

Classification of Healthy Family Indicators in Indonesia Based on a K-means Cluster Analysis

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Objectives: Health development is a key element of national development. The goal of improving health development at the societal level will be readily achieved if it is directed from the smallest social unit, namely the family. This was the goal of the Healthy Indonesia Program with a Family Approach. The objective of the study was to analyze variables of family health indicators across all provinces in Indonesia to identify provincial disparities based on the status of healthy families.

Methods: This study examined secondary data for 2021 from the Indonesia Health Profile, provided by the Ministry of Health of the Republic of Indonesia, and from the 2021 welfare statistics by Statistics Indonesia (BPS). From these sources, we identified 10 variables for analysis using the k-means method, a non-hierarchical method of cluster analysis.

Results: The results of the cluster analysis of healthy family indicators yielded 5 clusters. In general, cluster 1 (Papua and West Papua Provinces) had the lowest average achievements for healthy family indicators, while cluster 5 (Jakarta Province) had the highest indicator scores.

Conclusions: In Indonesia, disparities in healthy family indicators persist. Nutrition, maternal health, and child health are among the indicators that require government attention.

Key words: Family, Health, Indicator, Cluster analysis

INTRODUCTION

The goal of health development is to raise everyone's public awareness, willingness, and ability to live healthily in order to achieve the highest level of public health. This goal is achievable if health development begins with the family unit [1]. A family approach allows the in-depth mapping of health prob-

lems through home visits. The Healthy Indonesia Program with a Family Approach (HIPFA, also known as PIS-PK) was founded from this initiative.

The implementation of PIS-PK aimed to improve family access to comprehensive health services, including promotive and preventive services as well as basic curative and rehabilitative services. PIS-PK supported the attainment of district/city minimum service standards and national health insurance, as well as the goals of the Healthy Indonesia Program. According to Ministry of Health Regulation (Permenkes) Number 39 of 2016, to measure family health status, the Ministry established 12 major indicators, grouped into 3 categories: maternal and child health, communicable and non-communicable diseases, and health behavior [2]. The more indicators a family could fulfill, the closer it would be to meeting the criteria for a healthy

Received: Nov 3, 2023 Revised: Jan 16, 2024 Accepted: Feb 7, 2024

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family. As a result, the level of public health in that region would also be higher.

A 2013 study on basic health research (Riskasdas) used the concept of healthy family indicators to evaluate residents' health status in different regions and prioritize health problems requiring intervention [3]. The indicators derived from the collection of family data have also been used by public health centers (Puskesmas) in preparing proposed activity plans and were included in the routine Puskesmas report [4]. Though the indicators have been an important component in the process of planning and evaluating regional health programs, indicator values have not been evenly distributed across Indonesia. Several studies have found that a regional disparity persists, particularly in the provinces of Papua and West Papua when compared to other provinces in the islands of Java-Bali, Sumatra, Kalimantan, and Sulawesi [5,6].

To improve how program priorities are determined for each region in Indonesia, we analyzed healthy family indicators according to regional classifications. This process determined which provinces had poor health quality and would require immediate interventions.

The objective of the current study was to analyze variables of family health indicators across all provinces in Indonesia and identify provincial disparities in the health status of resident families. The results may be useful as a reference for the government in policy-making to improve the health status of communities through family units and to advocate for increasing the health budget in each province.

METHODS

This study examined secondary data for 2021 from the Indonesia Health Profile, provided by the Ministry of Health of the Republic of Indonesia [7], and from the 2021 welfare statistics by Statistics Indonesia (BPS) [8]. Cluster analysis, a multivariate method of grouping objects according to their characteristics, was applied to the data. Within a cluster, objects have a relatively homogeneous level of similarity, while their characteristics are markedly different or heterogeneous compared to other clusters.

