Eduvest - Journal of Universal Studies
Volume 4 Number 11, November, 2024
p- ISSN 2775-3735- e-ISSN 2775-3727

THE IMPACT OF USING CLEAN FUEL ON THE RISK OF STUNTING IN CHILDREN AGED 0-59 MONTHS

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ABSTRACT

Stunting is a critical global health challenge, particularly in developing nations, affecting children's physical, cognitive, and socioeconomic outcomes. This study investigates the impact of clean cooking fuel use on stunting risk among children aged 0–59 months in Indonesia, employing cross-sectional data from the 2014 Indonesian Family Life Survey (IFLS) and the Propensity Score Matching (PSM) method. The results reveal that households using clean cooking fuels, such as liquefied petroleum gas (LPG), significantly improve children's Height-for-Age Z-scores, reducing stunting risk. Factors including higher household education, income levels, and access to urban areas positively influence clean fuel adoption. The study underscores the importance of clean energy policies and increased awareness, particularly in rural areas, to mitigate health disparities and improve childhood growth outcomes. These findings contribute to the growing evidence linking clean energy transitions with enhanced public health and child development indicators.

KEYWORDS *Stunting, Clean Cooking Fuels, Child Health.*

INTRODUCTION

Stunting remains a significant health concern, with stunting associated with childhood infections, mortality, lower immunity, reduced cognitive function, and lower educational attainment. Long term effect of childhood growth retardation can be seen in height inappropriate for the child's age, increased risk of nutritional distortions and chronic diseases related to low immunity, as well as socioeconomic status in adulthood (Ranathunga et al., 2021). Stunted children have lower academic achievement levels than normal children (World Health Organization, 2000), impacting their productivity and socioeconomic status. In addition, stunting also inhibits cognitive growth, which

How to cite: Sakinah Rahma Firdaningtyas, Djoni Hartono (2024). The Impact of Using Clean Fuel on the Risk of Stunting in Children Aged 0-59 Months. *Journal Eduvest. 4* (11): 10162-10178
E-ISSN: 2775-3727

causes the child to experience a slowdown in learning ability, so stunted children are usually late to get education from an early age (Crookston et al., 2011).

In 2020, the global prevalence of stunting was recorded at around 149.2 million children under five years old, or 22 percent (World Health Organization, 2018). Stunting prevalence in Indonesia tends to fluctuate each year. The prevalence of stunting in Indonesia experienced an increasing trend in the 2010-2013 period of 37.6 percent, then decreased in the 2014-2018 period to reach a value of 30.8 percent. In 2021, Indonesian Nutrition Status Survey (SSGI) showed a decrease around 3.3 percent in prevalence from the previous year to 24.4 percent, and in 2022, it had a downward trend to 21.6 percent. Although Indonesia's stunting prevalence continues to decline every year, this figure is still a severe problem because the World Health Organization's standard regarding stunting prevalence is less than 20 percent (Indonesian Ministry of Health, 2022). The knowledge about the causes of *stunting* in children expecially under five years old is needed to end child *malnutrition/stunting*.

Children under the age of five tend to have vulnerable immune and respiratory systems, where continuous Exposure to air pollution during their growing years can lead to respiratory problems, immune disorders, lower body weight than typical children, shorter height at birth, or incomplete growth (Liang et al., 2020; Smith et al., 2014). In addition, there is an annual increase in premature deaths of children and women due to indoor air pollution resulting from the use of solid cooking fuels such as firewood, coal, charcoal, and kerosene (World Health Organization, 2022). Research conducted by Smith (2000) explains that the level of Exposure to households that do not have ventilation and use solid fuels will have an impact 10-50 times greater than if the household has good ventilation.

Considering the negative health impacts of solid cooking fuels, most countries worldwide are working to reduce the use of solid cooking fuels. The World Health Organization (WHO) has globally set the 7th Sustainable Development Goals (SDGs) target to ensure that clean, affordable, reliable, sustainable, and modern cooking fuels are universally accessible. In Indonesia, the government introduced a clean cooking fuel transition program, namely the kerosene to liquefied petroleum gas (LPG) conversion program that was carried out in stages starting in 2007, which had a high success rate in changing the habits of Indonesians to switch to cleaner cooking fuels. However, surveys conducted in Indonesia explain that 9 out of 10 households in Indonesia cook indoors; although most of household that using solid cooking fuels has been massively reduced due to the government's policies about clean energy transition program, there are still around 20 percent of households in Indonesia still using solid cooking fuels, especially in rural areas (Demographic and Health Survey, 2018).

