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CANONICAL CORRELATION ANALYSIS OF FACTORS AFFECTING NUTRITIONAL STATUS OF UNDER-FIVE CHILDREN IN INDONESIA

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ABSTRACT

The purpo.se o/ *this stud y* we.s *to analyze the correlation of factors affecting the nutritional* .sintu.s o/ *under-five children in Indone.sia in 2015. Thi.s stud y emyloyed a canonical correlation method which aimed to determine the relation.shiy hetween two variables and identify the dimen.sion.s between two* group.s *of variables. The* re.salt.ssfiowrd *that* variable.s o/ *complete basic immunization, complete neonatal* vi.sir.s, *vitamin A, birth weight, and birth height were strongly correlated with malnutrition* .status *and yoor nutritional* .status, *but indicated a negative correlation with good nutritional andoveniutrition* .statu.s. *The independent variables which gave the highe.st* e@ecr.s *on the decrease of malnutrition and yoor nutritional* stares *were complete* ña.sic *immunization, complete neonatal vi.sit.s, vitamin A , and hirth weight,* n.s *they indicated a* .srrong *negnrive and an inversedcorre lation hetween the two variables.*

Keywords: canonical correlation, nutritional status, under-fivechildren.

INTRODUCTION

Good and quality human resourcesplay a significant role in the fulfillment and maintenance of the nation’s independence since they become one of the main factors needed for the national development.It is really important that mutually sustainable efforts are made to improve the quality of human resources. One of the factors affecting the quality of human resources is the health and nutrition. Therefore, people will not be able to develop their capacity rnaxirnal ly unless they achieve optimal health and nutritional status (Ministry of Heala, 2oo1).

A good nutritional status is needed to developquality human resources and should essentially begin as early as possible, that is since the human is still in the womb. At this stage, food with sufficient nutrients is badly important. From the food, the humans getsome nutrients which are the basic needs to live and grow. Limited knowledge of how to feed under-five children in terms of the amount, type, and frequency, as well as the health-threateninghabits, will, directly and indirectly,cause malnutrition in children (Husaini et al, 1909).

Having healthy and intelligent children is a dream of every parent. To make it happen, parents should always pay careful attention, watch and care for their children especially during the period of growth and development. Furthermore, childhoodiscrucial for every child and becomes a determining stage of the physical, psychological and cognitive growth and development (Sulistijani, 2001).

The prevalence of pr›nr nutrition in under-fis’e children (weight/U <-2SD) in Indonesia shows a fluctuatingstatistics. ln 2007, the prevalence was I S.4*/c and decreased to I 7.9*/c in 2010. Furthermore, the prevalence showed another increaseto I 9.6°/e in 2013. In some provincessuch as Bangka Belitung, East Kalimantan, Central Kalimantan, and Central Sulawesi, the prevalenceexperienced a declining trend. Two provinces were found to have the highest prevalence (>30°/c) namely East Nusa Tenggara and West Papua. On the other hand, two other provinces (Bali and Jakarta) had the lowest prevalence of < IS°/c. The problem of stunt ing in under-five children in Indonesia is still quite serious as indicated by the national statistics of 37.2*/c. This statistics x’aries from the lowest in Riau Islands, Yogyakarta, Jakarta and East Kalimantan (<30*/e) to the highest (> 50°/e) in East Nusa Tenggara. The unchanged prevalence of this nutritional status is likely due to the une›’enmonitoring of children’s growth and development. Furthermore, it can be seen that the projxirtion of under-five children that has never been measured for their weight in the past six months had increased from 25.5°/e in 2007 to 34.3°/c in 2013(Basic Health Research, 2013).

The prevalence of low birth weight infants reduced from I I .1°/c in 2010 to 10.2°/c in 2013. The statistics show a very clear ›’ariation across the provinces in Indonesia from the lowest in North Sumatra (7.2*/e) to the highest in Central Sulawesi (16.9*/e). For the first time in 2013, data collection regarding the height of newborn was carried out. The results found a national rate of infants with stunting problem (height <4S cm) was 20.2°/e, and this varied from the highest in East Nusa Tenggara (28.7*/c) to the lowest in Bali (9.6 */c).