The 2 main approaches for cluster analysis involve hierarchical and non-hierarchical methods. This study employed a non-hierarchical method for classifying objects, in which the number of clusters to be formed was predetermined. This non-hierarchical approach has the advantage of analyzing larger

Table 1. Variables of healthy family indicators used in the analysis [7,8]

Variables	Information (by province, 2021)
X1	Family planning methods: women aged 15-49 y who have been married and have used contraceptive or traditional methods to delay or prevent pregnancy
X2	Delivery in healthcare facilities
X3	The monitoring of toddlers for growth and development
X4	Complete basic immunization for infants
X5	Exclusive breastfeeding of babies
X6	Household access to proper sanitation facilities (healthy jamban)
X7	Residents aged ≥ 5 y who did not smoke tobacco in the past month
X8	Household access to a source of clean drinking water
X9	Indonesian National Health Insurance (JKN) membership
X10	The effectiveness of tuberculosis patients' treatment

samples more efficiently, and it has only a few flaws regarding outlier data, distance measures, and irrelevant or imprecise variables. The k-means algorithm, a frequently employed cluster analysis technique, was used to determine a temporary cluster center that was updated until termination criteria were met. For optimal cluster analysis results, the researchers compared the output of non-hierarchical methods (k-means) and hierarchical methods such as complete linkage, which was used to measure the distance between clusters relative to the farthest object. For the current study, clusters of 2, 3, 4, 5, and 6 were formed. The optimal number of clusters was determined using the pseudo *F*-statistics criterion. In addition, the researchers calculated the internal cluster dispersion (ICD) rate to determine the optimal cluster analysis technique.

Health family indicators are used to determine whether a family is deemed healthy or not. The Healthy Indonesia Program considered 12 primary indicators for determining a family's health status, including nutritional program indicators for maternal and child health, indicators for the control of communicable and non-communicable diseases, and indicators for behavior and environmental health. Table 1 describes the 10 variables that were analyzed.

Ethics Statement

Permission to use the dataset was obtained from the Ministry of Health. Since this study was a secondary analysis of the Indonesia Health Profile and individual considerations such as names and addresses were not included, the ethical approval was not required.

Table 2. Characteristics of healthy family indicator variables

Variables	Mean ± SD	Variance	Median (Min-Max)
X1=Family planning methods	37.27 ± 9.89	97.88	37.11 (20.79-72.94)
X2=Delivery in healthcare facilities	83.95 ± 16.52	272.85	85.95 (22.80-114.80)
X3=Monitoring of toddler growth	62.30 ± 17.26	297.94	64.95 (2.10-88.20)
X4=Complete basic immunization	80.87 ± 13.72	188.17	84.15 (42.70-100.00)
X5=Exclusive breastfeeding	52.79 ± 16.30	265.70	54.90 (13.00-82.40)
X6=Access to proper sanitation facilities	83.64 ± 16.86	284.11	87.70 (3.70-100.00)
X7=Not smoking	76.46 ± 2.57	6.62	76.66 (71.93-83.46)
X8=Access to a source of clean water	73.75 ± 12.43	154.57	75.63 (37.94-94.49)
X9=National Health Insurance membership	91.01 ± 18.57	344.69	85.35 (71.40-173.60)
X10=Effective tuberculosis treatment	86.08 ± 5.64	31.81	88.15 (71.70-94.90)

SD, standard deviation; Min, minimum; Max, maximum.

RESULTS

Characteristics of Healthy Family Indicators

Table 2 summarizes the characteristics of the family health indicators across Indonesia. Participation in the National Health Insurance program had the highest average compared to the other indicators, and the use of family planning methods had the lowest average value.

The large variance values in this analysis arose from the wide data distribution and significant deviations from the mean. For instance, the variance of the X3 indicator (monitoring toddler growth) was 297.94, with a mean of 62.30%. This variance included provinces with values as low as 2.10%, which are considerably below the average. The significant disparity in average values among provinces contributed to the large variance values.

The researchers compared hierarchical and non-hierarchical analytical approaches to determine the best clustering technique. By using pseudo *F*-statistics criteria, we calculated the optimal number of clusters between 2 and 6. Table 3 shows the results of the analysis, indicating that 5 was the optimal number of clusters, with the highest k-means value (15.1931). We determined that cluster analysis using the non-hierarchical method (k-means) was superior because the pseudo *F*-value was greater than in the hierarchical method.

