

1 **Original Research**

2
3 **Potential Economic Losses Due to Stunting in Toddlers In Ogan**
4 **Komering Ilir Regency**

5 **Anita Rahmiwati¹, Ahmad Rivai²**

6 ^{1*)} Nutrition Department Faculty of Public Health, Universitas Sriwijaya, Palembang, Indonesia

7 ²⁾ Public Health Department Faculty of Public Health, Universitas Sriwijaya, Palembang, Indonesia

8
9 ***Corresponding Author:** anita_rahmiwati@fkm.unsri.ac.id

10
11 **ABSTRACT**

12 Stunting is a chronic condition that arises due to nutritional deficiencies during pre- and postpartum
13 periods. It is a significant public health issue in Indonesia, with a prevalence of approximately 29.6%
14 nationwide and about 22.6% in Ogan Komering Ilir Regency. Therefore, this research aimed to
15 identify the risk factors associated with stunting in toddlers aged 12-35 months and calculate the
16 economic losses incurred by this condition. To achieve this, a cross-sectional design was employed,
17 and a sample of 77 toddlers was selected through simple random sampling. Data was collected using
18 questionnaires, and calculations based on the Konig 1995 and Horton 1999 formulas were used to
19 analyze the Gross Regional Domestic Product (GRDP) per capita. The research found that stunting
20 had a prevalence rate of 51.9% in toddlers. Additionally, the research identified that dietary diversity
21 was significantly related to the occurrence of stunting with a p-value of 0.0001 and was identified as
22 the most dominant factor, whereas economic status, toddler participation, and history of infectious
23 diseases were not significantly related to stunting with a p-value> α . The study also estimated the
24 potential economic losses incurred by stunting, which amounted to IDR 170 billion and IDR 765
25 billion, respectively, or 0.67% - 3.03% of OKI's GRDP, resulting from a 2% and 9% decrease in
26 productivity. Hence, this research suggests that food consumption diversity is the most dominant
27 factor significantly related to stunting in toddlers in Ogan Komering Ilir Regency.

28 **Keywords:** Economic Losses, Nutritional Status, Risk Factors, Stunting, Toddlers.

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29 **INTRODUCTION**

30 Stunting is a long-term condition caused by poor healthcare and nutritional problems during the
31 prenatal and postnatal periods.⁽¹⁾ This accumulation effect can lead to increased mortality rates, motor
32 development disorders, bodily function imbalances, and cognitive impairments in children.⁽²⁾
33 Children who experience stunting after the age of two have their body growth hindered, and their
34 potential for growth is not maximized until they reach adolescence or adulthood. Even if growth
35 occurs, it will not be in height, but rather in width. The impact of stunting goes beyond physical
36 growth and can have detrimental effects on health resilience, development, and productivity due to
37 linear growth disturbances.⁽³⁾

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38 According to estimates from the World Bank, cases of malnutrition in the community result in a
39 2.5% loss in Gross Domestic Product.⁽⁴⁾ Furthermore, there is a negative correlation between the
40 Gross Regional Domestic Product (GRDP) per capita and the prevalence of malnutrition in toddlers.
41 This means that the higher the value of GRDP per capita in an area, the lower the prevalence of
42 malnutrition.⁽⁵⁾ This is because a large GRDP value indicates a large economic resource capacity and
43 vice versa.⁽⁶⁾

44 According to the 2017 Nutritional Status Monitoring (NSM), the prevalence of stunting in toddlers
45 decreased from 37.2% in 2013 to 29.6% but increased from 27.5% in 2016. The prevalence of
46 stunting in toddlers in South Sumatra province is 22.8%. Furthermore, the NSM report shows that

47 there are 12 Sub-district in South Sumatra province still in the acute-chronic category, with more
48 than 20% of toddlers experiencing stunting.⁽⁷⁾ Therefore, this research aims to identify the risk factors
49 associated with stunting in toddlers aged 12-35 months in Pedamaran Sub-district and the economic
50 losses incurred by the Ogan Komering Ilir (OKI) Regency.

51 **METHOD**

52 **Research Design**

53 This research was conducted using a cross-sectional design.

54 **Research Subjects**

55 The sample consisted of 77 mothers who had toddlers aged 12-35 months. Furthermore, the sampling
56 technique used was proportional stratified random sampling.

57 **Data Collection/Materials and Tools**

58 In this research, to calculate the economic losses secondary data was used including the Gross
59 Regional Domestic Product per capita of Ogan Komering Ilir Regency by field of work in 2017⁽⁸⁾,
60 the number of births and population by age group in 2017 OKI Regency⁽⁹⁾, The benchmark interest
61 rate from Bank Indonesia, and the prevalence of stunting in Ogan Komering Ilir Regency. The data
62 collected was then analyzed using the Konig and Horton formula with the Microsoft Excel program.
63 The formula used for calculating the economic value of a child when they start to work is as follows:

$$64 \quad FV_{[r,t]} = P_0 (1 + r)^t$$

65 The large economic value until the child enters the retirement period was calculated using the
66 following formula:

$$67 \quad FVA_{[r,t]} = \frac{FV_{[r,t]} [(1 + r)^t - 1]}{r}$$

68 The potential economic value of a child at the age of 0 years was calculated using the following
69 formula:

$$70 \quad PV_{[0]} = \frac{FVA_{[r,t]}}{(1 + r)^t}$$

71 The magnitude of the lost productivity cost due to stunting was calculated using the following
72 formula:

$$73 \quad P_{PEM} = Prev \times \sum BL \times PV_{[0]}$$

74 Calculation of the magnitude of the economic loss due to stunting with the correction factor from
75 Horton, states that in actual conditions, the child can still recover and still has a productivity value
76 of less than 100%. Therefore, it will only experience a productivity loss of 2-9%. The following
77 formula is used:

$$78 \quad P_{PEM} = f_{(cor)} \times Prev \times \sum BL \times PV_{[0]}$$

79 **Description:**

- 80 a. $FV_{[r,t]}$ = Income in productive age (15-64 years old).
- 81 b. $FVA_{[r,t]}$ = Economic value until the child enters retirement age.
- 82 c. $PV_{[0]}$ = Child's economic potential at 0 years old.
- 83 d. P_0 = PDRB per capita.
- 84 e. r = Annual interest rate.
- 85 f. t = Years in productive age.

- 86 g. PPEM = Potential economic loss due to stunting.
87 h. Prev = Prevalence of stunting.
88 i. $\sum BL$ = Total births.
89 j. f(cor) = Correction factor (2% and 9%).

90 **Data Analysis**

91 The data analysis performed was univariate, bivariate, and multivariate. Bivariate analysis was
92 performed using statistical tests and the Chi-Square test, while multivariate analysis was performed
93 using the predictive logistic regression model test.

94 **Ethics Approval**

95 This study was ethically approved by Health Research Ethics Committee Faculty of Public Health
96 Sriwijaya University, with number: 75/UN9.1.10/KKE/2019.

97

98 **RESULT**

99 **Family and Sample Characteristics**

100 Family characteristics collected include descriptions of parents' education, occupation, and average
101 age. Meanwhile, the characteristics of the sample include a description of the gender and the average
102 age of the toddlers. The characteristics of the family indicate that the highest level of education for
103 fathers was high school graduates, accounting for 33.8%, while 39% for mothers. Based on the
104 parents' occupation, the majority of fathers work as self-employed/traders, accounting for 58%, while
105 the majority of mothers are housewives/not working, accounting for 77.9%. The characteristics of
106 the sample show that 50.6% of the boy and 49.4% are girl. The average age of the toddlers collected
107 was 22 months.

108 **A. Characteristic Respondent**

109 In this research, the data in the table shows that more than 50% of the toddlers examine fall under
110 the category of stunted toddlers. Subsequently, of the families that participated, almost 60%, belong
111 to the category with low economic status. In this research, there are more families with limited dietary
112 diversity, accounting for 61%, compared to those with diverse diets. Almost 80% of the toddlers in
113 the families examine have good habits of attending integrated service post programs. The results
114 show that 87% of toddlers have a history of infectious diseases.

115

116 **B. Economic Losses**

117 Based on the analysis results, it was found that out of 46 toddlers from low-economic families, there
118 was an equally balanced proportion of stunted and normal status. The statistical results of the
119 bivariate analysis in the presented table above show that the economic status described by household
120 food expenditure is not related to the occurrence of stunting in toddlers (p-value > 0.05).

121

122 Table 3 above shows that the group of families with limited dietary diversity has the largest
123 proportion of stunting in toddlers, accounting for about 70.2%. Meanwhile, in families with diverse
124 diets, the largest proportion was reported in the influence on the normal toddler height.

125 The statistical results show that the dietary diversity variable is related to the occurrence of stunting
126 in toddlers in the Pedamaran sub-district, with a p-value of 0.0001 (p-value < α). Subsequently,
127 diversity in food is a risk factor: PR = 7.745 CI 95% 2.706-22.175, which means if a family consumes
128 a limited variety of foods, it can increase the risk of stunting in toddlers by 7.745 times greater than
129 families with diverse food consumption.

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130 Table 4 shows that there are still toddlers experiencing stunting with the highest proportion in the
131 group whose attendance at integrated service posts is less than <8 times, accounting for 56.3%. The
132 p-value in the statistical results is 0.916 (p-value > α), which means there is no relationship between
133 toddler participation in integrated service posts and stunting.

134 Table 5 above shows that 40 toddlers experienced stunting, of which 36 had a history of infectious
135 diseases with a proportion of 53.75%. The p-value generated from statistical calculations is 0.637,
136 which means there is no relationship between the history of infectious diseases in toddlers during the
137 last month and stunting.

