Pathway Analysis of Growth Faltering Pattern Based on Height for Age in Children Under Five in Indonesia Based on Indonesian National Health Survey 2013

Ina KUSRINI, Donny Kristanto MULYANTORO and Sri SUPADMI

Departement of Health Research and Development, Ministry of Health, Magelang 50268, Indonesia
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Summary Growth failure has a severe impact on public health problems. Stunting is a particular growth failure contributing to the child mortality and morbidity of non-communicable diseases in adults. Objective: To analyze the determinants of growth failure patterns in children under five years in Indonesia. The further analysis was taken from 6,020 samples, based on the Indonesian National Health Survey (Riskesdas) 2013 (cross-sectional survey with a multistage cluster sampling method). Inclusion criteria are data that have completed records. The exclusion criteria were data having no outlier in anthropometric measurement. Nutrition status is analyzed using WHO AnthroPlus 2009. Data analysis is taken by path analysis in SPSS 21. The growth curve height for the under five-year children in Indonesia is less than the WHO growth standard. The mean height for age z-score (HAZ) has declined in linear patterns among the first five years of life. The determinant of growth is divided into two age groups. Overall, socioeconomic status has an indirect effect adjusted by both age and gender with r 0.10. In children <36 mo, the nutrition status of the mother has a direct and indirect effect on the birth nutrition status with r 0.17, while low birth weight, breastfeeding status, infectious disease, and immunization are the direct factor to HAZ score. In children aged 37–59 mo, infectious disease is a direct factor. Socioeconomic status, BMI of a mother, breastfeeding status, immunization, and infectious disease are the determinants of growth failure patterns in Indonesia.

Key Words growth failure, pathway, children under five, Indonesia

Growth faltering pattern of early childhood is an important indicator describing nutrition status in a vulnerable group. It was marked by the growth curve fails to achieve the linear pattern on early years. Stunting is the particular of growth failure that has a negative effect in a long term life (1). Previous study showing the children stunted associated with their cognitive development (2, 3), risk of obesity and non-communicable disease (3, 4). Early monitoring of growth faltering ensures the suitable intervention that can reduce later risk of poor growth (5).

More than 156 million children under five years are stunted and most of them live in the developing countries (6). Globally, childhood stunting prevalence decreased from 39.7% in 1990 to 26.7% in 2010, and it is estimated to decrease 21.7% in 2020 with linear mixed effect modeling (7). However, these required comprehensive efforts reduce 40% of stunting in children under five as global health targets in 2025. (8) Indonesia had 37.2% prevalence of stunting in 2013 and it slightly declined to 30.8% in 2018. (9, 10) Actually, it needs approximately 9–10% more to reach global target of stunting reduction.

Previous study showed framework determinant of health status of children. Infectious diseases, adequacy nutrition intake and family factors were the main factor contributing to growth and development. However, pathway analysis describing the determinant of growth failure in specific age group is unclear. Considering specific characteristic are important to scale up the effectiveness of intervention program to reduce of growth faltering in future. This present study objectives are to assess the growth failure pattern based on the height and which kind of specific determinants of this pattern in Indonesia.

MATERIALS AND METHODS

Subjects A National Health Basic Research Survey (Riskesdas) as a cross-sectional study was conducted in Indonesia with a multistage stage cluster sample method in 2013 integrated with the National Census Population from Central Bureau of Statistics of Indonesia. We have 300,000 households as primary sampling units (PSU). We choose the number of households from the 2010 population census with Probability Proportional Size (PPS) that provides information about the household, address, and type of residence. (9).

The methods are described as follows 1) Selecting several of block census (BS). There were 12,000 BS as the cluster that was systematically selected for each district/city according to the domain allocation considering

E-mail: dyy_syg@yahoo.com
rural and urban areas. BS was selected by following PPS method with the number of households results from the updated 2010 Population Census; 2) Number of census buildings ($n=25$) were taken systematically based on the census building data to represent the household sample; 3) Selected households that have children under five in their family are listed as the selected primary sampling unit of this study ($n=9$).

**Data selection**

We took further analysis based on National Health Basic Research Survey in 2013. The populations of this study are households with children under five. There are 82,666 children under five. Inclusion criteria for all subjects are data that have completed records: it has a birth record such as the weight, the height, the date, the gender, and the anthropometric data (the measurement of weight and height). The exclusion criteria were data having no outlier in anthropometric measurement. Outlier criteria flagged values (results from WHO-anthro analysis) more than 0 (zero) whereas Z score of $HAZ_{-6} > 6$ SD and or $HAZ_{+6} > 6$ SD). Based on these criteria only 6,020 numbers of samples can be involved in this analysis.