The next step in determining the appropriate clustering method was to examine the ICD rate, which quantifies the level of dispersion within a cluster. Lower ICD values reflect better grouping results. The ICD rate of the hierarchical method was 0.3411, and that of the non-hierarchical method was 0.3230. The non-hierarchical k-means method had a lower ICD rate than the hierarchical method, meaning that the k-means meth-

Table 3. Pseudo *F*-values for hierarchical and non-hierarchical methods

No. of clusters	Hierarchical (complete linkage)	Non-hierarchical (k-means)
2	13.5365	13.5365
3	12.4696	12.4696
4	13.0348	13.0348
5	14.0023	15.1931
6	13.1418	14.6858

od performed better in classifying Indonesia's 34 provinces based on healthy family indicators.

Figure 1 displays the results of k-means cluster analysis, along with the number of cluster members. Cluster 1 contained 2 provinces, clusters 2 and 5 had 1 member province each, and clusters 3 and 4 had 15 provinces each. The provinces corresponding to cluster 1 represented the eastern region of Indonesia, specifically the Papua and West Papua provinces. These 2 provinces exhibited the lowest healthy family indicator scores in comparison to the other clusters. The provinces located on the islands of Sumatra, Kalimantan, and Sulawesi were categorized into clusters 3 and 4, exhibiting comparable achievement scores for healthy family indicators. However, variations existed among these scores in terms of toddler growth, exclusive breastfeeding, and basic immunization. Aside from the provinces of Banten and DKI Jakarta, the majority of provinces located on the island of Java were included in a single cluster.

Cluster Interpretation

Table 4 shows the average values of each cluster's healthy family indicators. Cluster 1 had the lowest average scores for healthy families in 6 indicators, whereas it had the highest av-

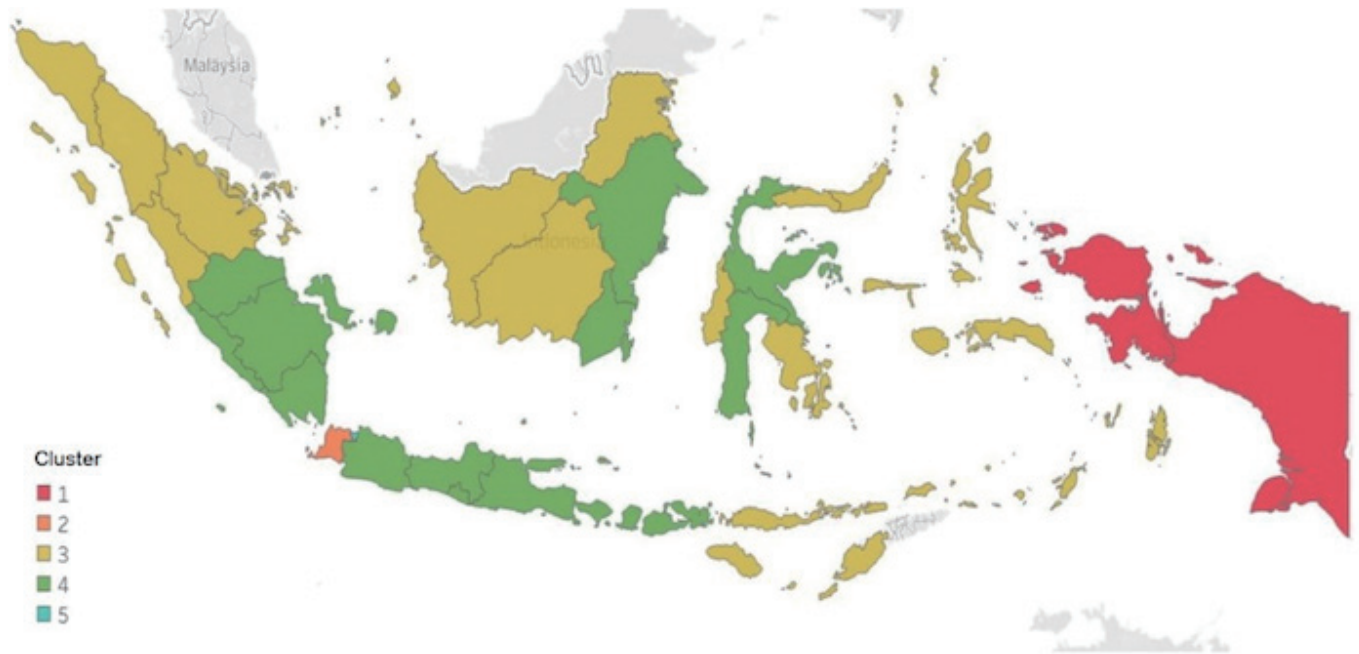


Figure 1. Grouping of provinces in Indonesia based on healthy family indicators.

