

# Determinants of HAZ score in children under five in Glagah, Lamongan, Indonesia: A SEM-PLS analysis

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## Abstract

**Background:** Stunting is a nutritional condition of children with a Height for Age Z-score (HAZ score) under -2. The percentage of stunting in Indonesia in 2018 for children under five years of age was 30.80%, which has consistently increased since 2000. Glagah is a subdistrict in Lamongan Regency, which includes the national priority of the stunting intervention program. A multisectoral and comprehensive intervention must be related to evidence-based and previous relevant research and framework. However, there are various results about the determinants of stunting.

**Objective:** This study aimed to identify direct and indirect effects from the determinant of HAZ score in children under five years of age in Glagah, Lamongan, Indonesia.

**Methods:** This research employed a case-control design with  $K=2$  and utilized a modified research questionnaire to collect the data. The population was mothers with 6–59-month-old children in Glagah. The samples were 88 control and 44 cases. The analysis was performed with SEM-PLS analysis with bootstrapping using  $\alpha$  0.05.

**Results:** Our model shows an R-square of 0.433. Variables with the most affecting factors are Energy intake  $\rightarrow$  HAZ ( $\beta$  0.541), Protein intake  $\rightarrow$  HAZ ( $\beta$  -0.327), Parenting score  $\rightarrow$  HAZ ( $\beta$  0.309), parenting score  $\rightarrow$  energy intake ( $\beta$  0.411), parenting score  $\rightarrow$  protein intake ( $\beta$  0.435), parenting score  $\rightarrow$  energy intake  $\rightarrow$  HAZ ( $\beta$  0.222).

**Conclusion:** These results provide an essential brief for community empowerment to increase parenting quality in a stunting intervention program. This research proposes an improvement on the environment and population variables for further study.

**Keywords:** children; determinants; HAZ; parenting; SEM-PLS

## Background

Stunting is a malnutrition condition in children with a Height for Age Z-score (HAZ) under -2 (United Nations International Children's Emergency Fund, 2013). Stunting is the determinant of patent cognitive disorders and psychomotor restrictions (Trihono et al., 2015). In 2018, based on the National Basic Health Research result, under-five-years-old

children with stunting in Indonesia was 30.80%. Another survey in 2017 revealed that around 20.10% of under-two-year-old children and 29.60% of under-five-year children have stunting (Kementerian Kesehatan Republik Indonesia, 2018). The prevalence of stunting significantly increased over 15 years, from 36% in 2000 to 40.20% in 2015 (Trihono et al., 2015). Lamongan is one of the districts with the highest stunting

prevalence. In 2018, 48.87% of children under five years old in Lamongan had stunting. Lamongan is one of the districts with the highest chronic children's nutrition problem in the community ([Kementerian Kesehatan Republik Indonesia, 2018](#)). The National Planning Agency of Indonesia released ten sub-districts in Lamongan that included the priority stunting intervention program. Five villages were in the Glagah sub-district ([Ministry of National Development Planning & TNP2K, 2017](#)).

Stunting is a multisectoral and comprehensive problem with a sensitive and specific approach. A previous study showed various risk factors similar to the WHO (World Health Organization) framework of the stunting program approach ([World Health Organization, 2017](#)). The complexity of the stunting framework explains the effect among factors related to stunting. Protein, energy intake, and disease or infection history significantly affect HAZ or stunting in children. The other risk factors that indirectly affect the stunting status include environmental situation, water, sanitation hygiene (WASH), and government regulation ([Sumiaty, 2017](#); [World Health Organization, 2017](#)).

The Indonesian Government focused on reducing the prevalence of stunting to 14% in 2024 with 30% on specific interventions and 70% on sensitive interventions. Within this framework, increasing nutrition intake in an evidence-based policy is the main focus of the Ministry of Health and the NPFPA (National Population and Family Planning Agency) ([Badan Koordinasi Keluarga Berencana Nasional, 2022](#)). This research aimed to identify direct and indirect effects from the determinant of HAZ score in children under five in Glagah, Lamongan, Indonesia.

## Methods

### Study Design

This research used an unpaired matched case-control study design with the K-value of 2 as a comparison.

