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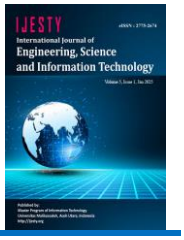

Implementation of Data Mining for Nutrition Clustering of Toddlers at Posyandu Using K-Means Algorithm

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Abstract

This study aims to determine the nutritional status of toddlers in the Peulimbang sub-district using a clustering method that can group toddlers based on their dietary indicators, such as gender (jk), age (u), height (tb), weight (bb), and upper arm circumference (Lila). By using data analysis techniques such as K-Means clustering, this study successfully identified several groups of toddlers with different nutritional statuses, ranging from malnutrition to good nutrition to obesity nutritional status. The data for this study were taken directly from the Peulimbang Health Center, and as many as 765 toddler data were collected from 16 villages in the Peulimbang area. The programming language used in this study is PHP, which functions in web development and is often used to process data sent via web formula, interact with databases, and manage user sessions. Based on the results of clustering with the K-Means method using Euclidean Distance as a measurement between points, toddler data has been grouped into three Clusters, namely C1, C2, and C3. Cluster C1 covers 22.81% of 147 malnourished toddlers, C2 covers 48% of 323 well-nourished toddlers, and C3 covers 29.19% of 205 obese toddlers. Based on the clustering results, improving nutrition education programs for parents is essential, especially in areas with poor or lacking nutritional status. This program can include counseling on the importance of balanced nutrition, nutritious cooking methods, and choosing the right Food for toddlers. Thus, this study is expected to improve toddlers' nutritional status and overall public health in the Peulimbang District.

Keywords: *Toddlers, Clustering, K-Means, Nutrition, PHP.*

1. Introduction

According to the Ministry of Health of the Republic of Indonesia, stunting was 38.9% in 2020. Balanced nutrition is the arrangement of daily intake and the type and amount of nutritional substance the body needs. Fulfillment intake nutrition is also a must-notice principle of diverse Food, physical activities, behavioral life, and maintaining normal weight to prevent problems with nutrition. Toddlers are children under 5 years, at the age of the important very for parents For notice, they grow a flower. The growth and development of a toddler are influenced by nutritional status. To guard toddlers' growth, parents must notice the intake of nutrients given to them. Assessment of stunting status in toddlers can determined through measurement of body man, including age (u), type gender (j), body weight (bw), height, and circumference arm above [1].

Government efforts in handling nutrition-destructive toddlers one of them is with do activity integrated health posts; activities integrated health service posts cover several Health services (immunization), providing IEC (Communication, Information, and Education) to mothers and toddlers, doing consultation health For toddlers, including recording administration or recording weight, height, circumference arms and circumference the usual head written in the Health Card[2]. The recording results can be processed to produce grouping nutrition in toddlers to help prevent stunting at an early age. Problems that occur in activities Integrated Health Service Post Subdistrict Balance that is the difficulty determining nutritional status toddlers, where cadre Integrated Health Service Post only chooses based on Body Weight (BW), Height, and Age contained in the Health Menu Card (KMS) and matching based on nutritional status toddlers on the table book reference, so that cadre and also midwife difficult know whether toddler the classified as in a well-nourished child bad, nutrition Good or obesity[3].

By implementing data mining using the K-Means cadre clustering method, midwives can easily use the data mining application, as well as level efficiency and interactivity, where the technique Can easily group the nutritional status of toddlers. The K-Means algorithm is one of the non-hierarchical clustering methods. Algorithm This partitions data into clusters so that the data has the same characteristics grouped in the same cluster and contains different characteristics in another cluster. Data mining is a settlement problem in Posyandu that analyzes the data in the database, where the data is stored electronically, and its search is done automatically, as in computers. Data mining also involves the extraction of hidden information from an extensive database. Grouping data into several groups, also called clustering, is one of the data mining techniques that similar characteristics of each data in the existing group. One of them is clustering algorithms, which can be used for grouping data based on the specified number of clusters, formerly called K-means clustering [4].
This method tries To minimize variation between the data contained in a cluster and maximize variation with the data in other clusters. This K-Means algorithm started with a random selection: the cluster you want to be formed from the data you want to cluster. The K-Means algorithm is also one of the algorithms used in clustering[5]