There have been some improvementsin the outcomes of child health programs especially the complete basic immunization which increased from 41 .6°/c in 2007 to 59.2°/c in 2013. Howex’er, as many as 32.1°/c of babies did not receive a complete basic immunization, and 8.7°/e were found to never receive any immunization due to several reasons. These included the feeling of afraid t hat the baby might get a fever due to the immunization, ungranted permission from the family, far distance to the immunization center, insufficient information regarding the location of immunization center, and the very crowded activities. The other improved programs of child healthcarewere the complete neonatal visit, which increased from 31.8°/e in 2007 to 39.3°/c in 2013, and the administration of vitamin A which increased from 7 I .Sale in 2007 to 75.5°/c in 2013. Furthermore, exclusi›’e breastfeeding in the last 24 hours of infants of 6-month age also increased from I 5.3*/c in 2010 to 30.2*/c in 2013. An initiation of early breastfeeding of <1 hour also increased from 29.3°/c in 20 l0to 34.5°7c in 2013 (Research of Basic Health, 2013).

Children who are born with low birth weight have a potential toha›’e poor nutrition or even malnutrition. This malnutrition will give an impact on the decreased le›’el of intelligence or lQ. Every child suffering from malnutrition is at a risk of losing the lQ of 10 - 13 }x›ints. A further impact of malnutrition is the increasing incidence of morbidit y and inortaliq . The growth and development of children require a sufficient intake of energy and protein, and some other micronutrients needed primarily for the production of enz ymes, hormones, and regulating biological prcicesses for the growth and development, immune system and reproductive system (Devi, 2010).

This study aimed to analyze the correlation of factors affecting the nutritional status of under-fix’e children in 1ndonesia by 20 IS.

MATERIALSANDMETHOD

This study described a non-reactive or an unobtrusive study since the researchers used secondary data in the measurement of the utilizedvariables. This study was conducted in April to May 20 I Sand used the resulted data from the Basic Health Research in 2013. In this study, the data included the nutritional status based on the body weight per age, namely malnutritional status (Y i), poor nutritional stat us (Y;), gotxl nutritional status (Ys), overnutritional status (Yi), complete basic immunization (X i), complete neonatal visit (X•), administration of vitamin A(Xs), birth weight ( ) and birth height (X,) in 33 provinces in Indonesia.

The data were analyzed by using the canonical correlation method. According to Siregar (2006), canonical correlation analysis is a multivariate statistical model which identifies and quantifies the relationship between two sets of variables. The general form of canonical function in this study is shown in formula 1.

$$Y_1 + Y_2 + Y_3 + Y_4 = X_1 + X_2 + X_3 + X_4 + X_5 \quad (1)$$

In which:
Y i : Malnutritionstatus
Y : Poor nutritional status

Ys: Gocd nutritional status
Yi:Overnutritionstatus
X i: Complete basic immunization
X : Complete neonatal visit
Xs:Provision of vitamin A
Xi: Birth weight
X,: Birth length

RESULTAND DISC USSIGN

A. Testing ofAssiimptinn

Before processed by usingthe canonical correlation analysis, the data should meet some assumptions, including multivariate normalit, , free of inulticollinearity, and showed linearit y between the variables.

1. Normality Test

The purpose of normalit y test was to ascertainwhether the distribution of data was or close to the normal distribution. The “good” data should show a normal pattern that is like the bell—shaped curve.

The normalit y test on the multivariate data is actually very complex since it should be performed in all s’ariables together. However, this test can be performed on each variable, with a logical reasoning that if individually each variable meets the assumption of normalit y, then the multivariate variables can also be considered to meet the assumption of normalit y.

The hypothesis states:

Hit: dataare normally distributed

H i: data are abnormally distributed

Normal multivariate assumption testing in this study was conducted by using the Kolmogorov- Smirnov test. lf the obtained significance value is <0.05, then H i is accepted, which means that the data is abnorinall y distributed, and if the significance valueis >0.05, 1-lo is accepted, which means the data is normally dist ributed. The results of the Kolinogorov-Smirnov test were presented in table 1.