138 *C. Final Modeling Results*

139 From the table, it is found that the variable that enters the final modeling is Dietary Diversity. The
140 statistical results show that there is a relationship between the diversity of food consumed in the
141 family and stunting in toddlers. Other statistical results show a PR value of 7.745, meaning
142 consuming a monotonous diet in the family can affect the development of a toddler's height and can
143 cause the toddler to be classified as stunting 7.745 times more than families who consume diverse
144 foods.

145 *D. Calculation of Losses*

146 The results of the calculations performed using the appropriate formula are presented in table 7
147 below. The amount of income during the productive age (FV) is 128 million rupiahs. The economic
148 value until the child reaches retirement age (FVA) is 9.402 billion rupiahs. The potential economic
149 value of the child at the age of 0 (PV) is 2.284 billion rupiahs. The amount of productivity loss due
150 to stunting (PPEM) is 8.498 billion rupiahs.

151 However, according to Horton (1999), individuals who experience malnutrition problems will
152 experience a decrease in productivity of 2%-9%. Therefore, in table 8, the amount of losses caused
153 by a 2% and 9% decrease in productivity due to stunting in the calculation using the last formula is
154 Rp170 billion - Rp765 billion.

155

156 **DISCUSSION**

157 **A. Relationship between family economic status and stunting**

158 In this research, the economic status was measured using the household expenditure indicator for
159 food for one month. Previous research has shown that in developing countries, people usually use
160 their income to buy food. Subsequently, family economic status was divided into two categories,
161 namely low and high economic status.⁽¹⁰⁾

162 The results of the statistical test results showed that the economic status, as described by household
163 food expenditure was not significantly associated with the occurrence of stunting in toddlers in the
164 Pedamaran sub-district (p-value > 0.05). This result is different from previous research that also used
165 household food expenditure as an indicator of economic status, the results of statistical tests showed
166 that economic status as described by household food expenditure had a significant relationship with
167 the incidence of stunting in toddlers in Palembang City, to be precise at the 11th Public Health Center
168 Ilir (p-value > 0.031).⁽¹¹⁾ Then research conducted by Indrastuty and Pujiyanto, which reported a
169 significant relationship between family economic status and stunting in toddlers.^{(12),(13)}

170 Between economic status and stunting is that the amount of money spent by households is not
171 maximally used to buy high-quality food ingredients. Although families with higher food spending
172 may have more money, that doesn't necessarily mean more money is being used to buy more diverse
173 and higher-quality food for their children. The quality and quantity of food needed to meet nutritional
174 requirements cannot be met. Therefore, diversity is necessary because each food provides different
175 chemical elements needed by the body for growth and health.⁽¹⁴⁾

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176 **B. Diversity of Toddler Consumption (Dietary Diversity) with Stunting Incidents**

177 Toddlers' food consumption quality can be assessed through the variety of menus and food
178 ingredients they consume, which can be measured by the dietary diversity score (DDS).
179 Subsequently, an individual's dietary diversity score aims to reflect their nutritional adequacy, and
180 research across different age groups has shown that an increase in an individual's dietary diversity
181 score is associated with an increase in the nutritional adequacy of the food consumed.⁽¹⁵⁾

182 The chi-square test results show a significant relationship between dietary diversity and the incidence
183 of stunting in toddlers ($p \leq 0.05$). This result is consistent with a survey conducted by Ruel and
184 Arimond in 11 countries, which showed a relationship between dietary diversity and nutritional status
185 measured by weight-for-length/height (TB/U) in children aged 6-23 months. In addition to this
186 research, other findings from Faiqoh, Suyatno, and Kartini indicate a significant relationship between
187 dietary diversity and the incidence of stunting in toddlers aged 24-59 months.⁽¹⁶⁾

188 Food consumption is a crucial factor in determining a person's nutritional status, as it involves the
189 types and amounts of food an individual or a group consumes at a specific time.^{(17),(18)} The quality of
190 the diet can be determined by the diversity of consumption since various nutritional needs can be met
191 through a variety of foods.⁽¹⁹⁾

192 **C. The Relationship between Toddler Participation in Integrated Healthcare Center and**
193 **Stunting**

194 Madanijah and Triana grouped the mothers of toddler's participation in integrated health posts into
195 four categories, based on attendance, activity, use of the Towards Health Card (KMS), and efforts to
196 develop the integrated health posts such as providing funding, facilities, personnel, and time, as well
197 as providing food or supplementary feeding.⁽²⁰⁾

198 The statistical test results showed that there was no relationship between toddler participation in
199 integrated health posts and the incidence of stunting in the Pedamaran sub-district. This research is
200 consistent with an investigation conducted by Wahyuningtyas, which found no relationship between
201 maternal perception of Integrated Healthcare Center and toddler participation in Integrated
202 Healthcare Center with the incidence of stunting in toddlers in Gilingan Surakarta.⁽¹⁷⁾ Furthermore,
203 research by Rarastiti found no relationship between the frequency of toddler visits to the Integrated
204 Healthcare Center and their nutritional status.⁽¹⁹⁾ This research is not in line with an investigation
205 conducted by Anggraeni, which found a significant relationship between family activity in Integrated
206 Healthcare Center activities and the nutritional status of toddlers.⁽²¹⁾

207 The lack of correlation between toddlers' participation in the Integrated Healthcare Center and the
208 occurrence of stunting may be due to suboptimal utilization of the Integrated Healthcare Center.
209 Furthermore, Fitri stated that Integrated Healthcare Center is one of the good approaches to reducing
210 morbidity or mortality in children and improving the nutritional status of toddlers.⁽²²⁾

211 **D. Correlation between History of Disease Infection and Incidence of Stunting**

212 Infectious disease is a direct cause of nutritional problems, and its presence in a child's body can have
213 an impact on the nutritional status. The results of statistical tests conducted show no relationship
214 between the history of infectious diseases and the occurrence of stunting in children in the Pedamaran
215 Sub-district. This research is different from the results of the previous investigation conducted by
216 Soekirman, which showed that infectious diseases are one of the factors associated with stunting.⁽⁵⁾
217 Subsequently, diarrheal diseases among children also contribute to the incidence of stunting in some
218 African countries, such as Libya.⁽²³⁾

219 These results showed a negative correlation, which could be because the infectious diseases surveyed
220 only covered the past month, which may not necessarily represent the infectious diseases that the
221 children in Pedamaran have experienced. Subsequently, Nirmalasari stated that stunting is the result

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222 of a combination of poor quality consumption, morbidity, infectious diseases, and environmental
223 problems over a long or chronic period.⁽²⁴⁾

224 **E. Potential Economic Losses Due to Stunting**

225 The loss of economic potential due to stunting in toddlers in Ogan Komering Ilir Regency, when they
226 are adults and experience a loss of productivity of 2% was IDR 170 billion, while a 9% productivity
227 loss was IDR 765 billion. Looking at this as a percentage of GDP, the loss of economic potential due
228 to a 2% and 9% drop in productivity was about 0.67% - 3.03%.

229 Renyoet stated that the economic losses caused by stunting in toddlers cannot be fully calculated yet
230 because the calculation does not include the cost of treatment due to infectious diseases that occur in
231 stunted toddlers, as well as the cost of premature death caused by non-communicable or other
232 diseases caused by stunting.⁽⁵⁾

233 Every newborn baby is a potential human resource that has its economic productivity value.
234 Meanwhile, high birth rates and increasing numbers of stunted children can lead to high potential
235 economic losses as well. According to Freijer, the total additional cost for malnutrition-related adult
236 patients was estimated at 1.9 billion euros in 2011, which is equivalent to 2.1% of the total national
237 healthcare expenditure in the Netherlands and 4.9% of the total healthcare sector costs.⁽²³⁾ A meta-
238 analysis of 45 longitudinal studies in the United States shows that there is a significant relationship
239 between height and career success and salary in the work environment. A person who is six feet (1.82
240 m) on average earns a salary over a 30-year career of about \$166,000 more than someone who is five
241 feet five inches (1.55 m) tall. This shows that a person's height affects the type of work, income, and
242 work productivity.^{(5),(25)}

243

244 **CONCLUSION**

245 In conclusion, the study found that stunting was a prevalent issue in the Pedamaran Sub-district, with
246 a rate of 51.9% in toddlers aged 12-35 months. Meanwhile, the results showed that there was a
247 relationship between dietary diversity and the incidence of stunting (p-value=0.0001; PR=2.705-
248 22.175). There was no significant relationship between other factors such as economic status (p-
249 value=0.854), participation of toddlers in integrated health posts (p-value=0.916), and history of
250 infectious diseases (p-value=0.637) and the relationship with the incidence of stunting. Therefore,
251 the most dominant factor related to stunting was dietary diversity. There were economic losses
252 caused by decreased productivity of 2% and 9% due to stunting, amounting to IDR 170 billion and
253 IDR 765 billion, respectively, or 0.67% - 3.03% of the 2017 OKI GRDP.