Table 4. Average values of healthy family indicators by cluster

Variables	Clusters				
	1	2	3	4	5
X1=Family planning methods	63.90	34.23	39.16	31.61	43.77
X2=Delivery in healthcare facilities	36.20	99.30	80.67	90.52	114.80
X3=Monitoring of toddler growth	13.55	88.20	57.79	70.48	78.90
X4=Complete basic immunization	56.95	94.80	74.30	90.87	63.30
X5=Exclusive breastfeeding	20.55	57.60	46.00	62.51	68.60
X6=Access to proper sanitation facilities	63.20	3.70	82.89	91.78	93.50
X7=Not smoking	76.54	73.11	76.60	76.35	79.07
X8=Access to a source of clean water	51.85	74.63	73.50	75.48	94.49
X9=National Health Insurance membership	121.50	82.60	87.55	85.45	173.60
X10=Effective tuberculosis treatment	73.00	90.10	86.69	87.40	79.30

average value for the X1 indicator (family planning methods). The mean values varied in cluster 2, such that it had the highest average score for 3 indicators and the lowest average score for the X6 indicator (sanitation access).

Clusters 3 and 4 shared similar characteristics, except for a few indicators with higher average values in cluster 4. Cluster 4 also had the lowest average score among clusters for the X1 indicator.

In comparison to the other clusters, cluster 5 members had the highest healthy family indicator scores overall. The majority of the indicators in cluster 5 had the highest averages; of the 10 indicators analyzed, 6 of them had the highest average value.

DISCUSSION

Our analysis found disparities across provinces in the indicators for nutrition, maternal health, and child health. West Papua and Papua (cluster 1), for example, had the lowest average coverage, which means that the Papua region requires massive development in all aspects of healthy family indicators. In general, children in Papua typically encounter challenges in various aspects of their development, including language acquisition, fine motor skills, adaptive behavior, personal-social interactions, and gross motor abilities [9]. It has been shown that the monitoring of young children's growth and develop-

ment in Papua remained poor, influenced by various external factors, including the physical environment, social environment, and maternal upbringing [9]. In addition, Papuan children in the midland and mountainous terrain areas are more likely to have inadequate nutrition [10].

Poor access and inadequate provision of healthcare services could have accounted for the disparities in this region. The unfavorable geographical conditions exacerbate the challenges, particularly in the eastern region of Indonesia [11]. In Ghana, geographical discrepancies have contributed to the lower coverage for a continuum of care among poor women and children [12]. Similarly, disparities in monitoring child growth are more consistent within and across geographical regions in Africa [13].

Inadequate hygiene practices due to a lack of sanitation and clean water could also have contributed to lower average coverage of healthy family indicators, particularly in cluster 2, representing Banten Province. This association is supported by the fact that 15% of households in Banten currently lack access to sanitary latrines. Persistent disparities in access to proper sanitation facilities result in inadequate hygiene practices [14]. Proper sanitation facilities, such as toilets and latrines, are essential for maintaining good health because they allow people to dispose of their waste appropriately, preventing the contamination of their environment and reducing the risk of diarrhea and other infections. Moreover, people with lower levels of formal education are more likely to defecate openly and show a reluctance to construct and maintain hygienic latrines, due to a lack of necessary knowledge and awareness about proper sanitation practices [15].

Another important finding was that cluster 4, containing the regions of Java, Bali, Nusa Tenggara, Sumatra, and Sulawesi, had a lower rate of utilization of family planning contraceptives than other clusters. It has been demonstrated that attitudes towards family planning were a strong predictor for the low uptake of contraceptive methods in these regions. Having more children is generally seen as a parental investment because many Indonesian parents remain committed to the old local proverb, "*Banyak anak, banyak rejeki*" ("more children mean more blessings and luck") [16]. In addition, the use of contraception was significantly lower among couples intending to have more children, having a lack of awareness of family planning, showing more limited decision-making processes, and having limited access to desired contraceptive methods [17]. Recently, the family planning program has become less rigorously observed, although the implementation has been

considered successful for more than 50 years [18].

