| ≤ 11.96 | 11.96 < x < 23.93 | ≥ 23.93 |
| 6  | $X_6$   | 29.1    | 20.7    | 0       | 20.7  | 6.9 | ≤ 6.9  | 6.9 < x < 13.8  | ≥ 13.8  |
| 7  | $X_7$   | 50.1    | 23.1    | 2.3     | 20.8  | 6.9 | ≤ 9.23 | 9.23 < x < 16.16 | ≥ 16.16 |
| 8  | $X_8$   | -       | 124.2   | 29.1    | 95.1  | 31.7| ≤ 60.8 | 60.8 < x < 92.5  | ≥ 92.5  |
| 9  | $X_9$   | 48.38   | 97.95   | 77.8    | 20.1  | 6.71| ≤ 84.51 | 84.51 < x < 91.23 | ≥ 91.23 |
| 10 | $X_{10}$| 41.95   | 94.95   | 69.42   | 25.5  | 8.51| ≤ 77.93 | 77.93 < x < 86.44 | ≥ 86.44 |
| 11 | $X_{11}$| -       | 100     | 67.5    | 32.5  | 10.8| ≤ 78.33 | 78.33 < x < 89.16 | ≥ 89.16 |
| 12 | $X_{12}$| -       | 74.4    | 0       | 74.4  | 24.8| ≤ 24.8 | 24.8 < x < 49.6  | ≥ 49.6  |
| 13 | $X_{13}$| 52.1    | 100     | 80.4    | 19.6  | 6.53| ≤ 86.93 | 86.93 < x < 93.46 | ≥ 93.46 |
| 14 | $X_{14}$| 47.9    | 95      | 70.2    | 24.8  | 8.26| ≤ 78.46 | 78.46 < x < 86.73 | ≥ 86.73 |

Table 9. Characteristics of the optimal cluster

| Cluster | Karakteristik                                                                 |
|---------|-------------------------------------------------------------------------------|
| I       | 14 indicators of maternal health services                                       |
| II      | TT1 dan TT2; Obstetric complications handling. Deliveries assisted by health personnel, postpartum women receive services, TT3, TT4, TT5, TT2+, Fe1 30 tablets, Fe3 90 tablets received vitamin A, K1 and K4 |
| III     | TT1, TT2, and Deliveries assisted by health personnel, TT3, TT4, TT5, TT2+       |
4.2 Discussions  
The smallest Squared Euclidean Distance is on object 7 (Aceh Barat District) and 12 (Aceh Barat Daya District) with distance coefficient value is 287,677; these two objects will merge into one cluster. Then the distance matrix is improved with the median clustering method, the smallest objects will be reunited. Through the dendogram, it can be seen the formation of each object that joined until all the objects merge to big cluster. Based on the cluster and the number of members formed, each group will produce a standard deviation ratio. Cluster with the smallest ratio is the best grip in clustering object (district/city). The characteristics of health services were divided to low, medium and high clusters, using the cluster boundary.

5. Conclusions
The number of optimal clusters formed is 4 cluster with the standard deviation ratio is 10.23%. Based on the results of the analysis that has been done then generated conclusion as follows:
   a. Cluster I: Simeulu district with low average value in all pregnant women's health services. In this cluster, this awareness of pregnant women on health services is “very bad” that is 35.01%.
   b. Cluster II: Aceh Selatan, Aceh Timur, Aceh Besar, Pidie, Bireun, Aceh Utara, Aceh Tamiang, Bener Meriah and Lhokseumawe districts. This cluster has a low average value on TT1 and TT2, medium in the treatment of obstetric complications, delivery assisted by health personnel, postpartum service, TT3, TT4, TT5, TT2 +, Fe1 30 tablet, Fe3 90 tablet, got vitamin A, K1 and K4. The level of awareness of pregnant women to health services is categorized “bad” ie 57.64%.
   c. Cluster III: Aceh Tengah districts. The level of awareness of pregnant women to health services is 66.09%, and is categorized as “high”. Assessment of each indicator on this grip is a low average value in TT1, TT2 and vitamin A, the medium at delivery is assisted by health personnel, receiving postpartum service, Fe1 30 tablet, Fe3 90 tablet, K1 and K4. and a high mean score on TT3, TT4, TT5, TT2 + and obstetric complications.
   d. Cluster IV: Aceh Singkil, Aceh Tenggara, Aceh Barat, Aceh Barat Daya, Gayo Lues, Nagan Raya, Aceh Jaya, Pidie Jaya, Banda Aceh, Sabang, Langsa, Subulussalam districts. This cluster has a mean value of medium on delivery assisted by health personnel, received postpartum service, TT2, TT3, TT4, TT5 received vitamin A, and handling obstetric complications, high mean values obtained at TT1, TT2 +, Fe1 30 tablet, Fe3 90 tablet, K1 and K4. The level of awareness of pregnant women in this cluster on health services is 67.71% and is categorized “very well”.

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