254 **ACKNOWLEDGMENTS**

255 We would like to acknowledge all respondents who contribution in this study and Ogan Komering
256 Ilir Regency.

257 **AUTHOR CONTRIBUTION**

258 Study design: AR, ANR

259 Data analysis: AR, ANR

260 Manuscript writing and revisions for
261 important content: AR, ANR

262 **CONFLICT OF INTEREST**

263 There are no conflicts of interest associated with this publication.

264

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Table 1. Frequency Distribution of Univariate Results

No	Variable	N	%
1	Stunting	40	51.9
	Normal	37	48.1
2	Economic Status		
	Low (< Rp 1.923.857,-)	46	59.7
	High (≥ Rp 1.923.857,-)	31	40.3
3	<i>Dietary Diversity</i>		
	Undifferentiated Consumption	47	61.0
	Diverse Consumption	30	39.0
4	Toddler Participation in Posyandu		
	Not Good (<8x)	16	20.8
	Good (≥ 8x)	61	79.2
5	History of infection		
	Yes	67	87.0
	No	10	13.0

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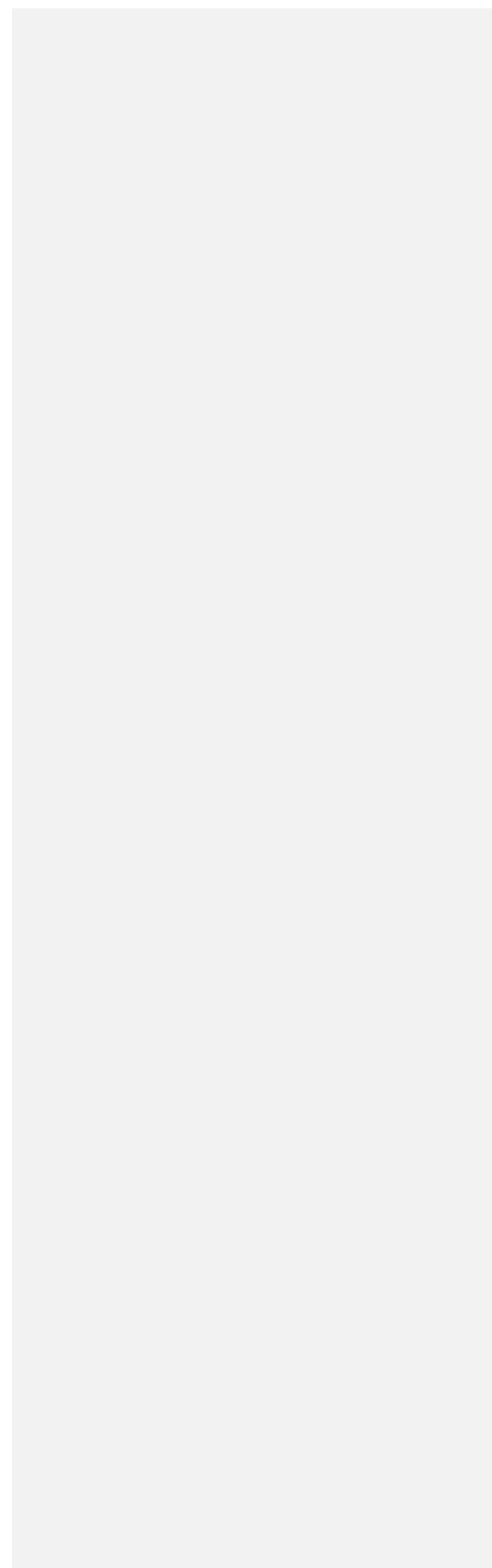
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**Table 2. Relationship between Economic Status
(Household Food Expenditures) and Stunting**

Economic Status	TB/U Nutritional Status				N	p-value	PR 95% CI
	Stunting		Normal				
	n	%	n	%			
Low	23	50.0	23	50.0	46	0.854	0.824 (0.330 – 2.053)
High	17	54.8	14	45.2	31		

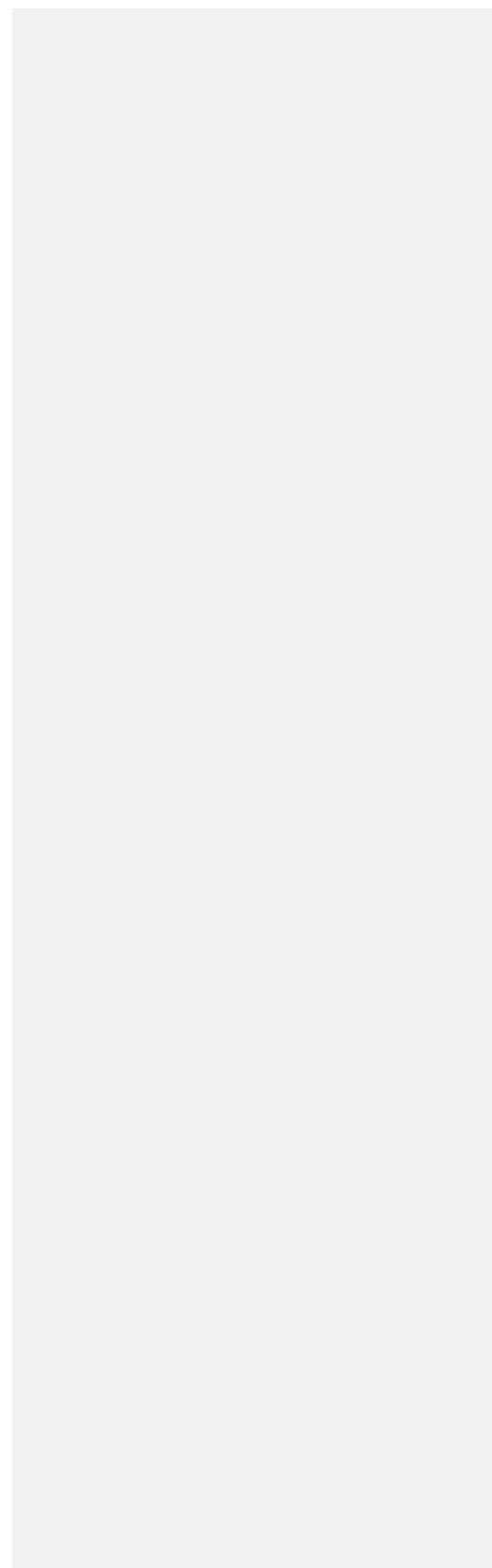
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Table 3. Relationship between Dietary Diversity and Stunting

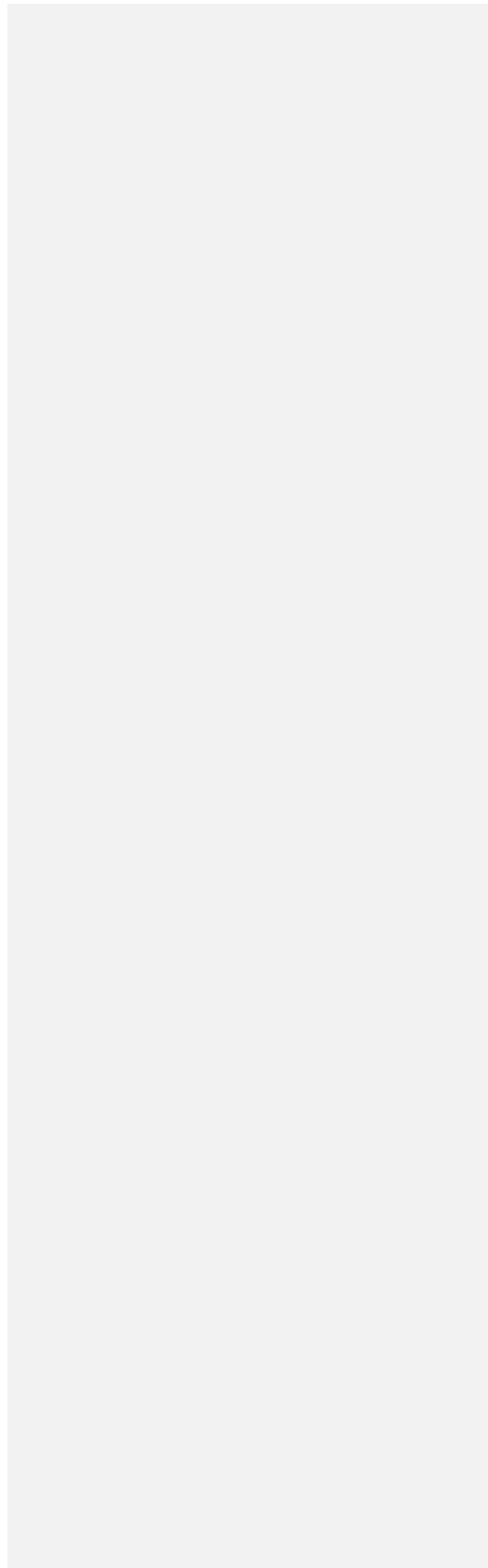
<i>Dietary Diversity</i>	Status Gizi TB/U				N	p-value	PR 95% CI
	Stunting		Normal				
	n	%	n	%			
Consumption does not vary	33	70.2	14	29.8	47	0.000	7.745
Various consumption	7	23.3	23	76.7	30	1	(2.705 – 22.175)



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Table 4. Relationship between Toddler Participation in Integrated Service Post and Stunting

Toddler participation in integrated service post	TB/U Nutritional Status				N	p-value	PR 95% CI
	Stunting		Normal				
	n	%	n	%			
Not Good	9	56.3	7	43.7	16	0.916	1.244 (0.411 – 3.768)
Good	31	50.8	30	49.2	61		



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Table 5. Relationship between History of Disease Infection and Stunting

History of infection	TB/U Nutritional Status				N	P-value	PR 95% CI
	Stunting		Normal				
	n	%	n	%			
Ya	36	53.7	31	46.3	67	0.637	1.742 (0.450 – 6.741)
Tidak	4	40.0	6	60.0	10		