### Samples/Participants

The study design used gender and clean water sources as matching variables to reduce the exposure bias. The data was collected from June to July 2019 in the Glagah Sub-district. The children (aged 6-59 months) with HAZ (Height-for-Age Z score) less than -2 were taken as the case

population, and children with HAZ -2 or more were taken as the control population. The other inclusion criterion was gas fire stoves. The sample size used the Lemeshow Formula ( $\alpha = 5\%$ ;  $\beta = 20\%$ ; estimated effect design = 1.50) with the estimation of dropout of 10%. Therefore, the sample size of this research is 44 children as the case sample and 88 children as the control sample. The case samples were selected by purposive sampling based on the inclusion criteria, and the control samples were selected with random sampling from the sample frame. The sample frame consists of the data of children under five years old in the integrated service post of the five highest villages with the incidence of stunting. The distribution in each selected village was done by the PPS (Probability Proportionate to Size) technique.

### Instrument

The structured questionnaire includes income per capita, maternal height, maternal nutritional knowledge score (eight items), parenting score (eleven items), and birth weight. The children's height was measured with the Microtoise (precision of 1 mm) or the length board (with the same precision). The HAZ was generated with R studio using Anthro packaged ([Schumacher et al., 2023](#)). The energy and protein intake were assessed with the semi-quantitative food frequency questionnaires (SQ-FFQ) instrument and were analyzed with the Indonesian NutriSurvey Software. The Mother Child Health Book was observed to assess the systole and diastole blood pressure in the third trimester of the mother's pregnancy

### Data Analysis

The data were analyzed with a Partial Least Squares Structural Equation Modeling (PLS-SEM) using the "SeminR" Package in RStudio with the setting of alpha ( $\alpha$ ) 0.05 and bootstrapping ([Hair et al., 2019](#)). The model was developed based on the WHO framework of stunting among children under five years old, with some filtering to numerical variables that can be analyzed with PLS-SEM analysis ([World Health Organization, 2017](#)). This analysis was used to perform direct and indirect effects from each variable to dependent variables and the total effect ([Hair et al., 2019](#)). The other classical test includes validity convergent test (loading factor  $> 0.5$ ), validity discriminant test, composite reliability test (AVE value  $> 0.5$  and alpha Cronbach  $> 0.7$ ), and collinearity test ( $0.2 < VIF < 5$ ).