Table 1. Results of normalit y test of the data

Variables	Kolmogorov-SmirnovSig.
Yi (malnutritionstatus)	0.799
Y (poor nutritional status)	0.295
Ys(grx›d nutritionalstatus)	0.950
Yr (overnutritionalstatus)	0.528

Based on the above table, it could be seen that the significance v'alue of the 4 variables was >0.05, therefore, HO was accepted, meaning that the data were normally distributed. Thus, the normal multi›'ariate assumption on the variables of malnutritional, prior nutritional, good nutritional and ov'ernutritionstatuseswasfulfilled.

2. MiiftiroffinenrifyTest

Multicollinearity test aimed to determine a definite linear relationship among the independent ›'ariables, which could be identified by investigating the ›'ariance inflation factor (VlF). lf the VlF was <l0, then multicollinearity did not occur. The multicollinearity results for the dependent variables of Y i, Y , Ys and Yiwere shown in Table 2, 3, 4 and 5.

Table 2.. Multicollinearity Test of Dependent Y ariable Y i

Independent variables	V lF	Notes
X i	3.0 12	Free ofmulticollinearity
X;	3.021	free ofmulticollinearity
X?	2.914	Free ofmulticollinearity
X‹	1.493	Free ofmulticollinearity
Xs	1.053	free ofmulticollinearity

Table 3. MulticollinearityTest of Dependent Variable Y2

Independent variables	VlF	Notes
X i	3.012	free ofmulticollinearity
X?	3.021	Free ofmulticollinearity
Xj	2.914	Free ofmulticollinearity
Xa	1.493	free ofmulticollinearity
Xj	1.053	free of multicollinearity

Table 4. Multicollinearity Test of Dependent Variable Y3

Independent variables	VlF	
X i	3.012	Free of multicollinearity
X	3.021	Free of multicollinearity
Xj	2.914	free of multicollinearity
Xi	1.493	Free of multicollinearity
Xs	1.053	Free of multicollinearity

Table 5.MulticollinearityTest of Dependent Variables Y4

Independent variables	VlF	Notes
X	3.012	Free of inulticollinearity
2	3.021	Free of inulticollinearity
X	2.914	Free of inulticollinearity
X,	1.493	Free of inulticollinearity
Xs	1.053	Free of inulticollinearity

3. Lineari yTest

Linearity among the independent and dependent variable was tested by using a curve. The model was said linear if the plot between the standardized residual values and the standardized prediction values did not form a particular pattern.

The results of the linearity test based on figure 1, 2, 3 and 4 found that the plot of data regarding the malnutrition status, poor nutritional status, good nutritional status, and overnutrition statusdid not form a specific pattern. Therefore, the results of linearity assumption among the variables were fulfilled.

Figure 1. Linearity te ton malnutrition status

Figure 2.Linearity test on poor nutritional status

Figure 3. Linearity test on good nutritional status

Figure 4. Linearity test on overnutritional status

B. Formatinnofcanonicalfunction

The first step of canonical correlation analysis was to obtain one or more canonical functions. Each canonical function consisted of a pair of variables, one representing the independent variableand another one describing the dependent variable. The formation of the canonical function was used as a determination of a function that could be further analyzed for use in the interpretation of the results of canonical variates. This study involved 4 dependent variables so that there would be 4 canonical functions formed. Of the four functions, two t ypes of tests (individual and joint tests) were performed for determining the functions that could be analyzed funher. Individual tests were shown in Table 6 and Table 7.

Table 6 Eigenvalues and canonical relationships

Root No.	Eigenvalue	Pet.	Cum Pet.	Canon Cor.	Sq. Cor
1	1.65328	71.04564	71.04864	.78937	.6231 I
2	.48682	20.92077	91 .96942	.5722 I	.32742
3	.12379	5.31997	97.28939	.33190	.11016
4	.06308	2.7106I	ISO.0OOO0	.24358	.Ofi933

Table 6 showed that the determination of functions I , 2, 3 and 4 which could be further analyzed could be seen from the results of the value in the canonical correlation s’alue. The standard value used in the canonical correlation was > 0.5; therefore, if the resulted value exceeded the limit, then the function could be analyzed further. A canonical correlation s’alue >0.5 indicated that the function could be further analyzed for interpretation of canonical v’ariates. Thus, function I with a value of 0.75937 and function 2 with a value of 0.57221 was chosen for further analyses.