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498 **Table 6. Final Multivariate Modeling Results (final model)**

Variable	p-value	PR Crude	95% CI	
			Min	Max
<i>Dietary Diversity</i>	0.00001	7.745	2.705	22.175

499
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503 **Original Research**

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505 **Potential Economic Losses Due to Stunting in Toddlers In Ogan**
506 **Komering Ilir Regency**

507
508 **ABSTRACT**

509 Stunting is a chronic condition that arises due to nutritional deficiencies during pre- and postpartum
510 periods. It is a significant public health issue in Indonesia, with a prevalence of approximately 29.6%
511 nationwide and about 22.6% in Ogan Komering Ilir Regency. Therefore, this research aimed to
512 identify the risk factors associated with stunting in toddlers aged 12-35 months and calculate the
513 economic losses incurred by this condition. To achieve this, a cross-sectional design was employed,
514 and a sample of 77 toddlers was selected through simple random sampling. Data was collected using
515 questionnaires, and calculations based on the Konig 1995 and Horton 1999 formulas were used to
516 analyze the Gross Regional Domestic Product (GRDP) per capita. The research found that stunting
517 had a prevalence rate of 51.9% in toddlers. Additionally, the research identified that dietary diversity
518 was significantly related to the occurrence of stunting with a p-value of 0.0001 and was identified as
519 the most dominant factor, whereas economic status, toddler participation, and history of infectious
520 diseases were not significantly related to stunting with a p-value > α . The study also estimated the
521 potential economic losses incurred by stunting, which amounted to IDR 170 billion and IDR 765
522 billion, respectively, or 0.67%-3.03% of OKI's GRDP, resulting from a 2% and 9% decrease in
523 productivity. Hence, this research suggests that food consumption diversity is the most dominant
524 factor significantly related to stunting in toddlers in Ogan Komering Ilir Regency.

525 **Keywords:** Economic Losses, Nutritional Status, Risk Factors, Stunting, Toddlers.

526 **INTRODUCTION**

527 Stunting is a long-term condition caused by poor healthcare and nutritional problems during the
528 prenatal and postnatal periods (1). This accumulation effect can lead to increased mortality rates,
529 motor development disorders, bodily function imbalances, and cognitive impairments in children (2).
530 Children who experience stunting after the age of two have their body growth hindered, and their
531 potential for growth is not maximized until they reach adolescence or adulthood. Even if growth
532 occurs, it will not be in height, but rather in width. The impact of stunting goes beyond physical
533 growth and can have detrimental effects on health resilience, development, and productivity due to
534 linear growth disturbances (3).

535 According to estimates from the World Bank, cases of malnutrition in the community result in a
536 2.5% loss in Gross Domestic Product (4). Furthermore, there is a negative correlation between the
537 Gross Regional Domestic Product (GRDP) per capita and the prevalence of malnutrition in toddlers.
538 This means that the higher the value of GRDP per capita in an area, the lower the prevalence of

Commented [A13]: Pada metode sebaiknya dijelaskan populasinya siapa dan besar populasinya

539 malnutrition (5). This is because a large GRDP value indicates a large economic resource capacity
540 and vice versa (6).

541 According to the 2017 Nutritional Status Monitoring (NSM), the prevalence of stunting in toddlers
542 decreased from 37.2% in 2013 to 29.6% but increased from 27.5% in 2016. The prevalence of
543 stunting in toddlers in South Sumatra province is 22.8%. Furthermore, the NSM report shows that
544 there are 12 Sub-district in South Sumatra province still in the acute-chronic category, with more
545 than 20% of toddlers experiencing stunting (7). Therefore, this research aims to identify the risk
546 factors associated with stunting in toddlers aged 12-35 months in Pedamaran Sub-district and the
547 economic losses incurred by the Ogan Komering Ilir (OKI) Regency.

548 **METHOD**

549 Research Design

550 This research was conducted using a cross-sectional design.

551 Research Subjects

552 The sample consisted of 77 mothers who had toddlers aged 12-35 months. Furthermore, the sampling
553 technique used was proportional stratified random sampling.

554 Data Collection/Materials and Tools

555 In this research, to calculate the economic losses secondary data was used including the Gross
556 Regional Domestic Product per capita of Ogan Komering Ilir Regency by field of work in 2017 (8),
557 the number of births and population by age group in 2017 OKI Regency (9), The benchmark interest
558 rate from Bank Indonesia, and the prevalence of stunting in Ogan Komering Ilir Regency. The data
559 collected was then analyzed using the Konig and Horton formula with the Microsoft Excel program.
560 The formula used for calculating the economic value of a child when they start to work is as follows:

$$561 \underline{FV_{[r,t]} = P_0 (1 + r)^t}$$

562 The large economic value until the child enters the retirement period was calculated using the
563 following formula:

$$564 \underline{FVA_{[r,t]} = \frac{FV_{[r,t]} [(1 + r)^t - 1]}{r}}$$

565 The potential economic value of a child at the age of 0 years was calculated using the following
566 formula:

$$567 \underline{PV_{[0]} = \frac{FVA_{[r,t]}}{(1 + r)^t}}$$

568 The magnitude of the lost productivity cost due to stunting was calculated using the following
569 formula:

$$570 \underline{P_{PEM} = Prev \times \sum BL \times PV_{[0]}}$$

571 Calculation of the magnitude of the economic loss due to stunting with the correction factor from
572 Horton, states that in actual conditions, the child can still recover and still has a productivity value
573 of less than 100%. Therefore, it will only experience a productivity loss of 2-9%. The following
574 formula is used:

$$575 \underline{P_{PEM} = f_{(cor)} \times Prev \times \sum BL \times PV_{[0]}}$$

Commented [A14]: Pada judul hanya menampilkan Potential Economic Losses, bagaimana dengan tujuan lainnya yaitu identify the risk factors associated with stunting in toddlers aged 12-35 months

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Commented [A17]: Sebaiknya disatukan didata collection tentang factor significantly related to stunting in toddlers ??

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Description:

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k. $FV_{[r,t]}$ = Income in productive age (15-64 years old).

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l. $FVA_{[r,t]}$ = Economic value until the child enters retirement age.

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m. $PV[0]$ = Child's economic potential at 0 years old.

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n. P_0 = PDRB per capita.

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o. r = Annual interest rate.

582

p. t = Years in productive age.

583

q. $PPEM$ = Potential economic loss due to stunting.

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r. $Prev$ = Prevalence of stunting.

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s. $\sum BL$ = Total births.

586

t. $f(\text{cor})$ = Correction factor (2% and 9%).

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Data Analysis

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The data analysis performed was univariate, bivariate, and multivariate. Bivariate analysis was

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performed using statistical tests and the Chi-Square test, while multivariate analysis was performed

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using the predictive logistic regression model test.

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RESULT

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Family and Sample Characteristics

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Family characteristics collected include descriptions of parents' education, occupation, and average

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age. Meanwhile, the characteristics of the sample include a description of the gender and the average

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age of the toddlers. The characteristics of the family indicate that the highest level of education for

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fathers was high school graduates, accounting for 33.8%, while 39% for mothers. Based on the

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parents' occupation, the majority of fathers work as self-employed/traders, accounting for 58%, while

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the majority of mothers are housewives/not working, accounting for 77.9%. The characteristics of

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the sample show that 50.6% of the boy and 49.4% are girl. The average age of the toddlers collected

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was 22 months.

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Characteristic Respondent

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In this research, the data in the table 1 shows that more than 50% of the toddlers examine fall under

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the category of stunted toddlers. Subsequently, of the families that participated, almost 60%, belong

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to the category with low economic status. In this research, there are more families with limited dietary

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diversity, accounting for 61%, compared to those with diverse diets. Almost 80% of the toddlers in

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the families examine have good habits of attending integrated service post programs. The results

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show that 87% of toddlers have a history of infectious diseases.

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Economic Losses

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Based on the analysis results, it was found that out of 46 toddlers from low-economic families, there

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was an equally balanced proportion of stunted and normal status. The statistical results of the

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bivariate analysis in the presented table above show that the economic status described by household

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food expenditure is not related to the occurrence of stunting in toddlers ($p\text{-value} > 0.05$).

613

614

Table 3 shows that the group of families with limited dietary diversity has the largest proportion of

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stunting in toddlers, accounting for about 70.2%. Meanwhile, in families with diverse diets, the

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largest proportion was reported in the influence on the normal toddler height. The statistical results

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show that the dietary diversity variable is related to the occurrence of stunting in toddlers in the

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Pedamaran sub-district, with a $p\text{-value}$ of 0.0001 ($p\text{-value} < \alpha$). Subsequently, diversity in food is a

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risk factor: PR 7.745 CI 95% 2.706-22.175, which means if a family consumes a limited variety of

620 foods, it can increase the risk of stunting in toddlers by 7.745 times greater than families with diverse
621 food consumption.

622 Table 4 shows that there are still toddlers experiencing stunting with the highest proportion in the
623 group whose attendance at integrated service posts is less than < 8 times, accounting for 56.3%. The
624 p-value in the statistical results is 0.916 (p-value > α), which means there is no relationship between
625 toddler participation in integrated service posts and stunting.

626 Table 5 shows that 40 toddlers experienced stunting, of which 36 had a history of infectious diseases
627 with a proportion of 53.75%. The p-value generated from statistical calculations is 0.637, which
628 means there is no relationship between the history of infectious diseases in toddlers during the last
629 month and stunting.