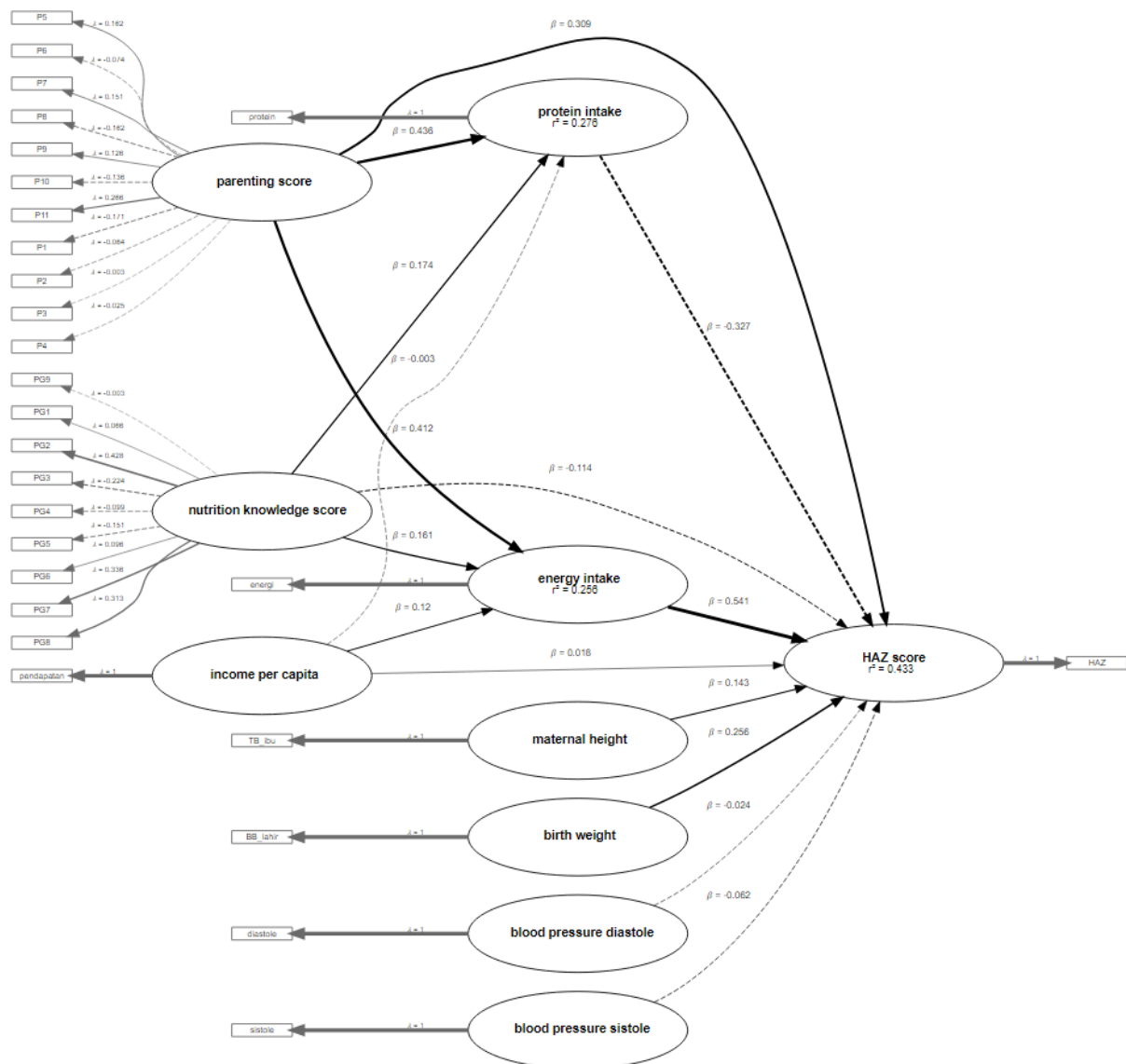
## Ethical Considerations

Ethics approval was conducted by the Ethics Commission of the Faculty of Health Sciences of UIN Syarif Hidayatullah Jakarta in May 2019 with letter number Un.01/F10/KP.01.1/KE. SP/05.06.024 /2019.

## Results

The analysis result (after bootstrapping) shows the plot in **Figure 1**. All the nutrition knowledge (8 items)

has good validity (R-value > R table) and reliability (Cronbach Alpha = 0.722; high reliability). The 11 items of the parenting pattern show good validity (R-value > R table) and high reliability (Cronbach alpha > 0.700). The statistical result is shown in **Table 1**. Based on the Confidence Interval of 95% ( $\alpha$  5%), there is no significant relationship between independent and dependent variables because the confidence interval crosses zero. The confidence interval indicates that the variables' effect accommodates both the positive effect and the negative effect (not significant effect).



**Figure 1** The PLS-SEM Plot of the Determinant of the HAZ score

Based on the value of coefficient  $\beta$ , several pathways show a higher effect, including parenting score → HAZ (direct effect of  $\beta$  0.309), as well as parenting → energy intake → HAZ (indirect effect of  $\beta$  0.222), parenting score → energy intake (direct effect of  $\beta$  0.411), and parenting score → protein intake (direct effect of  $\beta$  0.435), birth weight → HAZ (direct effect of  $\beta$  0.255), energy intake → HAZ.