The canonical functionswhich could be further analyzed for the interpretation of canonical variates in indis’idual tests were determined based on the diinensionality reduction analysis by considering their significance values. The significance value should be < 0.05. The result of dimensionalit yreduction analysis can be seen in table 7 below.

Table 7. Analysis of dimensionalit y reduction

Roots	Wilks L.	F	Hypoth. DF	Error DF	Sig. of F
I TO 4	.21 218	2.39995	20.00	80.55	.003
2 TO 4	.56298	I .34269	12.00	66.44	.217
3 TO 4	.83705	.80612	6.00	52.00	.570
4 TO 4	.94067	.85152	2.00	27.00	.438

Based on the results in the Sig of F column, which tested the significance of the canonical function, it could be seen that the significance v’alues for functions I , 2, 3 and 4 were consecutively 0.003, 0.217, 0.570 and 0.435. Of these results, the significance value of function I was far below 0.05, and thus this function was indi›’idually significant and could be further analyzed. Meanwhile, function 2, 3 and 4 showed the significance value of >0.05 and thus could not be individually considered for a fun her analysis.

The formation of further canonical function hereinafter was ajoint test with 3 procedures, including the Pillai’s, Hotelling‘s and Wilks tests to find out whether functions 1, 2, 3 and 4 were jointly significant and could be further analyzed. The significance value used in the joint test was <0.05. The results of the joint test were presented in table 8.

Table 8. Results of the Pillai's, Hotelling's and Wilks Tests

Name	Value	Approx. F	Hypnth.DF	Error DF	Sig.of F
Pillais	1.12002	2.10006	20.00	108.00	.008
Hotellings	2.32697	2.61785	20.00	90.00	.00 I
Wilks	.21 218	2.39995	20.00	80.55	.003
Roys	.6231 I				

Based on the above table, it could be seen that the overall value of the Pillai's, Hotelling's and Wilks tests in the Sig column of F showed a significance value of <0.05, namely 0.005, 0.00 1 and 0.003. Thus, if combined together, the canonical functions I , 2, 3 and 4 were significant and could be furtherprocessed.

Based on the results of the individual tests, the selected function for further analysis was the canonical functions 1. According to Santoso (2010), there were indeed differences between the individual and collective testing, and as a guideline, further analyses could be determined from the highcanonicalcorrelationvalue.

C. Interpretation of canonical variates

Afier the canonical function I was found significant, the next step was to interpret the results of canonical variates existing in function 1. The interpretation of canonical variates was aimed at determining relationships between the independent variables in the canonical function and the dependent variables being measured. The analytical limit of analysis was > 0.5. lf the value generated was above the limit, therefore, a high correlation or a strong positive relationship was existing.

Canonical variate measurement s could be done in two ways: canonical weights and canonical loadings.

Table 9 Canonical weight fordependent variates

Variables	Correlational value
Malnutritionstatus(Y i)	8.84792
Poor nutritional status (Yi)	10.56620
Good nutritional status (Ys)	14.94837
Overnutritional status I Y., \ñ	.O2 fi 23

Table 10 Canonical weight for independent variates

Variables	Correlational value
Complete basicimmunization(Xi)	.68322
Complete neonatal s'isit (X,)	-.72327
Provision of Vitamin A (Xs)	.96887
Birth weight (X‹)	-.65708
Birth height fY,â	OO

Based on table 9, it could be seen that the correlational value of the dependent variables (malnutrition stat us (Y i), poor nutritional status (Y‹), good nutritional status (Ys) and overnutrition status (Yi)) hada strong positive relationship with the independent variables (complete basic immunization (X i), complete neonatal visits (X), administration of vitamin A (Xs), birth weight ( ), and birth length (X,)), since the valuewas abos'e the limit of 0.5.