Theoretically, indoor pollution caused by Exposure to solid cooking fuels can cause health and nutritional problems in children, which is explained by the causal potential of solid fuels to affect the occurrence of stunting in children. First, recurrent infections caused by direct exposure to harmful pollutants such as suspended particulates (PM2,5), small particulates (PM10) and carbon monoxide (CO) gas into the air are the result of incomplete combustion of solid fuels (González-Martín et al., 2021; Somanathan et al., 2022; Imelda, 2020). In addition, children who is under five years of age have immune systems that have not fully developed and susceptible to many pollutants (Schwartz. J, 2004). It can also be explained by how newborns or children under five are often held by their mothers while cooking or brought close to a warm fireplace. As a result, children under 5 years old spend much time breathing polluted air during the first year of life when their respiratory and immune systems are still vulnerable, making them more susceptible to recurrent infections resulting from direct exposure to harmful pollutants. In addition, using clean cooking fuels can improve the quality of indoor air, boosting child's immune systems then reducing the risk of stunting in children aged 0-59 months (Islam et al., 2021; Caleyachetty et al., 2022).

Using clean cooking fuels has been approved to reduce the risk of hypertension, lung disease, asthma and can improve individual physical health outcome (Li et al., 2022). Essentially, using clean cooking fuels improves indoor air quality by minimizing harmful pollutants emitted by incomplete combustion of solid fuels. In addition, to improving individuals' health, using clean cooking fuels can directly affect food quality (Mall & Rani, 2020; Maji et al.; Ma et al., 2022). Then, to its impact on individuals' health, using clean cooking fuel is also expected to reduce stunting in children. Therefore, empirical research is needed to see the effect of using clean cooking fuel on the risk of stunting in children. Previous empirical research on the effect of indoor pollution on stunting has been conducted in developed countries such as China (Liang et al., 2020). However, research on the impact of clean cooking fuel use on stunting in Indonesia still needs to be completed. In the case of Indonesia, previous research has focused more on the effect of clean cooking energy transition on individuals' physical health, such as infant mortality and low birth weight (Imelda, 2020). Moreover, it reduces the risk of health problems such as cough, shortness of breath, fever, diarrhoea, and eye pain (A'yun & Umaroh, 2020). Therefore, to fill the research gap, this study will analyse the effect of clean cooking fuel use on stunting in children aged 0-59 months in Indonesia using cross-section data. Previous studies have focused only on the impact of indoor pollution on the mortality of children aged 0-59 months, but few studies have been looked at the impact of households' clean cooking fuels use on the risk of stunting in children aged 0-59 months.

This study contributes to the literature in two main ways: first, although there have been previous studies investigates impacts of clean cooking energy transitions on low birth weight (Imelda, 2020). Further research on the effect of using clean cooking fuels on child height indicators in Indonesia is needed. Second, this study uses cross-section data and Propensity Score Matching (PSM) estimation method, that can overcome estimation bias due to endogeneity originating from the selection mechanism so that it can produce the value on causal effect of cooking using clean fuels on the treatment group that relative to the control group. Most previous studies examining the consequences of cooking energy on health are often studied using observational data or cross-sectional data. It may conflate the causal effects of indoor air pollution with the determinant that influence exposure (Liu et al., 2022; Qiu et al., 2023).

RESEARCH METHOD

Data

Data that is used in this study is cross-section data sourced from Indonesian Family Life Survey (IFLS) Wave five which held in 2014. It is longitudinal data that covers 83 percent of the population in Indonesia, involving 30,000 individuals and 12,000 households from 13 provinces. This data was chosen because it is consistent in measuring and explaining the stunting on children aged between 0-59 months. Although IFLS is panel data, this study only uses cross-sectional data from 2014 because stunting variables are calculated with the HAZ (height-for-age) indicator over 5 years.