2. Literature Review

2.1. Nutrition

According to the Ministry of National Health, Nutrition is a process of organisms using Food consumed generally through the process of digestion, absorption, distribution, storage, metabolism, and excretion of substances that are not used to maintain life, growth, and normal function of organs, and produce energy[6]. Nutrition is the most essential part of the growth and development of toddlers, namely babies under five years old, and it has a close relationship with health and intelligence. So, consuming Food dramatically affects the assessment of the nutritional status of toddlers. The emergence of malnutrition in children or toddlers is not only a lack of food intake but is caused by disease. Nutritional problems in toddlers can cause several serious effects. The consequences of these dietary problems, such as failure in physical growth and lack of optimal growth and intelligence, even result in death in toddlers [7].
The short-term effects of malnutrition on toddler development include toddlers becoming apathetic, speech disorders, and other disorders. The occurrence of malnutrition and severe malnutrition can cause triggers for stunting in toddlers, and early detection is needed. How can it be detected through monitoring growth and development, including monitoring the nutritional status of toddlers at the Posyandu by midwives in the village or other health workers [8]? Stunting is a condition where toddlers experience chronic nutrition in early growth and development, starting in the fetus. It can be interpreted that stunting in children aged 0-59 months with the provision of TB (Height) according to age <-2SD (Standard Deviation) from the WHO (World Health Organization) median. The negative impact of stunting in the long term is that it can reduce cognitive abilities and learning abilities, decrease endurance, and cause new diseases such as diabetes, heart disease, stroke, and many other comorbidities. Many factors affect the nutritional status of toddlers, including food intake, physical activity, economic factors, and others [9].

2.2. Integrated Health Post

Posyandu (Integrated Service Post) is a form of community-based health service that aims to improve the quality of public health, especially for mothers and children. Posyandu is a health service effort carried out from, by, and for the community with health workers' guidance [10].
Following several objectives, the Integrated Health Service Post was carried out and held in every area or specific areas :

1. Improving Maternal and Child Health: Providing Health services for pregnant mothers, mothers breastfeeding, and children with toddlers to prevent and reduce the number of deaths between mother and child.
2. Child Growth Monitoring: Monitoring the growth and development of toddlers through regular measurements of weight, height, and head circumference.
3. Immunization Administration: Administering vaccinations to children according to the predetermined schedule to prevent vaccine-preventable diseases.
4. G Supplementary Feeding: Providing nutritious supplementary Food to toddlers and pregnant women to support their growth and health.
5. Health Counseling: Providing education and counseling on health, nutrition, hygiene, and child care to the community.

Immunization is an effort to provide immunity to toddlers by introducing a vaccine into the body so that the body produces antibodies to prevent certain diseases. The process of forming antibodies to fight antigens naturally is called natural immunization. In contrast, the immunization program through vaccination aims to stimulate the immune system to produce antibodies to combat diseases by neutralizing weakened antigens derived from vaccines. Meanwhile, a vaccine is a substance used to promote the formation of antibodies, which is introduced into the body through injections such as BCG, Hepatitis, DPT, and Measles vaccines, and orally, such as Polio [11].