**Measurement**

**Study procedures and measurements.** Before collecting the data was conducted, enumerators were trained first by the Riskesdas technical team for seven days. During the training, the enumerators were given an understanding of the questionnaire they would ask the respondent and also how to measure biomedical sampling. After the training, the enumerator immediately descends the field to collect the data in the specified BS. 25 households in each BS were visited to conduct interviews, observations, training practices for anthropometric measurement and examinations (9).

They interviewed respondents with a closed questionnaire (RKD13.RT Questionnaire) and it was completed by guidelines how to fill the questionnaire. This interviewing technique is held to assess household characteristics, home environment, sociodemography of household. Respondents for the RKD13.RT Questionnaire are family heads, housewives who can provide information about household.

The individual data collection on various age groups was carried out using interviewing techniques called the RKD13.IND Questionnaire completed using guidelines on how to fill the questionnaire. This questionnaire was used to measure health status in each household member based on the result of the interview and measurement. There is a special treatment for household members who are less than 15 y old and in the sick conditions that the interviews are conducted with the help of their relatives worked as an assistant.

**Anthropometric**

We measured birth and weight of children under five using AND/Fesco and height measurement that has calibrated previously. For height, data was measured by a “Multifunctional” height measuring instrument with a measuring capacity of two meters and an accuracy of 0.1 cm. For weight, data was measured by the digital weight scale which is calibrated every day. All anthropometric measurements were carried out using measurement guidelines.
Statistical analysis

Data management and statistical analyses were performed using IBM SPSS 21 (IBM Corp., Armonk, NY, USA). Before choosing the analysis, data were tested for normality using the Kolmogorov Smirnov test.

Nutritional status was analyzed by WHO AnthroPlus 2009. We categorize growth faltering in this study when the z-score for data height for ages below $-2$ SD (standard deviation).

When data were not normally distributed, we used non-parametric tests consists of Spearman mean rank test for correlation between two numeric variables (Fig. 2) and Chi-square test for correlation between two categorical variables (Table 1 and Table 2).

We obtained socioeconomic data based on integrated data from National Economic Survey from Central Bureau of Statistics of Indonesia into five quintile categories. Quintile 1 and 2 show the low socioeconomic status, quintile 3 (the middle of socioeconomic status), quintile 4 dan 5 shows the high socioeconomic status. Path analysis was taken to show the direct and indirect factors to growth faltering.

Ethical procedure

The study and all procedures were approved by the Indonesian Health Research and Development Ethics Committee with ethic number LB.02.01/5.2/KE.006/2013. All participants provided written informed consent before participation. Data collection was carried out January to November 2013.

RESULTS

Descriptive characteristics

The nutritional status of children under five is measured based on the height for age. The assessment of nutritional status height for each children under five is converted into a standard score (Z score) using the standard children anthropometry of WHO in 2005. Growth failure is characterized by a z score $<-2$SD. The results of univariate analysis can be seen in Table 1.

Overall, Table 1 shows that in the particular children aged 0–59 mo and have completed the records, mean of z score based on height for age is $-1.11 \pm 2.08$ (SE). Proportion of growth failure based on indicators height for age (stunting) children was 32.9% (CI: 31.3–34.6). These are under estimated 5% with the national prevalence of stunting as a result of the 2013 national basic health research survey that 37.2% children under five are stunted due to different of denominators considering completed variable. Growth failure based on the characteristics can be seen in Table 1. Proportion of stunting in rural area is slightly higher than urban area 35.7%, 30.3%, respectively. Proportion of children with stunted in rural is higher than in urban approximately 6%. It means proportion of stunting living in rural area were higher proportion than urban area.

The highest prevalence was found in both father and
mother with the lowest education level 38.2%: 37.9%, respectively and gradually decreased along with the increasing of education level. From Table 1, it can also be seen that the variable height of the mother is related to growth failure, the most proportion of stunting was found in mother with height $\leq 150.1$ cm.

Overall the most prevalence of stunting was found in rural area, in the male group, aged 13–36 mo, from the short maternal stature (mother who has height below 150.1 cm) and the proportion gradually decreases along with socioeconomic status and education level of parents.