Based on table 10, it was identified that out of 5 independent variables, only birth height (X,) showed a low correlational value towards the dependent variable. Meanwhile, other independent v'ariables including the complete basic immunization (X i), complete neonatal v'isits (X), vitamin A (Xs) and birth weight ( ) showed a correlation or strong positive relationship with the dependent variablesincethey hadthe correlational value of above the limit of0.5.

In addition to an analysis using the canonical weight, the interpretation was also undertaken by considering the value of canonical loadings. The results of the canonical loading analysis were presented in table I I and table 12.

Table I I . Canonical loadings for dependent variates

Variables	Correlational value
Malnutrition status (Y i)	.97039
Poor nutritional status (Y;)	.7463 2
Gotxl nutritional status (Ys)	-.93609
Overnutritional status (Yi\	-.29423

Table 12. Canonical loadings for independent variates

Variables	Correlational value
Complete basic immunization (Xi)	-.S 1499
Complete neonatal visist (X)	-.90034
Provision of Vitamin A (X;)	-.62503
Birth weight ( )	-.77867
Binh heieht fX,4	-.22224

Based on table I I and table 12, a correlational function of canonical loadings could be obtained, namely 0.97039Y i+ 0.74632Y + (-0.93609Ys) + (-0.29423 Y) = (-0.8 l499X i) + (-0.9O034X) + (-0.62503 Xs) + (-0.77867Xi) + (-0.22224Xs).From this model, the correlational s'alue of malnutrition status (Y i) and poor nutritional status (Y›) indicated a high correlation or a strong pnsitis'e correlation with the independent variables: complete basic immunization (Xi), complete neonatal v'isits (X,) , v'itamin A (Xs) , birth weight (M) and birth length (X,) as their v'alues were above the measurement limit of 0.5. Meanwhile, gorxl nutritional status (Ys) was highly correlated but indicated a strongnegative relationship with the independent variablessince it had a ›'alue above the limit of 0.5. Furthermore, overnutritional status (Yi) showed a low correlational v'alue and a weak negative relationship with the independent variables because it had a value below the measurement limit.

Based on the correlation function of canonical loadings for the independent variables, of the 5 independent variables, there was only one variable (birth weight (X,)) that indicated a low correlation or a weak negative relationship with the dependent variable, since the correlation value was below the measurement limit of 0.5. Meanwhile, the other independent variables had a high correlational value or a strong negative relationship with the dependent variablesas the value was above the measurement limit of0.5.

Based on the atx»'e calculation, the following results were identified:

a. Four dependent v'ariables and 5 independent variables had a significant relationship. In other words, there was a relationship between the nutritional status and complete basic immunization, complete neonatal visit, pro›'ision of vitamin A, birth weight and birth lengih if they were tested in grou ps.

b. Of all 5 independent variables, one ›'ariable (i.e. birth weight) indicated no relationship. The other four ›'ariables: complete basic immunization, complete neonatal visit, pro›'ision of vitamin A, and birth weight had a very high but negativ'e relationship. Thus, it could be interpreted that children who did notreceive complete basic immunization, did not attend a complete neonatal visit, were not given s'itamin A, and born with abnormal binh weight could experience malnutrition status or poor nutritional status.

CONCLUSION

1. Assumption testing of the data before they were analyzed by using the canonical correlation was performed. The results re›'ealed that the data were of thenormal distribution, free of inulticollinearity, and linear between variables or yielded in a curve which did not form a certain pattern.
2. Variables of complete basic immunization, complete neonatal s'isit, vitamin A, birth weight and birth height had a strong positive correlation with malnutrition status and poor nutritional statusbut showed a negatis'e correlation with gocd nutritional status and overnutritionstatus.
3. The independent variables which gave the highest effects on the decrease of malnutrition status and poor nutritional status were complete basic immunization, complete neonatal x'isit, administration of vitamin A, and binh weight since they had a strong negative and an inversedcorrelationbetweenbothvariables.

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