2.4. Data Mining

Data Mining is a processing method that can generate data from a research study[12]. The data will provide information that can be used as a database, so data mining can also enhance the information obtained from big data, facilitating decision-making[13]. Data mining can also be considered a semi-automatic process that utilizes various techniques such as evidence, mathematical, Artificial Intelligence, and Machine Learning[14]. It can be useful in extracting and identifying helpful information data from large databases[15].
De todas las explicaciones que se han presentado, a continuación se muestra un proceso de minería de datos que debemos conocer:

1. Recolección de Datos : Recopilar datos de diversas fuentes relevantes.
2. Preprocesamiento de datos : Realización de limpieza y transformación de datos para asegurar una buena calidad de los mismos.
3. Selección de Datos : Selección de un subconjunto relevante de datos para el análisis.
4. Transformación de Datos : Cambiar los datos a un formato adecuado para el análisis.
5. Modelado de Datos : Implementación de algoritmos y técnicas de minería de datos para encontrar patrones en los datos.
6. Evaluación e Interpretación : Evaluar resultados e interpretar patrones encontrados.
7. Presentación de Resultados : Comunicar los hallazgos de manera que puedan ser entendidos por las partes interesadas.

2.5. Clustering

Clustering is a technique for grouping data in a database that processes a large amount of data based on predetermined criteria[16]. Data grouping in the clustering method determines clusters without relying on specific classes. Clustering can also be used to group data whose class is unknown [17]. Even clustering can label data classes that are not yet known[18]. The concept of clustering is straightforward: to group objects into clusters that have similarities, the higher the similarity of the objects, the more accurate the result of the cluster will be[19].

2.6. Algoritma K-Means

K-Means is one of the algorithms for clustering. This algorithm is quite simple in performing clustering, where the clustering process of this algorithm involves partitioning or grouping the dataset into several clusters[20]. In the K-Means method, data is grouped into several clusters, each with similar or identical characteristics but with different characteristics compared to other clusters. This method minimizes the differences among data within a single cluster while maximizing the differences with other clusters[21]

In performing clustering, the K-means method has several steps:

1. Determine the number of clusters k.
2. Initialize cluster k to the cluster center.

This initialization can be done in several ways. The method most commonly used for this initialization is random, so the cluster centers are given initial values with random numbers. At the iteration stage, the formula below is used:

$$V_{ij} = \frac{1}{N^i} \sum_{k=0}^{ni} Xkj \quad (1)$$

Information :

V_ij = Average centroid of the cluster -I for a variable to j

N^i= Number of members of cluster i

i,k = Index from cluster

j = Index from variable

X_{kj}= the value of the k data variable for the j cluster

3. Place all data data into the cluster closest. It is said that two objects are near determined by distance from the second object mentioned and, likewise, with the proximity of data to the cluster.
4. Calculate the distance of all data to each cluster center using the following Euclidean distance formula:

$$D_{(i,j)} = \sqrt{(X_{1i} - X_{1j})^2 + (X_{2i} - X_{2j})^2 + \cdots + (X_{ki} - X_{kj})} \quad (2)$$

Information :

$D_{(i,j)}$= distance of data i to center j

X_{ki} = data to me on the k data attribute

X_{kj}= point center to j on attribute to k

Next, the distance of the cluster center will be recalculated using the current cluster membership. The cluster center is the average value of all the data within a specific cluster. If possible, the median of the same cluster can also be used. Therefore, the mean or average is not the only measure that can be used in clustering data. Each existing object is reassigned to use the new cluster center. If there are no further changes to the cluster center during the clustering process, then the clustering process is declared complete. The method used in determining cluster evaluation employs the Davies-Bouldin Index (DBI). The Davies-Bouldin index is one of the internal evaluation methods that measures cluster evaluation in a clustering method based on cohesion and separation values. The obtained ratio value is used to find the Davies Bouldin index (DBI) value from the following equation:

$$DBI = \frac{1}{K} \sum_{i=1}^{k} max_{i \neq j} (Rij) \quad (3)$$

From the equation said, k is the number of clusters used. The smaller the DBI value obtained (non-negative >= 0), the more both clusters obtained from K-Means clustering are used.