Variable Measurement

The dependent variable in this study was stunting, measured by height divided by age standard deviation according to WHO standards. WHO divides stunting by three categories: first, severely stunted (children that HAZ below -3 SD); second, moderately stunted (children that HAZ below -2 SD); and third, average height-for-age z-score. The child growth standards released by World Health Organization (WHO) in 2006 replaced the previous standards. In well-nourished populations, approximately 2.2 percent of children are between -2.0 and -2.99 standard deviations (SD), and 0.1 percent are -3.0 SD or more standard deviations below average.

Primary independent variable is the clean cooking energy use, obtained from the IFLS questionnaire. The dummy variable is assigned a value of 1 if the household uses clean cooking fuels and 0 if it uses dirty cooking fuels. This study specifically examines on the use of LPG fuels, so the household that use electricity for cooking are not included in the analysis.

Covariate variables include household characteristics that affect stunting, such as TV ownership, electrification exposure, average years of schooling, total household expenditure, region of residence, and number of household members. In addition, heterogeneity factors such as child gender and household location (rural or urban) were also analyzed.

Research Methods

This study uses the Propensity Score Matching (PSM) method to investigate the impact of clean cooking fuel use on stunting. Cross-section data from IFLS 2014 was analyzed using an OLS model, and then Propensity Score Matching (PSM) was used to overcome endogeneity and selection biases issues.

The marginal effect of clean cooking fuel use on the risk of stunting was estimated with an OLS model, using various control variables such as TV ownership, electrification exposure, average years of schooling, region, household expenditure, and number of household members. However, these estimates may contain bias, so PSM was used to address the issue.

PSM is a statistical technique that matches treatment and control group characteristics based on covariates. This methodology reduces bias due to the absence of randomization in the data. The primary goal of this study is to quantify the impact of clean fuel use on stunting, considering possible selection bias.

The study also included a heterogeneity analysis to examines how the impact of clean cooking fuel use by sub-samples such as gender and location (urban or rural). This is important for a comprehensive analysis, as the impact of clean fuel use may differ by these sub-samples.

RESULT AND DISCUSSION

Overview of Cooking Fuel Use in 2014

Based on data from the 2014 *Indonesian Family Life Survey* (IFLS) *wave* 5, the proportion of households that using clean fuel for cooking was 77.65 percent, this is a significant increase compared to the proportion of clean fuel for cooking in 2007 which was only 21 percent. In contrast, the households that use solid fuel for cooking has a proportion of 22.35 percent, when compared to 2007 where the proportion was 79 percent. This hightlights a substantial shift towards cleaner cooking fuels in Indonesia. The most commonly used cooking fuel in 2014 was *liquefied petroleum gas* (LPG) at 73.23 percent.

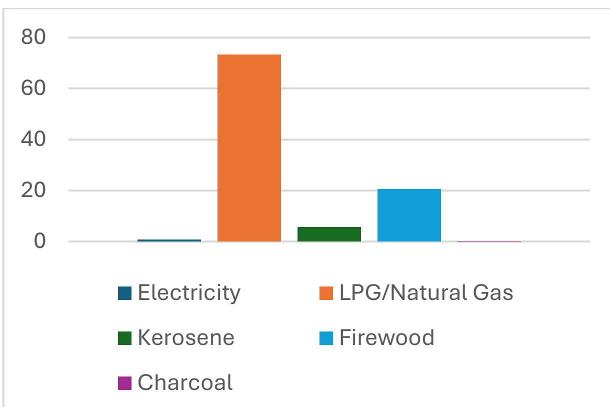

Figure 1. Proportion of Cooking Fuel Use in 2014
Source: IFLS 2014, processed

Overview of *Stunting* in 2014

The HAZ score is an indicator of a child's height for age z-score, based on the child's Height-for-age score using World Health Organization standards. According to WHO guidelines, a height for age z-scores below -2 indicates the onset of stunted growth of children, whereas a z-score lower than -3 indicates severely stunted growth. The World Health Organization (WHO) released the latest international reference population in 2006 (Leroy et al., 2015). The z-scores of the reference population are normally distributed, meaning a child in the reference group has less than a 2.3 percent likelihood of being stunted (Imai et al., 2014). Respondent's answers to the height questionnaire were of the centimetre type, which then created a height for age z-score indicator using data on the children's height, children's gender, children's date of birth, and date of survey collection, and calculated the height for age z-score using STATA, results are explained in Table 1.