### Growth faltering pattern

The growth curve height for ages in children less than five years in Indonesia is less than WHO growth standard. The mean of height for age z-score (HAZ) has declined in linear pattern among first five years age of life (Fig. 1). The most proportion of growth failure was obtained in children with 13–36 mo old. These spread in all socioeconomic status in rural area (Fig. 1). However, in urban area, the proportion of children with growth faltering based on height for age was shown in socioeconomic status with middle income and high income. It means determinant of growth faltering in rural and urban were probably different causes.

### Determinant of growth faltering

Growth failure is caused by multidimensional factors. Table 2 shows the proportion of stunting based on child health status. The most proportion of stunting was found on children with low birth weight and birth height below 48 cm, had been the infection disease, incomplete immunization and partial breast feeding status. Children with low birth weight have proportion of stunting greater than children with normal birth weight (Table 2).

Path analysis that was shown in Fig. 2 presented the determinant of growth failure in this study. Birth nutrition status (birth weight and height) has significant relationship and direct effect to growth faltering with r 0.13. These were influenced with maternal nutrition

### Table 1. Proportion of growth faltering based on height for age in children under five by characteristic.

| Mean $\pm$ SD | Growth Faltering (Z score height for age $<-2SD$) | $n$ | % | N | $p$ value$^1$ |
|---------------|-----------------------------------------------|-----|---|---|---------------|
| Area Type     |                                               |     |   |   |               |
| Rural         | $-1.25 \pm 2.09$                             | 993 | 35.7 | 2,779 | 0.00         |
| Urban         | $-1.07 \pm 1.99$                             | 981 | 30.3 | 3,241 |               |
| Sex           |                                               |     |   |   | 0.01         |
| Male          | $-1.17 \pm 2.10$                             | 1,065 | 34.4 | 3,097 |               |
| Female        | $-1.14 \pm 1.98$                             | 909 | 31.1 | 2,923 |               |
| Age Group (mo)|                                               |     |   |   |               |
| 0–6           | $-0.61 \pm 2.27$                             | 268 | 24.9 | 1,076 |               |
| 7–12          | $-1.00 \pm 2.21$                             | 315 | 28.8 | 1,092 |               |
| 13–24         | $-1.36 \pm 2.04$                             | 744 | 38.8 | 1,919 |               |
| 25–36         | $-1.35 \pm 1.78$                             | 451 | 34.4 | 1,312 |               |
| 37–48         | $-1.40 \pm 1.67$                             | 153 | 33.1 | 462  |               |
| 49–60         | $-1.17 \pm 1.55$                             | 43  | 27  | 159  |               |
| Economic status|                                             |     |   |   | 0.00         |
| Quintile 1    | $-1.53 \pm 2.04$                             | 258 | 43.1 | 599  |               |
| Quintile 2    | $-1.42 \pm 2.06$                             | 380 | 38.5 | 987  |               |
| Quintile 3    | $-1.25 \pm 2.03$                             | 462 | 35.1 | 1,317 |               |
| Quintile 4    | $-1.00 \pm 2.03$                             | 456 | 29.6 | 1,543 |               |
| Quintile 5    | $-0.92 \pm 2.01$                             | 418 | 26.6 | 1,574 |               |
| Father Education|                                          |     |   |   | 0.00         |
| Low           | $-1.33 \pm 2.06$                             | 716 | 38.2 | 1,875 |               |
| Middle        | $-1.13 \pm 2.02$                             | 1,091 | 31.6 | 3,456 |               |
| High          | $-0.74 \pm 2.08$                             | 167 | 24.2 | 689  |               |
| Mother Education|                                          |     |   |   | 0.00         |
| Low           | $-1.37 \pm 2.06$                             | 689 | 37.9 | 1,818 |               |
| Middle        | $-1.13 \pm 2.01$                             | 1,110 | 32.1 | 3,462 |               |
| High          | $-0.74 \pm 2.10$                             | 175 | 23.6 | 740  |               |
| Height of Mother|                                           |     |   |   | 0.00         |
| $<150.1$ cm   | $-1.51 \pm 1.92$                             | 897 | 41.1 | 2,181 |               |
| $\geq150.1$ cm| $-0.94 \pm 2.08$                             | 1,077 | 28.1 | 3,839 |               |
| Total         | $-1.11 \pm 2.08$                             | 1,974 | 32.9 | 6,020 |               |

$^1$ By chi square test for correlation between categoric variable.
status with r 0.15. Adequate nutrition intra uterine (during pregnancy) is determinant of the nutritional status of children after birth. However there is no adequacy variable that describes the maternal nutrition status during pregnancy in this study. Information of nutrition status only describes the height of mother that was shown in Table 1. Weight gain during pregnancy can indicate adequacy intake during pregnancy and mid upper arm circumference (MUAC) during pregnancy can provide information whether during pregnancy, the mother experiences less energy calories (CEM) or not valuable in this study.