2.7. PHP (Hypertext Preprocessor)

PHP (Hypertext Preprocessor) is a programming language that creates dynamic web applications. PHP was first developed by Rasmus Lerdorf in 1993 and has rapidly evolved into one of the most popular server-side programming languages. PHP is designed to function in the context of web development and is often used to process data sent through web forms, interact with databases, and manage user sessions. PHP is a server-side programming language, which means that PHP scripts are executed on the server, not on the client side like JavaScript. When a user accesses a PHP web page, the server will execute the PHP script and then send the result in the form of HTML that the user's browser can read. Therefore, the PHP code written on the web page will not be visible to the user unless the code prints its output to the layer [22]. One of the main advantages of PHP is its ability to interact with various types of databases. PHP is often used with MySQL, although it also supports other databases such as PostgreSQL, Oracle, and SQLite. This feature enables the development of complex database-driven web applications, such as content management systems (CMS), forums, and e-commerce applications[23]

2.8. MySQL

MySQL is an open-source relational database management system (RDBMS) that uses Structured Query Language (SQL) to manage and organize data in a database. MySQL was first developed by the Swedish company MySQL AB in 1995 and is currently owned by Oracle Corporation. MySQL is widely used in various applications, especially web-based applications, and has become one of the most popular RDBMS in the world[24]. MySQL is one of the world's most widely used relational database management systems, known for its fast performance, scalability, and open-source nature. With SQL support and various other advanced features, MySQL remains the top choice for developers who need an efficient, user-friendly, and reliable database solution for web-based applications[25].

2.9. XAMPP

XAMPP is a software that provides a complete web development environment consisting of several essential applications needed to develop web applications locally. XAMPP stands for X (cross-platform), Apache, MySQL/MariaDB, PHP, and Perl. This package is designed to make it easier for developers to build and test web applications on a local computer without manually configuring each component[26]. XAMPP is a beneficial solution for web developers who want to create and test PHP, MySQL, and other web technologies locally. With components such as Apache, MySQL/MariaDB, PHP, Perl, and phpMyAdmin, XAMPP provides a complete and easy-to-use web development platform. Although more suitable for local development and learning, XAMPP remains the primary choice for many developers in building and testing web applications efficiently before deploying them to production servers[27].

3. Methods

The steps taken in this research process are as follows, using the waterfall method:

1. Literature Study: Research previous studies using the K-Means method and strengthen this research based on the theory used.
2. Needs Analysis: The needs analysis was conducted by collecting data and conducting open interviews with the Posyandu cadres in the Peulimbang sub-district, as well as data collection at the Peulimbang Health Center.
3. System Design: the Analysis of needs followed by the design using hardware or software on a computer.
4. System Implementation: System implementation begins with the combination of systems designed in the previous process and ultimately runs from the first part into a complete program.
5. System Testing: The program that has been designed will then be tested to determine whether the program is ready and meets the desired specifications.
6. System Evaluation: Identify deficiencies in the tested system and then address them by following the previous Analysis.

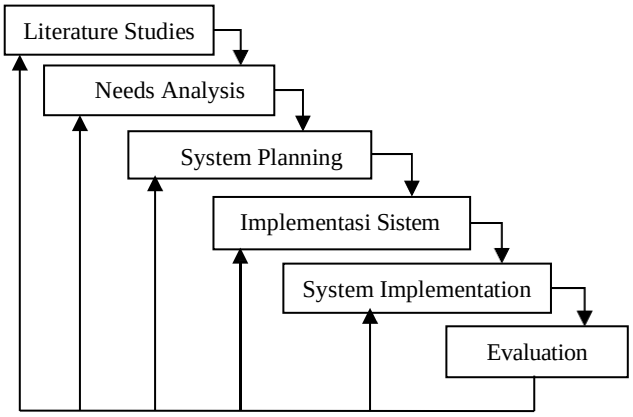

Fig 1. Research Flow Diagram

4. Results and Discussion

4.1. Dataset

The following is the dataset that will be implemented using the K-Means method. This data was taken directly from the health center in Peulimbang. The following data is presented in the form table under This:

Table 1. Dataset

No	Name	K1	K2	K3	K4	K5
1.	Dinara Azalea	P	423	8.5	76	13
2.	Salman Farasyi	L	283	9	71	13
3.	Alisha Mahrin	P	721	9.3	79.8	14
4.	Sahibul Sultan	L	645	10.4	79.8	14
5.	M Zahrul Mubarak	L	1130	11.5	89.7	14
	…..	…..	…..	…..	…..	…..
671.	Saifan Kamil	L	547	8.5	77	13
672.	Arjuna Vishaka	L	392	8.8	72	13
673.	M. Aiman	L	233	7.4	66	13
674.	Ahmad Tajul Sultan	L	223	7.8	66	13
675.	Zaina	P	271	7.1	66	13

4.2. Dataset Normalization

Data normalization aims to make the mark from each variable become an equivalent ratio value, then process it using the Min-Max Normalization method with a scale of 0 to 1. The *Min-Max Normalization* equation will served in a table like the following :

Table 2. Dataset Normalization

No	K1	K2	K3	K4	K5
1.	1	0.176711527	0.25	0.327273	0.075
2.	0	0.094792276	0.287879	0.236364	0.075
3.	1	0.351082504	0.310606	0.396364	0.1
4.	0	0.306612054	0.393939	0.396364	0,1
5.	0	0,590403745	0,477273	0,576364	0,1
….	…	…	…	…	…
671.	0	0,249268578	0,25	0,345455	0,075
672.	0	0,158572264	0,272727	0,254545	0,075
673.	0	0,065535401	0,166667	0,145455	0,075
674.	0	0.059684026	0.19697	0.145455	0.075
675.	1	0.087770626	0.143939	0.145455	0.075

4.3. Dataset Testing

The data has been normalized and then calculated using the K-Means method. Here is Step by Step calculation with K- Means method :

1. Determine the number of clusters (nutrition) evil, nutrition good, and obesity).
2. Determine the cluster center value (initial centroid)

   The initial centroid or cluster center is determined randomly and obtained from normalized data.

Table 3. Initial Centroids of Dataset

		initial centroid				
C1	Arif Maulana	0	0.399649	0.371212	0.470909	0.1
C2	Zakiatun	1	0.921592	0.613636	0.745455	0.175
C3	Muhammad Al-Qifari	0	0.535986	0.583333	0.563636	0.15

3. Calculation through the approach of Euclidean Distance

   After finding the centroid for calculation, the beginning will be used To count the distance between the data and the centroid. Here are the results of the calculation distance with the first, second, and third cluster centers :

Table 4. Initial Centroids of Dataset

Iteration 1					
No	**C1**	**C2**	**C3**	**Min**	**Results**
1.	1.04194523	0.933785	1,140913	0.933785	C2
2.	0.394358449	1.434883	0.628234	0.394358	C1
3.	1.005777717	0.738104	1.067263	0.738104	C2
4.	0.121364788	1.246578	0.34491	0.121365	C1
5.	0,242398262	1,078192	0.129893	0.129893	C3
…..	…..	…..	…..	…..	…..
671.	0.231668875	1,324481	0.496534	0.231669	C1
672.	0.339492918	1,396212	0.583163	0.339493	C1
673.	0.50991798	1,517437	0.758575	0.509918	C1
674.	0.50247608	1.512116	0.746084	0.502476	C1
675.	1,12047607	1.133963	1.254777	1,120476	C1

4. Determine new Centroid value at iteration second.

Table 5. Iteration centroids second

centroid Iteration 2						
C1	Arif Maulana	0.064935	0.241111	0.319805	0.34281	0.10101
C2	Zakiatun	1	0.565628	0.506507	0.165494	0.04876
C3	Muhammad	0	0.735564	0.639364	0.26135	0.077