Table 1. Summary of *Height-for-Age Z score* indicators in 2014

Variable	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**
stunting	2.781	-1,479964	1,400109	-7,27	12,87

Source: IFLS 2014, processed

Descriptive Statistics

After merging, cleaning, and data set-up, this study uses 2,781 eligible observations from the 2014 Indonesian Family Life Survey (IFLS) Wave 5. The sample structure used in this study began by processing the Indonesian Family Life Survey (IFLS) wave 5 data with the total of 35,000 individuals' observations in 2014. Individuals are categorized into two groups; the control group and the treatment group, according to the type of cooking fuel used. The control group is 624 households, in which there are children around aged 0-59 months that exposed by using solid cooking fuel, and the treatment group is 2,123 households, in which there are children around aged 0-59 months that exposed by using clean fuel for cooking.

Table 2 compares the characteristics of households that cook with clean cooking fuels (treatment group) and households that do not cook with clean cooking fuels (control group). The average numbers of household members using solid fuels tends to be less than that of households that use clean fuels for cooking. It is a result of the government's conversion program, which causes many households to convert to clean cooking fuels. Most households use clean cooking fuel, 60.15 percent, and live in urban areas.

Table 2. Descriptive Statistics of Research Variables by group

	Not using CCE			*Using CCE*		
Variable	Obs	Mean	Std. Dev	Obs	Mean	Std. Dev
TV Usage	624	0,8237179	0,3813657	2,157	0,966157	0,1808676
Electrical Exposure	624	0,9775641	0,1482152	2,157	0,996291	0,06088014
Average years of schooling	624	9,828152	2,206652	2,157	10,62031	2,579256
Region	624	0,6987179	0,4591831	2,157	0,3115438	0,4632319
Total Expenses	624	14,538	0,7592622	2,157	14,97728	0,7397296
Number of Household Members	624	4,796474	1,651475	2,157	4,658322	1,640906

Source: IFLS 2014, processed

Propensity Score Matching (PSM)

Estimating the propensity score, which represents the conditional probability that an individual will receive the treatment using on covariates used in this estimation. In this study, a probit model is employed to estimate the conditional probability of using of clean cooking fuel, followed by the radius caliper method (0.01) to compare households using clean cooking fuel with those not. Dependent variable in this study is the use of clean cooking fuels (clean_energy). In contrast, the independent variables include television use, electricity exposure, average years of schooling, region, total expenditure, and number of household members.

The probit estimation is presented in Table 3 explained that television usage, average years of schooling, and total household expenditure has a significant and positive influence on the of clean fuel use for cooking; this indicates that households that have television, average years of schooling and high total household expenditures tends to have a greater probability to use clean fuel as a primary fuel for cooking. Furthermore, households with access to electricity do not have an increased probability to use clean fuel for cooking. Meanwhile, number of households members and households living in villages has a negative and significant influence on the use of clean fuel for cooking, which means that many household members and households living in villages are more likely to have a lower chance of using clean fuels for cooking. This probit regression result will be applied to estimate the propensity score, which will subsequently be applied in analysis of Propensity Score Matching.

Table 3. Probit Regression to Determine *Propensity Score*

Variable	clean_energy
TV Usage (TV)	0,7369559***
	(0,1053665)
Electrical Exposure (elect)	0,3348242
	(0,3072309)
Average years of schooling (aggregate_educ)	0,0247357*
	(0,0131621)
Region (rural)	-0,8111552***
	(0,0583395)
Total Expenses (lntotexp)	0,3528623***
	(0,0440744)
Number of household members (hhsize)	-0,0950388***
	(0,0174924)
constant	-4,873861***
	(0,6641245)
Obs	2,781
R2	0,1626

Standard errors in parentheses *p<0.1, **p<0.05, ***p<0.01
Source: IFLS 2014, processed

Balance between groups before and after *Matching*

Before propensity score matching, Table 4.4 explains the difference between treatment groups (uses clean fuel for cooking) and control groups is significant. The statistically significant mean differences show this Difference.