Another determinant of growth faltering is infectious disease status on children. Figure 2 showed the direct effect of infectious disease to growth failure, with r 0.04. The proportion of growth failure that has a history of infectious diseases such as upper respiratory tract infection (URI), diarrhea, pneumonia, hepatitis and pulmonary tuberculosis are higher than children with no infection diagnose. Thus was influenced with immunization status. Children with completed immunization have proportion of stunting lower than children with un-completed of immunization status. While in the history of breastfeeding, children who never get breastmilk have a growth failure similar to children who are ever breastfed. There is no significant relationship between breastfeeding status and stunting in this study. The limitation in this study is not getting data about exclusively of breastfeeding status.

Overall, the most influenced of determinant stunting is health status of mother (maternal factor) with r 0.17. Health status of mother consists of the number of children (parity) and also height of mother that describes chronic nutrition status during pregnancy. It has direct and indirect effect to growth failure. Another determi-

| BirthWeight (<2,500) | Growth Faltering (Z score height for age<−2SD) | p value |
|---------------------|-----------------------------------------------|---------|
| Yes                 | −1.43±2.14                                    | 226     |
| No                  | −1.12±2.03                                    | 1,748   |
| BirthLength<48 cm   |                                               |         |
| Yes                 | −1.38±2.03                                    | 903     |
| No                  | −1.00±2.04                                    | 1,071   |
| Infection Status    |                                               |         |
| Yes                 | −1.25±1.98                                    | 977     |
| No                  | −1.06±2.09                                    | 997     |
| Imunization Status  |                                               |         |
| Complete            | −0.72±2.22                                    | 260     |
| No                  | −1.24±1.99                                    | 1,714   |
| Breast Feeding Status |                                            |         |
| Still               | −0.95±2.21                                    | 472     |
| Partial             | −1.18±2.14                                    | 542     |
| No                  | −0.96±2.11                                    | 61      |

By chi square test for correlation between categoric variables.

| Determinant of Growth Faltering | Direct effect | Indirect effect | Total Effect |
|---------------------------------|---------------|-----------------|--------------|
| ALL                             | −0.01         | 0.01            |              |
| Age                             | −0.12         | 0.12            |              |
| Area                            | −0.06         | 0.030           | 0.090        |
| Infectious status               | 0.04          | 0.04            |              |
| Imunization                      | 0.09          | 0.0020          | 0.009        |
| Breast Feeding                   | −0.05         | 0.0040          | 0.054        |
| Birth Nutrition Status           | 0.13          | 0.130           |              |
| Mother health status             | −0.15         | 0.0200          | 0.170        |
| Sosio demografi                  | 0.10          | 0.0002          | 0.100        |

| Age                             | −0.17         | 0.170           |              |
| Area                            | −0.04         | 0.0028          | 0.043        |

| Infectious status               | 0.05          | 0.050           |              |
| Imunization                      | 0.10          | 0.0090          | 0.110        |
| Breast Feeding                   | −0.05         | 0.005           | 0.055        |
| Birth Nutrition Status           | 0.14          | 0.140           |              |
| Mother health status             | −0.11         | 0.0084          | 0.120        |
| Sosio demografi                  | 0.07          | 0.0011          | 0.071        |

| Area                            | −0.11         | 0.110           |              |
| Infectious status               | 0.05          | 0.050           |              |
| Birth Nutrition Status           | 0.11          | 0.110           |              |
| Mother health status             | −0.20         | 0.0100          | 0.200        |
| Sosio demografi                  | 0.15          | 0.0001          | 0.150        |
nant is the birth nutrition (r 0.13) and socio demography (r 0.10). Birth nutrition variable showed history of nutrition status intra uterin. Low birth weight and low birth height have a significant relationship with this composite variable.

Socio demography

It describes a predictor of stunting in specific age group. this study is divided into two analysis groups. Socioeconomic status has direct and indirect effect in both adjusted by age and sex. In children <36 mo, nutrition status of mother has a direct and indirect effect by previous birth nutrition, another indicator that was shown is breastfeeding status, the infectious disease that has a direct effect to HAZ score. In children on 37–59 mo, the infectious disease was a direct factor.