5. Recalculate using new centroids on iteration second
After the new centroid is determined, so Recalculate the Euclidean distance using the new centroid at the 2nd iteration as follows:

Table 6. Calculation results in iteration second

Iteration 2						KET
No	**C1**	**C2**	**C3**	**Min**	**Results**	
1.	0.940363872	0.493875	1,211722	0.493875	C2	Same
2.	0,196601453	1,129246	0.731272	0,196601	C1	Same
3.	0.943076792	0.37461	1,129011	0.37461	C2	Same
4.	0.129891739	1,065686	0.512826	0.129892	C1	Same
5.	0.453394382	1,083008	0.383546	0.383546	C3	Same
…..	…..	…..	…..	…..	…..	…..
671.	0.099192783	1,094967	0.628622	0.099193	C1	Same
672.	0.1473515	1,108587	0.683661	0.147351	C1	Same
673.	0.313241425	1,169048	0.828141	0.313241	C1	Same
674.	0.303061537	1,163135	0.816065	0.303062	C1	Same
675.	0.984080239	0.600744	1,295576	0.600744	C2	Not the same

If the cluster results are still no, the same as previously, iteration keeps going until no label or cluster changes again.

6. Determine the new centroid in the iteration third.
After getting cluster results on iteration second, the stage furthermore is to determine a new centroid value at the 3rd iteration.

Table 7. Iteration centroids third

centroid Iteration 3						
C1	Arif Maulana	0	0.275217	0.349485	0.379165	0.106085
C2	Zakiatun	1	0.550115	0.495349	0.549986	0.134514
C3	Muhammad	0	0.756167	0.649409	0.707535	0.154305

7. Calculate the new centroid using iteration third.
After the new centroid is determined so, Recalculate the Euclidean distance using the new centroid in the 3rd iteration, which can seen in the table as follows:

Table 8. Calculation results in iteration third

Iteration 3						KET
No	**C1**	**C2**	**C3**	**Min**	**Results**	
1.	1.011563042	0.502761	1.283037	0.502761	C2	Same
2.	0.240222895	1,162869	0.892419	0.240223	C1	Same
3.	1.0037928	0.313902	1,174162	0.313902	C2	Same
4.	0.057398728	1,046121	0.605921	0.057399	C1	Same
5.	0.393187605	1,001917	0.277962	0.277962	C3	Same
…..	…..	…..	…..	…..	…..	…..
671.	0,334258961	1,000991	0.323953	0.323953	C3	Not the same
672.	0.189721315	1,137406	0.84291	0.189721	C1	Same
673.	0.364658804	1.228835	1.01599	0.364659	C1	Same
674.	0.353980907	1.223413	1.005989	0.353981	C1	Same
675.	1.064411708	0.710238	1.422841	0.710238	C2	Same

If the result is still Still some clusters are not The same as previously, then it should Keep going until a cluster has changed.

8. Determine the new centroid in the iteration fourth
After getting cluster results on iteration third, the stage furthermore is to determine the new centroid value at the 4th iteration.

Table 9. Iteration centroids fourth

centroid Iteration 4						
C1	Arif Maulana	Arif Maulana	0	0.266494	0.343187	0.369436
C2	Zakiatun	Zakiatun	1	0.550115	0.495349	0.549986
C3	Muhammad	Muhammad	0	0.74813	0.645078	0.70504

9. Recalculate the new centroid using iteration fourth
After the new centroid is determined, so Recalculate the Euclidean distance using the new centroid at the 4th iteration, as follows:

Table 10. Calculation results in iteration fourth

Iteration 4						KET
No	**C1**	**C2**	**C3**	**Min**	**Results**	
1.	1.00965289	0.502761	1,277322	0.502761	C2	Same
2.	0.226108692	1,162869	0.883366	0.226109	C1	Same
3.	1.004471556	0.313902	1,169493	0.313902	C2	Same
4.	0.070225764	1,046121	0.596828	0.070226	C1	Same
5.	0.407108299	1,001917	0.269272	0.269272	C3	Same
…..	…..	…..	…..	…..	…..	…..
671.	0,102138115	1,093654	0.735179	0.102138	C1	Same
672.	0.175179774	1,137406	0.83391	0.17518	C1	Same
673.	0.35012531	1,228835	1,007068	0.350125	C1	Same
674.	0.339402155	1,223413	0.997062	0.339402	C1	Same
675.	1,05956859	0.710238	1,416541	0.710238	C2	Same

In the 4th iteration of the calculation iteration, it stopped because the results cluster calculation in the 3rd iteration got the same result. There are changes in the results 4th iteration. The results obtained from the data cluster Can seen under This:

Table 11. Toddler Nutrition Cluster Results

No	C	Number of Toddlers
1.	C1	147
2.	C2	323
3.	C3	205
	Amount	675

The following diagram shows the results of clustering the nutritional status of toddlers, which can be seen in the following table:

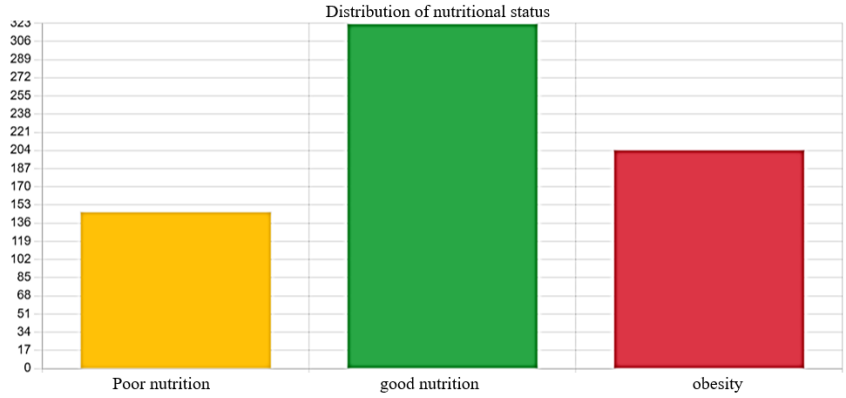

Fig 2. Toddler Nutrition Clustering Results Diagram

The results obtained from cluster data are 147 toddlers with inadequate nutrition, 323 with everyday Food, and 205 with obesity.

5. Conclusion

The clustering research on toddler nutrition aims to group toddlers based on their nutritional status, which can be used to map children's health conditions more efficiently. The results of this research typically focus on identifying patterns related to factors that influence nutritional status, such as food intake, environment, family economy, and other health factors. Here are some conclusions that can be drawn from the toddler nutrition clustering research:

1. Identification of Different Nutritional Groups: This research allows for categorizing toddlers into specific nutritional status groups, such as those with malnutrition, undernutrition, regular nutrition, or at risk of overnutrition. This can help in addressing dietary issues in a more focused manner.
2. Mapping Nutritional Issues: Through clustering, areas or groups of families that are more vulnerable to nutritional problems can be identified, allowing health and nutrition intervention programs to be tailored to the needs of each group.
3. Factors Affecting Nutrition: Economic status, dietary patterns, access to healthcare services, and environmental factors can be identified as significant variables in determining the nutritional status of toddlers. This allows for a more holistic approach to addressing dietary issues.
4. Improvement of Nutrition Policies: The results of this clustering can be used to design more specific and data-driven health policies, which include strategies to prevent stunting, malnutrition, and obesity in children.
5. Improving Public Health: This research provides a clear picture of the distribution of nutritional problems at the community level,

which can enhance the effectiveness of feeding programs, health education, and child nutrition monitoring in the community.

6. Overall, research on clustering toddler nutrition plays a vital role in understanding the variations in children's nutritional conditions so interventions can be more targeted and precise.

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