The study's findings support the ongoing importance of knowledge, attitudes, and perceptions about contraceptive use in Indonesia. Despite the low utilization of long-term methods of contraception, this method has been identified as a viable approach to reducing the number of pregnancies [19]. In South Sumatra, promotional activities by health cadres have affected the use of long-term reversible contraception (LARC) [20]. Other significant predictors for the use of LARC methods included age, educational level, and access to family planning services, as reported in East Java [21].

The results of this analysis are in line with several studies in Indonesia showing that inequality has been identified as a key constraint in healthcare. Jakarta, as the largest metropolitan city in Indonesia, has a more developed healthcare system [22]. In this study, Jakarta (cluster 5) had the most noteworthy achievements for all indicators, including delivery of care in health facilities. As noted in previous studies, there are more obstetrics and gynecology specialists and hospitals per capita in Jakarta than in other regions of Java [23], and these institutions are supported by a well-developed health infrastructure [24].

Though the government strives for the highest possible standard of health for all women in the country, disparities persist. Inequities may occur in the provision of delivery services within healthcare facilities as a consequence of disparities in health development [23,25]. To reduce this gap, the government has promoted the expansion of health insurance coverage, which was found to have a positive association with improving equitable access to maternal healthcare services in Indonesia [26]. Previous studies have shown that women with health insurance coverage were more likely to use antenatal care (ANC) [27,28]. Other factors, such as educational level, number of children, place of residence, and distance to healthcare facilities, were also found to be predictors of ANC utilization [29,30]. Furthermore, women from ethnic minorities and disadvantaged groups were less likely to use maternal healthcare services, including ANC visits [31,32].

Apart from social protection programs, the decentralization of health services to the districts does not appear to have improved the range of services available to many Indonesians, especially in the eastern regions. Multiple programs designed to expand access to maternal and child healthcare services, water, and sanitation still have not reached many households across the country. Increasing the health budget may not be sufficient in itself to address the problem [33]. Therefore, more

emphasis should be placed on cultural barriers, geographical barriers, and the development of the healthcare workforce in disadvantaged areas. Midwives, for example, have a potential role in improving maternal health, since they are more accessible to the community and have good compliance to standard ANC practices [34].

Given that the family unit plays a significant role in shaping, maintaining, and restoring the health of individual residents, the concept of a healthy family should be evocative and improve the empowerment of family and community. The main social functions of the family have been characterized as religion, social culture, love and affection, protection, reproduction, socialization and education, economy, and environmental development [35]. A family-centered approach will facilitate needs-based healthcare and provide viable and long-lasting solutions [36].

This study has a few limitations. Our analysis may help us to understand the existing disparities in health indicators across Indonesia, although the results are considered superficial. The substantial variations in aggregated data at the district level should be interpreted with caution, however. Further research should improve how indicators are assessed and conduct a more in-depth analysis to detect the causes of disparity. Due to the availability of secondary data, researchers were restricted to analyzing only 10 of the 12 family health indicators. Two variables were not considered: the adherence of hypertension patients to their prescribed medication and the availability of treatment for mental disorders.

In conclusion, the implementation of the k-means method for cluster analysis provided better results in the classification of Indonesian provinces based on healthy family indicators. As the indicators for nutrition, maternal health, and child health require attention to improve health status within the family unit, it can be suggested that the government consider using indicator scores to prioritize provinces and improve the effectiveness of the PIS-PK program optimization. Further, it is imperative for the Ministry of Health to allocate more resources to the regions exhibiting significantly low levels of healthy family indicators.

NOTES

Conflict of Interest

The authors have no conflicts of interest associated with the material presented in this paper.

Funding

None.

Acknowledgements

The authors express their gratitude to the Center for Data and Information (Pusdatin) of the Ministry of Health of the Republic of Indonesia and to Statistics Indonesia (BPS) for providing data for analysis. We would also like to express our gratitude to Dinda Galuh Guminta for her valuable assistance in the process of data analysis.

Author Contributions

Conceptualization: Maryani H. Data curation: Rizkianti A. Formal analysis: Maryani H, Izza N. Funding acquisition: None. Visualization: Maryani H, Izza N. Writing – original draft: Maryani H, Rizkianti A, Izza N. Writing – review & editing: Maryani H, Rizkianti A, Izza N.

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