**Table 1** Effect Tabulation of PLS-SEM Determinant of HAZ Score

Path	Direct effect	Indirect effect	T stat	95% CI
Parenting score → HAZ	0.309	-	0.020	-3.20 – 3.45
Parenting score → energy intake → HAZ	-	0.222	0.028	-2.08 – 4.29
Parenting score → protein intake → HAZ	-	-0.142	-0.017	-3.71 – 2.88
Nutrition Knowledge → HAZ	-0.113	-	-0.011	-2.62 – 2.13
Nutrition knowledge → energy intake → HAZ	-	0.086	0.013	-1.44 – 3.61
Nutrition knowledge → protein intake → HAZ	-	-0.056	-0.008	-2.32 – 2.89
Maternal Height → HAZ	0.143	-	0.022	-0.66 – 0.96
Birth weight → HAZ	0.255	-	0.067	-0.59 – 1.07
Diastole BP → HAZ	-0.024	-	-0.006	-1.01 – 0.82
Systole BP → HAZ	-0.062	-	-0.015	-1.28 – 1.07
Income per capita → HAZ	0.018	-	0.003	-0.71 – 0.86
The income per capita → energy intake → HAZ	-	0.064	0.032	-0.82 – 1.04
The income per capita → protein intake → HAZ	-	0.001	0.001	-0.76 – 0.98
Energy intake → HAZ	0.541	-	0.059	-1.42 – 2.54
Protein intake → HAZ	-0.327	-	-0.027	-3.30 – 1.71
The income per capita → energy intake	0.119	-	0.038	-0.92 – 1.14
Nutrition knowledge → energy intake	0.160	-	0.013	-1.78 – 2.83
Parenting score → energy intake	0.411	-	0.032	-2.06 – 3.68
The income per capita → protein intake	-0.003	-	-0.001	-1.04 – 1.15
Nutrition knowledge → protein intake	0.173	-	0.010	-2.11 – 3.09
Parenting score → protein intake	0.435	-	0.025	-2.75 – 4.44

**Table 2** The R square from the model

Variables	R square	Adjusted R square
Energy Intake	0.256	0.238
Protein Intake	0.276	0.259
HAZ score	0.433	0.391

(Direct effect of  $\beta$  0.541), protein intake → HAZ (direct effect of  $\beta$  -0.327). The highest direct effect from this model is from energy intake to HAZ score with the coefficient  $\beta$  0.541. It can be seen from the result that the increase of one point from energy intake is correlated to the increase of HAZ score of 0.541 if the other variables have been adjusted. Energy intake also becomes the mediating variable on the path from parenting score to HAZ with an indirect effect of 0.222. However, the model shows that the parenting score has a higher effect on the HAZ score (direct effect of  $\beta$  0.309) than with the mediating path (energy intake; indirect effect of  $\beta$  0.222). Energy intake also has a higher effect as a mediating variable from the income per capita to HAZ score (indirect effect of  $\beta$  0.064) than the direct

effect among the income per capita to HAZ score (direct effect of  $\beta$  0.018).

The R square is shown in **Table 2**. The model indicates that nutrition knowledge and parenting score can explain the variance of energy intake and protein intake, respectively, by 0.256 and 0.276. That means 25.6% of the variation in energy intake and 27.6% of the variation in protein intake can be explained by nutrition knowledge and parenting score. The other variables outside the models explain the other variations of dependent variables. The HAZ score has an R square of 0.433, which indicates that all variables in the model can explain 43.3% of the total variation of the HAZ score, and the rest (56.7%) are explained by the other variables outside the models.

## Discussion

This study found that parenting score has the highest effect on HAZ, with a total effect of 0.673. Parenting score has a direct impact on HAZ (0.309) and has an indirect effect on HAZ through energy intake (0.222). However, in this study, it was discovered that the parenting score does not significantly affect HAZ through protein intake (Indirect effect -0.142). These results are similar to a study in Muna Barat (Rohmawati et al., 2019), which revealed a positive effect on parenting patterns among toddlers with statistically significant results. Poor parenting respondents have a higher OR of 1.8 than respondents with good parenting (OR 1.8; 95% CI = 0.13 – 2.26; p-value = 0.000). Another study from (Utami et al., 2022) shared that parenting is related to the incidence of stunting in children under five years old Sukabumi Regency (p=0.000, R2=0.739). Gustina et al. (2020) also stated that maternal knowledge level, nutrition, and parenting score simultaneously affected the incidence of stunting (p=0.000, R2=0.876). The study showed that parental feeding style is related to the magnitude of the HAZ score in toddlers (AOR = 2.77; 95% CI: 1.97-3.91). The result showed that parents with poor parental feeding styles have a 2.89 times higher risk of stunting in children than parents with good parental feeding styles.

Parenting considerably influences the incidence of stunting among children under five years of age, especially related to feeding practices. Nutritional intake is strongly affected by food arrangements made by the mother or child caretaker. Good parenting not only plays a role in good nutritional status in children but also has a role in normal emotional and psychological development in children (Lestari, 2019; Utami et al., 2022).