630 **Final Modeling Results**

631 From the table 3, it is found that the variable that enters the final modeling is Dietary Diversity. The
632 statistical results show that there is a relationship between the diversity of food consumed in the
633 family and stunting in toddlers. Other statistical results show a PR value of 7.745, meaning
634 consuming a monotonous diet in the family can affect the development of a toddler's height and can
635 cause the toddler to be classified as stunting 7.745 times more than families who consume diverse
636 foods.

637 **Calculation of Losses**

638 The results of the calculations performed using the appropriate formula are presented in table 7. The
639 amount of income during the productive age (FV) is 128 million rupiahs. The economic value until
640 the child reaches retirement age (FVA) is 9,402 billion rupiahs. The potential economic value of the
641 child at the age of 0 (PV) is 2,284 billion rupiahs. The amount of productivity loss due to stunting
642 (PPEM) is 8,498 billion rupiahs.

643 However, according to Horton (1999), individuals who experience malnutrition problems will
644 experience a decrease in productivity of 2%-9%. Therefore, in table 8, the amount of losses caused
645 by a 2% and 9% decrease in productivity due to stunting in the calculation using the last formula is
646 Rp170 billion – Rp765 billion.

647 **DISCUSSION**

648 **Relationship between family economic status and stunting**

649 In this research, the economic status was measured using the household expenditure indicator for
650 food for one month. Previous research has shown that in developing countries, people usually use
651 their income to buy food. Subsequently, family economic status was divided into two categories,
652 namely low and high economic status (10).

653 The results of the statistical test results showed that the economic status, as described by household
654 food expenditure was not significantly associated with the occurrence of stunting in toddlers in the
655 Pedamaran sub-district (p-value > 0.05). This result is different from previous research that also used
656 household food expenditure as an indicator of economic status, the results of statistical tests showed
657 that economic status as described by household food expenditure had a significant relationship with
658 the incidence of stunting in toddlers in Palembang City, to be precise at the 11th Public Health Center
659 Iilir (p-value > 0.031) (11). Then research conducted by Indrastuty and Pujiyanto, which reported a
660 significant relationship between family economic status and stunting in toddlers (12,13).

661 Between economic status and stunting is that the amount of money spent by households is not
662 maximally used to buy high-quality food ingredients. Although families with higher food spending
663 may have more money, that doesn't necessarily mean more money is being used to buy more diverse
664 and higher-quality food for their children. The quality and quantity of food needed to meet nutritional

665 requirements cannot be met. Therefore, diversity is necessary because each food provides different
666 chemical elements needed by the body for growth and health (14).

667 **Diversity of Toddler Consumption (Dietary Diversity) with Stunting Incidents**

668 Toddlers' food consumption quality can be assessed through the variety of menus and food
669 ingredients they consume, which can be measured by the dietary diversity score (DDS).
670 Subsequently, an individual's dietary diversity score aims to reflect their nutritional adequacy, and
671 research across different age groups has shown that an increase in an individual's dietary diversity
672 score is associated with an increase in the nutritional adequacy of the food consumed (15).

673 The chi-square test results show a significant relationship between dietary diversity and the incidence
674 of stunting in toddlers ($p < 0.05$). This result is consistent with a survey conducted by Ruel and
675 Arimond in 11 countries, which showed a relationship between dietary diversity and nutritional status
676 measured by weight-for-length/height (TB/U) in children aged 6-23 months. In addition to this
677 research, other findings from Faiqoh, Suyatno, and Kartini indicate a significant relationship between
678 dietary diversity and the incidence of stunting in toddlers aged 24-59 months (16).

679 Food consumption is a crucial factor in determining a person's nutritional status, as it involves the
680 types and amounts of food an individual or a group consumes at a specific time (17,18). The quality
681 of the diet can be determined by the diversity of consumption since various nutritional needs can be
682 met through a variety of foods (19).

683 **The Relationship between Toddler Participation in Integrated Healthcare Center and Stunting**

684 Madanijah and Triana grouped the mothers of toddler's participation in integrated health posts into
685 four categories, based on attendance, activity, use of the Towards Health Card (KMS), and efforts to
686 develop the integrated health posts such as providing funding, facilities, personnel, and time, as well
687 as providing food or supplementary feeding (20).

688 The statistical test results showed that there was no relationship between toddler participation in
689 integrated health posts and the incidence of stunting in the Pedamaran sub-district. This research is
690 consistent with an investigation conducted by Wahyuningtyas, which found no relationship between
691 maternal perception of Integrated Healthcare Center and toddler participation in Integrated
692 Healthcare Center with the incidence of stunting in toddlers in Gilingan Surakarta (17). Furthermore,
693 research by Rarastiti found no relationship between the frequency of toddler visits to the Integrated
694 Healthcare Center and their nutritional status (19). This research is not in line with an investigation
695 conducted by Anggraeni, which found a significant relationship between family activity in Integrated
696 Healthcare Center activities and the nutritional status of toddlers (21).

697 The lack of correlation between toddlers' participation in the Integrated Healthcare Center and the
698 occurrence of stunting may be due to suboptimal utilization of the Integrated Healthcare Center.
699 Furthermore, Fitri stated that Integrated Healthcare Center is one of the good approaches to reducing
700 morbidity or mortality in children and improving the nutritional status of toddlers (22).

701 **Correlation between History of Disease Infection and Incidence of Stunting**

702 Infectious disease is a direct cause of nutritional problems, and its presence in a child's body can have
703 an impact on the nutritional status. The results of statistical tests conducted show no relationship
704 between the history of infectious diseases and the occurrence of stunting in children in the Pedamaran
705 Sub-district. This research is different from the results of the previous investigation conducted by
706 Soekirman, which showed that infectious diseases are one of the factors associated with stunting (5).
707 Subsequently, diarrheal diseases among children also contribute to the incidence of stunting in some
708 African countries, such as Libya (23).

709 These results showed a negative correlation, which could be because the infectious diseases surveyed
710 only covered the past month, which may not necessarily represent the infectious diseases that the
711 children in Pedamaran have experienced. Subsequently, Nirmalasari stated that stunting is the result

712 of a combination of poor quality consumption, morbidity, infectious diseases, and environmental
713 problems over a long or chronic period (24).

714 **Potential Economic Losses Due to Stunting**

715 The loss of economic potential due to stunting in toddlers in Ogan Komering Ilir Regency, when they
716 are adults and experience a loss of productivity of 2% was IDR 170 billion, while a 9% productivity
717 loss was IDR 765 billion. Looking at this as a percentage of GDP, the loss of economic potential due
718 to a 2% and 9% drop in productivity was about 0.67%-3.03%.

719 Renyoet stated that the economic losses caused by stunting in toddlers cannot be fully calculated yet
720 because the calculation does not include the cost of treatment due to infectious diseases that occur in
721 stunted toddlers, as well as the cost of premature death caused by non-communicable or other
722 diseases caused by stunting (5).

723 Every newborn baby is a potential human resource that has its economic productivity value.
724 Meanwhile, high birth rates and increasing numbers of stunted children can lead to high potential
725 economic losses as well. According to Freijer, the total additional cost for malnutrition-related adult
726 patients was estimated at 1.9 billion euros in 2011, which is equivalent to 2.1% of the total national
727 healthcare expenditure in the Netherlands and 4.9% of the total healthcare sector costs (23). A meta-
728 analysis of 45 longitudinal studies in the United States shows that there is a significant relationship
729 between height and career success and salary in the work environment. A person who is six feet (1.82
730 m) on average earns a salary over a 30-year career of about \$166,000 more than someone who is five
731 feet five inches (1.55 m) tall. This shows that a person's height affects the type of work, income, and
732 work productivity (5,25).

733 **CONCLUSION**

734 In conclusion, the study found that stunting was a prevalent issue in the Pedamaran Sub-district, with
735 a rate of 51.9% in toddlers aged 12-35 months. Meanwhile, the results showed that there was a
736 relationship between dietary diversity and the incidence of stunting (p-value = 0.0001; PR = 2.705-
737 22.175). There was no significant relationship between other factors such as economic status (p-
738 value = 0.854), participation of toddlers in integrated health posts (p-value = 0.916), and history of
739 infectious diseases (p-value = 0.637) and the relationship with the incidence of stunting. Therefore,
740 the most dominant factor related to stunting was dietary diversity. There were economic losses
741 caused by decreased productivity of 2% and 9% due to stunting, amounting to IDR 170 billion and
742 IDR 765 billion, respectively, or 0.67%-3.03% of the 2017 OKI GRDP.

743 **Author Contributions:**

744 ANR and AR in this study have a role in designing research and data analysis. Then ANR and AR
745 also has the role of writing manuscripts and revisions for important content.

746 **Declaration of Conflict of Interest:**

747 There are no conflicts of interest associated with this publication.

748 **Funding:**

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753 Komering Ilir District.