DISCUSSION

Growth failure in early childhood is due to multidimensional factor. Whilst, a complete recovery catching up to get better nutrition status can occur depending on their environment that supports it (11). Nutrition of mother before and during pregnancy is essential to support children achieving their optimal growth and development (8). This result shows that the maternal nutrition factor and the birth nutrition are the most determinant factor related to the height for age score. Many studies also showed that maternal height is a predictor of intrauterine growth retardation (IUGR). Despite the maternal height can result from genetic factor, but previous study in Guatemala showed that they also reflect the effect of early childhood nutrition on growth. Short maternal stature may grow to be short in adults and it was indicate chronically malnourished status in their previous step of life (12).

Growth faltering pattern will continue for a long term of their life (10). According to the nutrition life cycle scheme. it was described that the children malnutrition in early years of life with no improved nutrition intake during critical period of their life would influence the nutrition status in their adult period (13). Therefore, chronic malnutrition in mother and inadequate intake during pregnancy can cause inadequate fetal nutrition that related to the repeated low birth weight output in her infants. Life cycle process will continue if there is no effort to repair it (14).

Several studies describe the relationship maternal undernutrition and their infant nutrition. Lack of nutrient intake (macro and micro) during pregnancy is the factors that related to the poor birth nutrition status (12). These were remarked by low birth weight (LBW) and low birth height (LBH). Both indicators describe intra uterine nutrition that will affect the subsequent growth process (15, 16). These results are similar with previous study about maternal height. low birth weight. number of children. inadequate breastfeeding and also frequent of infectious disease likes diarrhea and respiratory disease that can influence the growth failure in children (17, 18). Another analysis based on the national health research survey in Indonesia with 24.657 samples of children under two years have similar results. number of children. low birth weight. and the most prevalent was taken in children 12–23 mo (19). Study taken in India showed that children with low birth weight had odd ratio (OR) 2.5 times to be stunted. otherwise in children whose mother height was below 145 cm with OR 2.04 to be stunted (20).

Nutrition of children in early two years is influenced by adequate intake during breastfeeding period. Cohort study that conducted in Tanzania showed that the nutrition status of lactation mother related to the micronutrient deficiencies of infant at early year (21). Contrast with the results of this study unadjusted by age. breastfeeding status which is divided into three criteria (still of breast fed. partial of breast fed. never to breast fed) has not related significantly to the height for age score. These are similar to study conducted in Ghana. in children 4–6 mo with exclusively breastfeeding showed that they catch rapidly in weight for age in 3–4 mo. but this was not the case for length for age (22). However quality of nutrition during breastfeeding for six months must be completed with complementary food in the following month.

An interaction between genetic and epigenetic factor has an important play role to the growth and development of early childhood (23). Failure to get sufficient nutrition intake (macro and micro nutrient) challenging of environment that related to infectious diseases and inadequate provision of care can disturb their physiological growth mechanism. This study showed the determinant model of nutrition status (height for age). socioeconomic contributed significantly to growth faltering (24).

Based on adapted models of growth and development in children from UNICEF. there are several factors that influence nutrition status directly and indirectly through another indicator. Engle 1999 divided into six categories which are education. nutrition and health from caregivers. mental health and self-confidence from caregivers (autonomy. time availability) and social support form family and society (25). Other models formulated indirect influencing factors are unintended pregnancy and socio-economic status. Similar with the results in this study showed that socioeconomic status and parents’ education are the most determinant of nutrition status in children under five. Socio economic status is a strong predictor of family availability to access acquired food. take health service and care to support growth and development. while maternal educations related to caring practices. child nutrition and survival (26, 27).

In Conclusion based on completed record as inclusion criteria in this analysis showed pattern of growth faltering in children under five in Indonesia. The pattern showed the height for age score was slightly decline through age. The most prevalent of growth faltering based on the height for age was shown in rural area. in 13–24 age groups and the most of them was boy.
Model structural that was formulated by path analysis showed that the maternal factorthat was described by maternal height, the number of children and also birth weight and birth height were contributed significantly direct and indirect to height for age. Sociodemographic is a distal predictor that influenced HAZ score through the maternal status, previous nutrition status and infectious disease. Another factor is completely immunization and breastfeeding status with lower relative power.

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