This study also showed that energy and protein intake had a direct effect on HAZ score (direct effect 0.541 and -0.327, respectively). This result is similar to a previous study that showed the effect of low energy intake on the HAZ score of 44.9% p = 0.050, while protein intake showed no effect on the HAZ score of 41.6% p = 0.780 (Basri et al., 2021). Another study also suggested no significant effect of protein intake on HAZ scores in subjects in the rural area of Sumba (p = 0.06) (Limardi et al., 2022).

In line with these findings, a study in Ethiopia showed a positive correlation between energy intake (r = 0.20; p < 0.001) and protein intake (r = 0.10, p = 0.11) to the HAZ score (Tessema et al., 2018). A study in Yogyakarta also showed that energy intake (r = 0.183; p 0.030) and protein intake (r = 0.203; p 0.016) are correlated with the HAZ score positively (Angelin et al., 2021).

The increase in the height of toddlers is strongly affected by the intake of macronutrients as energy producers, especially protein intake. Protein affects various metabolic processes in the body, including mediating Insulin Growth Factor-1 (IGF-1) (Rizky Maulidiana & Sutjiati, 2021; Tessema et al., 2018). IGF-1 is a hormone that mediates the effects of growth hormone and causes anabolic effects on skeletal muscles and other tissues (Tessema et al., 2018). Protein is formed by amino acids, which also have a biological role in the synthesis of fat in the body, bone elongation, and various processes required for linear growth (Tessema et al., 2018). Essential amino acids needed for growth are found more in animal-based than plant-based food (Angelin et al., 2021; Braun et al., 2016). Inadequate intake of protein and amino acids can reduce linear growth in children (Angelin et al., 2021). This result is relevant to the recent framework of stunting intervention in Indonesia, which has received great attention from the government. The result focuses on nutrition intake among children under five and pregnant women (Kementerian Pendayagunaan Aparatur Negara, 2023).

This study's result indicated no significant effect of protein intake on HAZ score in the study subjects. It was due to the low consumption of animal-based food protein in both groups in the population. This is common in developing countries like Indonesia, where plant-based food protein is the main source of protein (Angelin et al., 2021). High protein intake is useful for covering energy shortages due to inadequate carbohydrate intake, causing a lack of protein to regulate growth (Rizky Maulidiana & Sutjiati, 2021).

The limitation of this study is the limited access to explore SEM-PLS with the analytical design. This analysis is more suitable for variables with a dominant list item arrangement. However, the analysis results accommodated the desired variation and hypothesis testing. In addition, this



study used the SQ-FFQ instrument for a three-month recall period, yet the study was conducted during the harvest season in which the parents tended to spend more time in the fields. Thus, it potentially brings outlier bias in the assessed intake data.

## Conclusion

Although there is no significant relationship based on p-value, some variables have a higher effect on HAZ score including Energy intake → HAZ (direct effect with  $\beta$  0.541), Protein intake → HAZ (direct effect with  $\beta$ -0.327), Parenting score → HAZ (direct effect with  $\beta$  0.309), parenting score → energy intake (direct effect with  $\beta$  0.411), parenting score → protein intake (direct effect with  $\beta$  0.435), parenting score → energy intake → HAZ (indirect effect with  $\beta$  0.222). In addition, our models show an R-square of 0.433, a mean of around 43.3% from the HAZ score variation that can be explained by variables in the models. The results of this study can be used as basic considerations for the development of specific and sensitive stunting intervention programs that focus on empowering and improving the quality of parental care and child-feeding behavior. It is offered by considering variations in relevant and appropriate population characteristics for the next research. The researcher can develop the variables in the model, including the environmental and population variables that are appropriate with the WHO and UNICEF about the determinants of stunting.

### Declaration Conflicting Interest

The authors have no conflicts of interest to declare.

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### Author Contribution

Conceptualization: MTAA; Data curation: MTAA; Formal analysis: MTAA, MA; Funding acquisition: all authors; Investigation: MTAA; Methodology: all authors; Project administration: MTAA; Resources: all authors; Software: MTAA; Supervision: all authors; Validation: all authors; Visualization: MTAA, MA; Writing—original draft: all authors; Writing—review & editing: all authors.

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