754 **Ethics clearance**

755 This study was ethically approved by Health Research Ethics Committee Faculty of Public Health
756 Sriwijaya University, with number: 75/UN9.1.10/KKE/2019.
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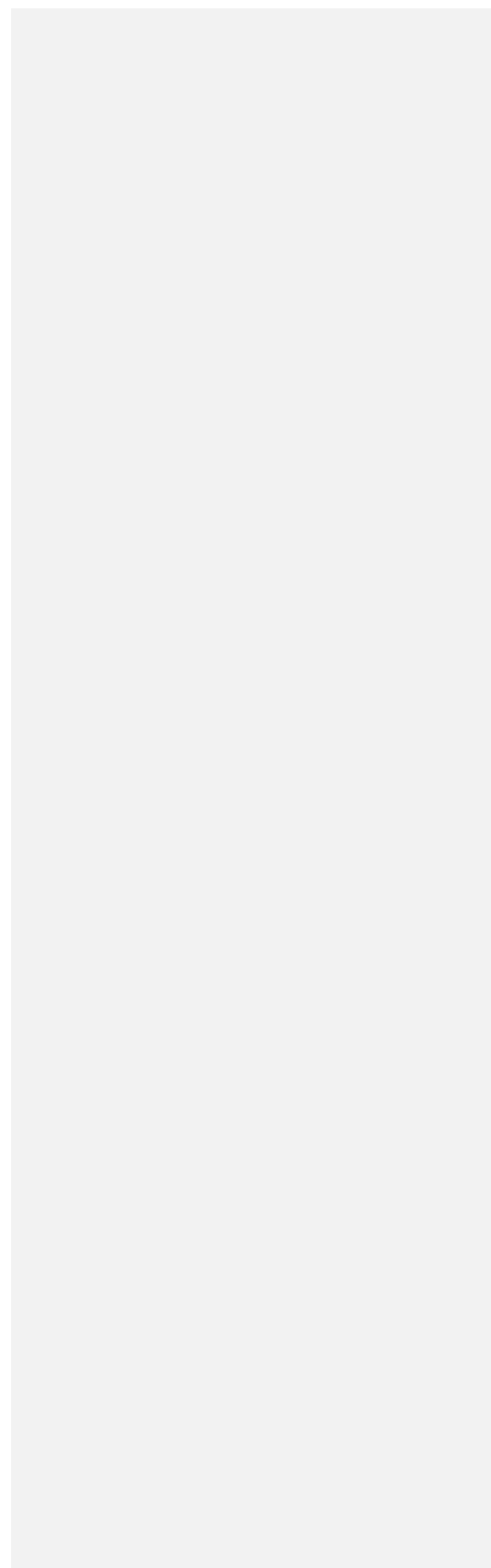
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Table 1. Frequency Distribution of Univariate Results

No	Variable	N	%
1	Stunting		
	Stunting	40	51.9
	Normal	37	48.1
2	Economic Status		
	Low (< Rp 1.923.857.-)	46	59.7
	High (> Rp 1.923.857.-)	31	40.3
3	Dietary Diversity		
	Undifferentiated Consumption	47	61.0
	Diverse Consumption	30	39.0
4	Toddler Participation in Posyandu		
	Not Good (<8x)	16	20.8
	Good (> 8x)	61	79.2
5	History of infection		
	Yes	67	87.0
	No	10	13.0

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Table 2. Relationship between Economic Status (Household Food Expenditures) and Stunting

Economic Status	TB/U Nutritional Status				N	p-value	PR 95% CI
	Stunting		Normal				
	n	%	n	%			
Low	23	50.0	23	50.0	46	0.854	0.824
High	17	54.8	14	45.2	31		(0.330 – 2.053)

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Table 3. Relationship between Dietary Diversity and Stunting

<i>Dietary Diversity</i>	<i>Status Gizi TB/U</i>				<i>N</i>	<i>p-value</i>	<i>PR 95% CI</i>
	<i>Stunting</i>		<i>Normal</i>				
	<i>n</i>	<i>%</i>	<i>n</i>	<i>%</i>			
<i>Consumption does not vary</i>	33	70.2	14	29.8	47	0.000	7.745
<i>Various consumption</i>	7	23.3	23	76.7	30	1	(2.705 – 22.175)

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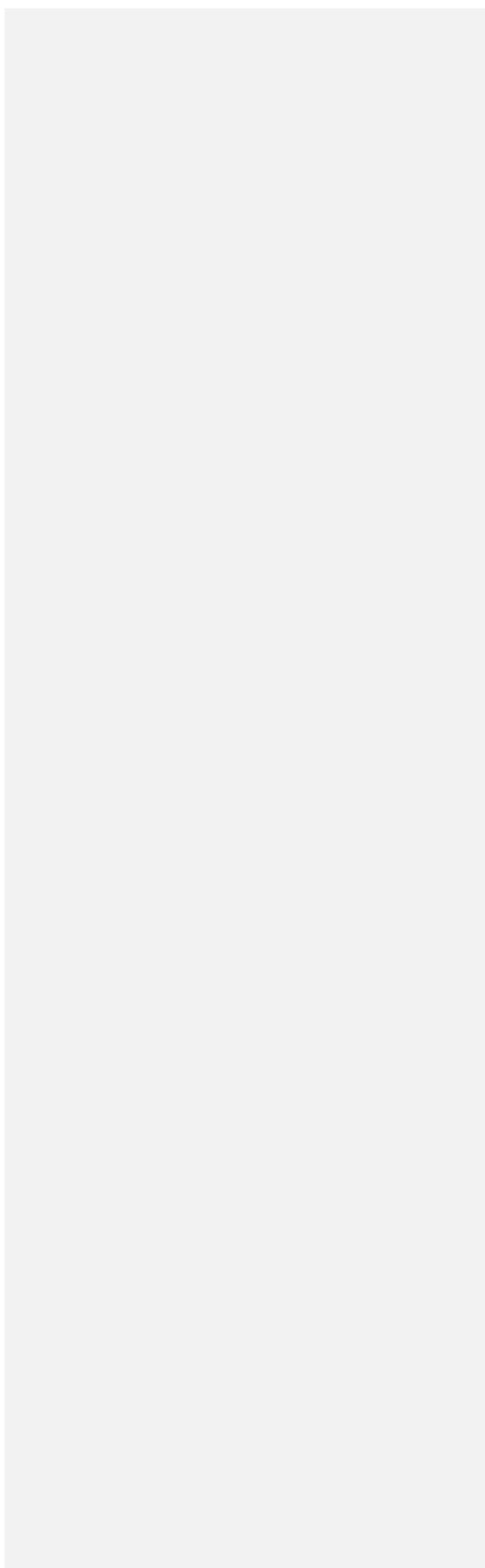
Table 4. Relationship between Toddler Participation in Integrated Service Post and Stunting

Toddler participation in integrated service post	TB/U Nutritional Status				N	p-value	PR 95% CI
	Stunting		Normal				
	n	%	n	%			
Not Good	9	56.3	7	43.7	16	0.916	1.244
Good	31	50.8	30	49.2	61		(0.411 – 3.768)

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Table 5. Relationship between History of Disease Infection and Stunting

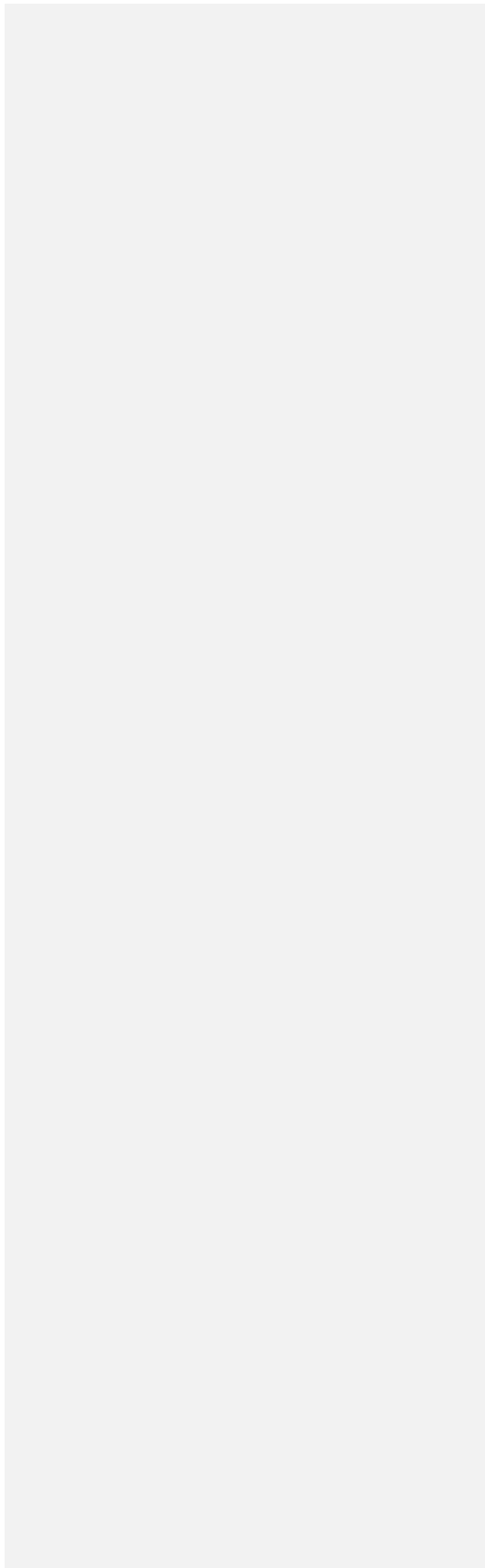
History of infection	TB/U Nutritional Status		N	p-value	PR 95% CI
	Stunting	Normal			
	n	%	n	%	
Ya	36	53.7	31	46.3	67
Tidak	4	40.0	6	60.0	10



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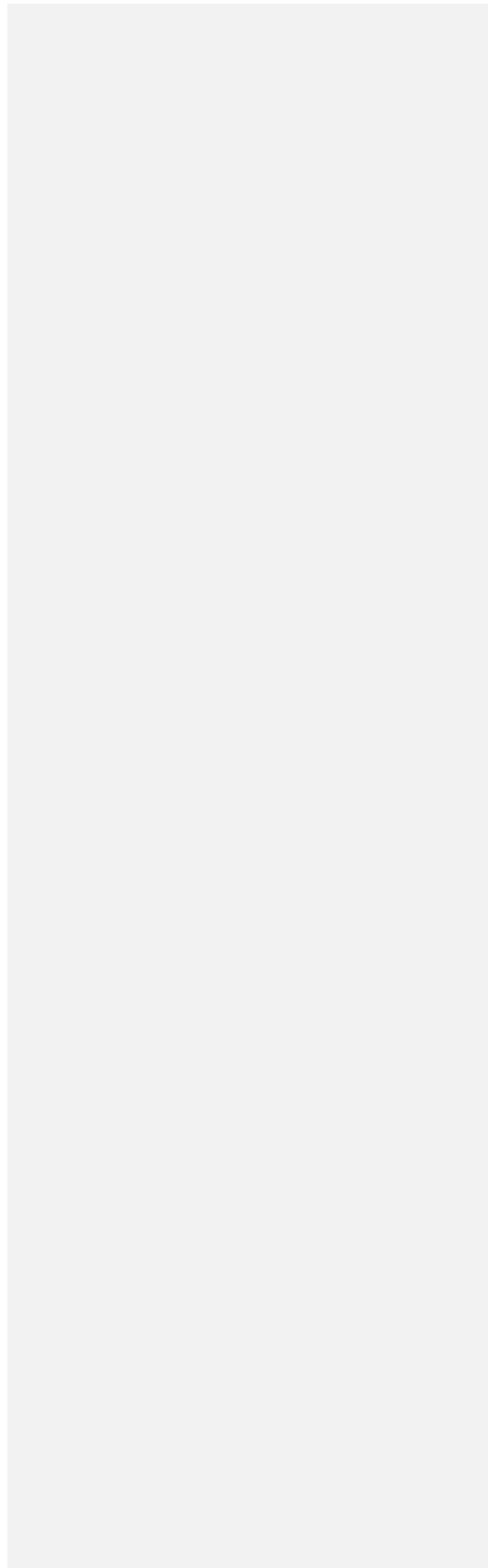
Table 6. Final Multivariate Modeling Results (final model)

Variable	p-value	PR Crude	95% CI	
			Min	Max
<i>Dietary Diversity</i>	<u>0.00001</u>	<u>7.745</u>	<u>2.705</u>	<u>22.175</u>



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<u>Formula Variables</u>	<u>Yield (Billion Rupiah)</u>
<u>FV</u>	<u>0.128</u>
<u>FVA</u>	<u>9.402</u>
<u>PV</u>	<u>2.284</u>
<u>PPem</u>	<u>8.498</u>



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Table 8. Potential Economic Losses due to Stunting in Ogan Komering Ilir Regency

Regency	2%	9%	%PDRB	
	(Billion rupiah)	(Billion rupiah)	2%	9%
Ogan Komering Ilir	170	765	0.67	3.03

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Table 7. Formula Calculation Results

Formula Variables	Yield (Billion Rupiah)
FV	0.128
FVA	9.402
PV	2.284
PPem	8.498

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Table 8. Potential Economic Losses due to Stunting in Ogan Komering Ilir Regency

Regency	2%	9%	%PDRB	
	(Billion rupiah)	(Billion rupiah)	2%	9%
Ogan Komering Ilir	170	765	0.67	3.03

BUKTI KORESPONDENSI ANITA RAHMIWATI JURNAL IJHN SINTA 2

This paper explore about stunting and estimation in economic cost impact, some revisions are needed to improve its readability.

Introduction: please give brief context to establish the importance of the issue & relevant to your study. please focused on how your study might add to the sum of scientific knowledge and better health policy or practice.

Methods: please describe the study design containing enough detail to allow another scientist to repeat your study, including the analysis. Give information about population inclusion and exclusion criteria sample frame, Sampling procedures. Give information about sample size calculations (effect, power). Describe the definition of variables that you used. Describe Data management.

Discuss Please add some information below:

One sentence repetition of "why this study "summary of principle findings in one paragraph. Headline message comparison with previous work. Give specific recommendations for further work: implications for policy/ practice Describe the limitations of the study, taking into account sources of potential bias or imprecision. Discuss both the direction and magnitude of any potential bias in the discussion section.please describe your limitation.

The conclusion should be concise and emphasize the relevance of the findings for This paper explore about stunting and estimation in economic cost impact, some revisions are needed to improve its readability.

Introduction: please give brief context to establish the importance of the issue & relevant to your study. please focused on how your study might add to the sum of scientific knowledge and better health policy or practice.

Methods: please describe the study design containing enough detail to allow another scientist to repeat your study, including the analysis. Give information about population inclusion and exclusion criteria sample frame, Sampling procedures. Give information about sample size calculations (effect, power). Describe the definition of variables that you used. Describe Data management.

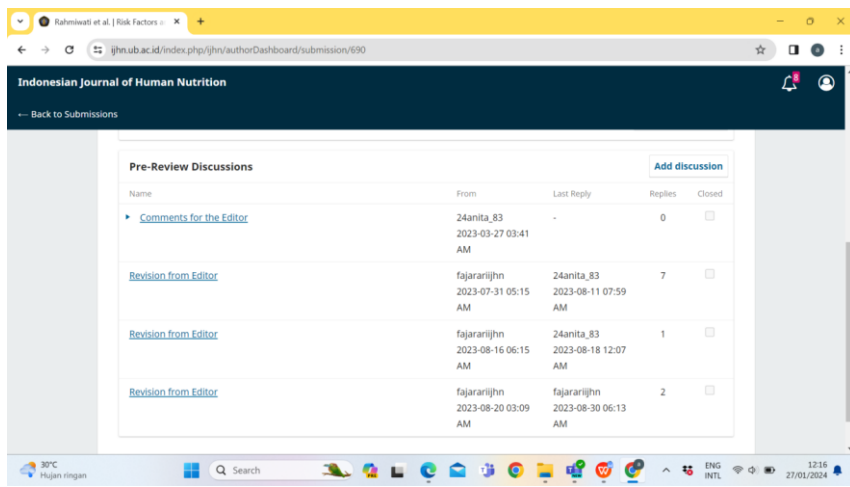
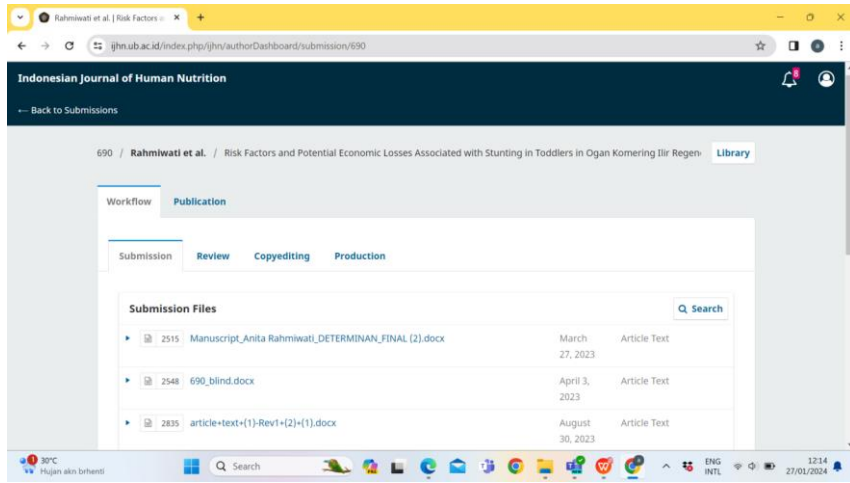
Discuss Please add some information below:

One sentence repetition of "why this study "summary of principle findings in one paragraph. Headline message comparison with previous work. Give specific recommendations for further work: implications for policy/ practice. Describe the limitations of the study, taking into account sources of potential bias or imprecision. Discuss both the direction and magnitude of any potential bias in the discussion section.please describe your limitation.

The conclusion should be concise and emphasize the relevance of the findings for an Indonesian Journal of Human Nutrition audience

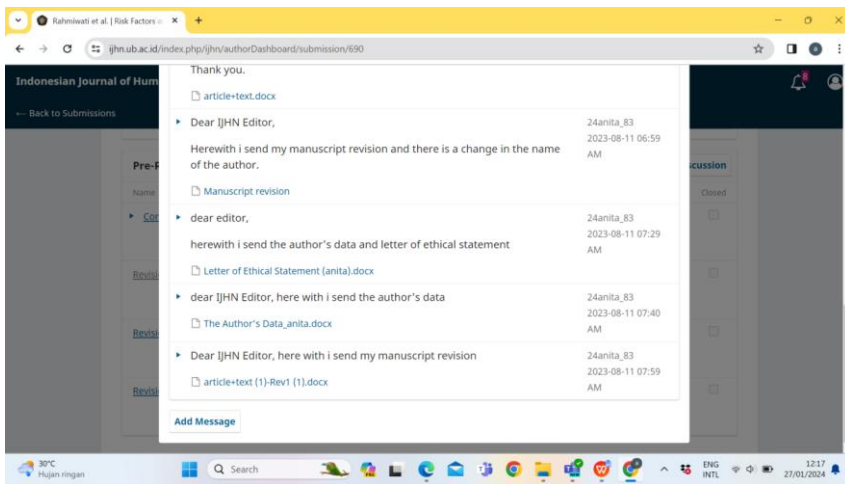
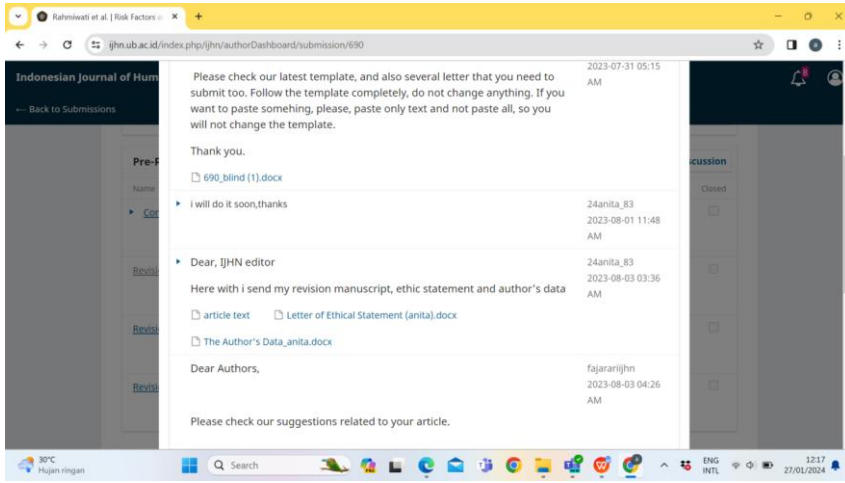
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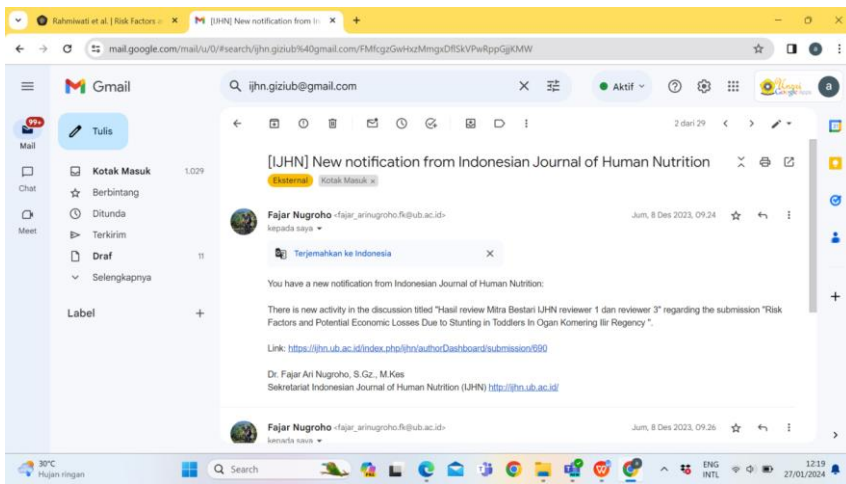
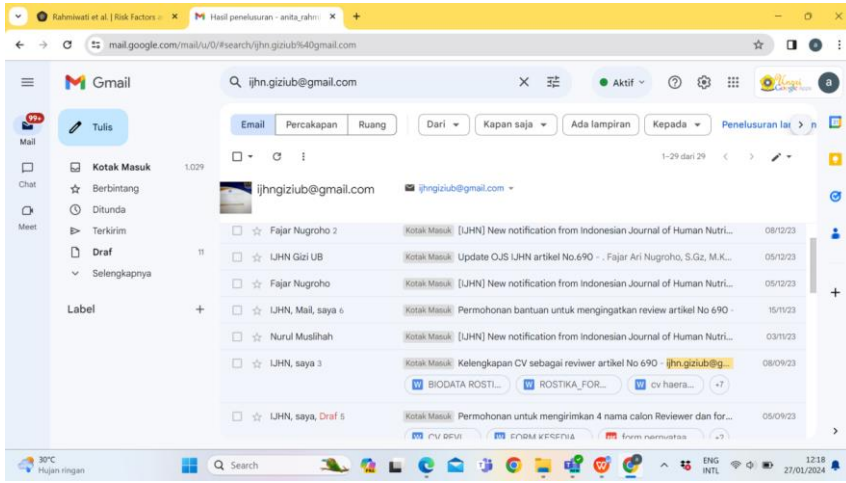
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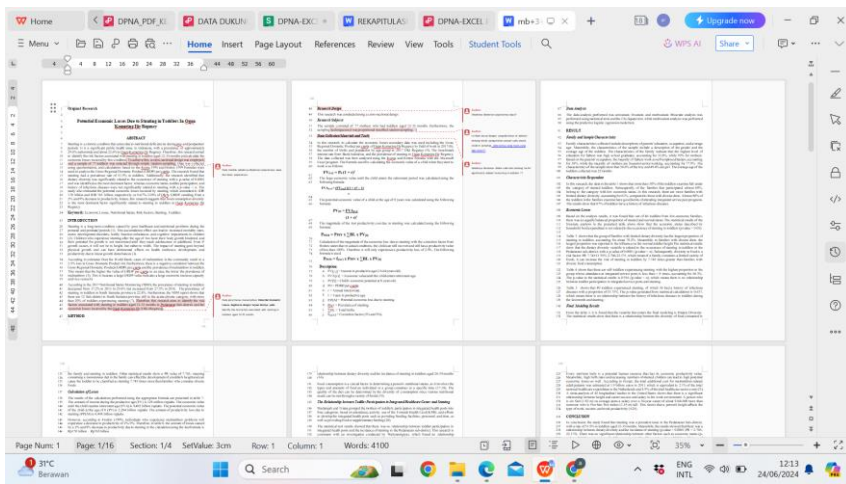
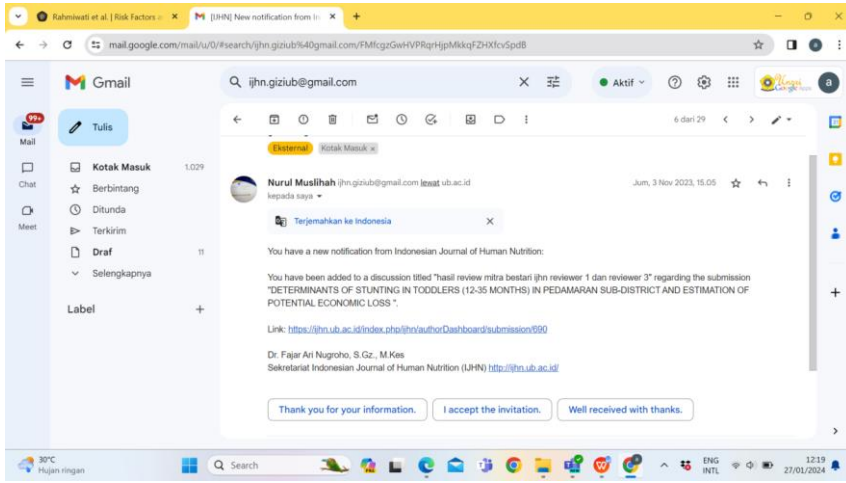
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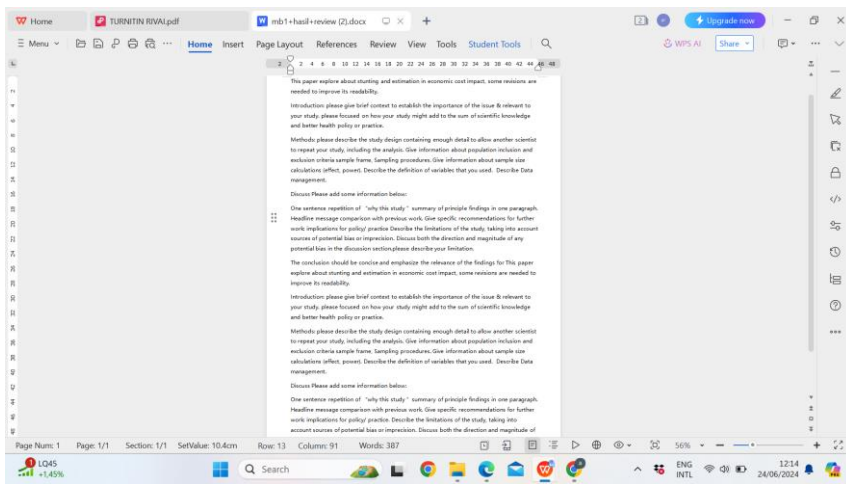
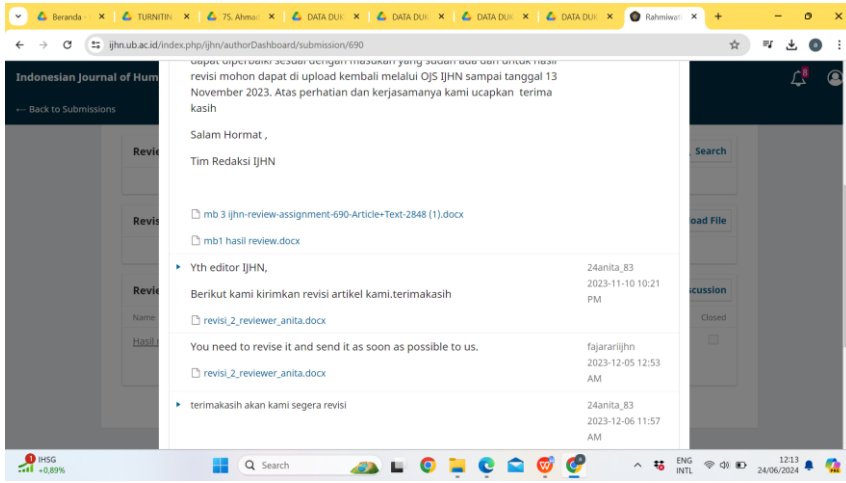
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