Table 4 describes the results of the t-test mean differences across all variables between households using clean cooking fuel (treatment group) and households did not use clean cooking fuel (control group), both before and after Propensity Score Matching (PSM), are presented. Table 4 indicates that all variables showed statistically significant mean differences between the two groups before matching, within p-values less than 0.001 (***p<0.001). This significant difference highlights the imbalance between the two groups prior to matching.

Table 4. *T-test Mean Differences* Before and After PSM *Matching*

	(1)	(2)
	Before Matching	After Matching
TV Usage (TV)	-0,1424388***	-0,00313
	(-13,0134)	(0,56)
Electricity usage (elect)	-0,018727***	0,00099
	(-4,6670)	(-0,58)
Average years of schooling (agg_educ)	-0,7921543***	0,071
	(-6,9693)	(-0,88)
Region (rural)	0,3871741***	0,01295
	(18,4236)	(-0,91)
Total Expenses (lntotexp)	-0,4393851***	0,027
	(-12,9897)	(-1,12)
Household Members(hhsize)	0,1381526*	-0,0029
	(1,8495)	(0,06)

t-stat in parentheses
Mean Difference = Mean of Control - Mean of Treatment
*p<0.1, **p<0.05, ***p<0.01
Source: IFLS 2014, processed

After Matching, it shown at the Table 4. that the mean differences between the treatment groups and control groups became statistically insignificant, as evidenced by p-values greater than 0.05. It indicates that propensity score matching (PSM) effectively reduced the mean differences between the treatment groups and control groups, as shown in Figure 4.2. The horizontal axis in the figure represents the mean difference value, with zero (0) as the reference point, indicating there is no difference between the two groups.

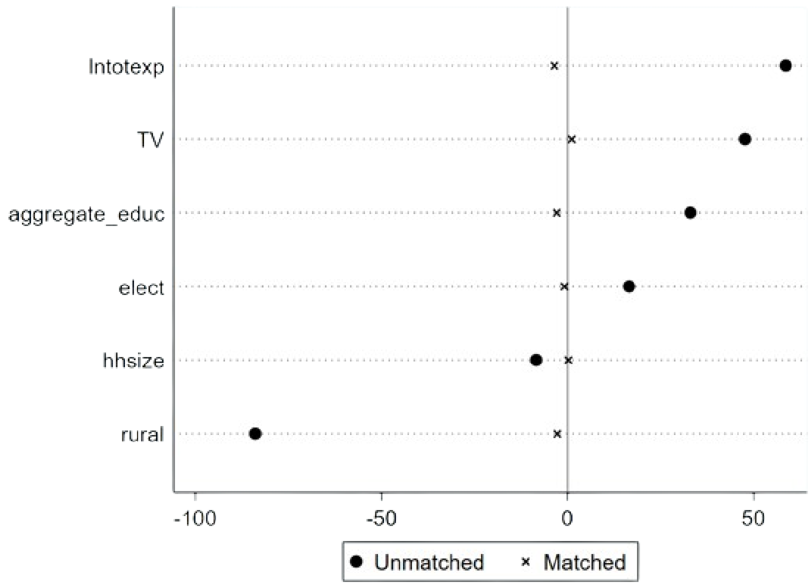

Figure 2. Visualization of *T-test Mean Differences* Before and After *Matching*
Source: IFLS 2014, processed

In Figure 2, before Matching, points on graph are did not approach the original point or zero. Although, after applying Propensity Score Matching, all variables move closer to zero, indicating that the average difference between treatment group and control group becomes small and insignificant.

Quality of the matching process is further assessed through the percentage bias in the test results. Table 5 explained the evaluation of the percentage bias following propensity score matching process. The results confirm that the matching process effectively balanced the characteristics between both of groups. After Matching, percentage bias is below 5 percent for all variables, which is considered acceptable.

Table 5. Validity of *Matching* Results with *pstest*

	Mean			*t-test*		V(T)/V(C)
Variable	*Treated*	*Control*	*%bias*	t	p>|t|	
TV Usage (TV)	0,96611	0,96298	1,0	0,56	0,579	.
Electricity usage (elect)	0,99629	0,99728	-0,9	-0,58	0,563	.
Average years of schooling (agg_educ)	10,616	10,687	-3,0	-0,88	0,381	0,89*
Region (rural)	0,31198	0,32493	-2,8	-0,91	0,362	.
Total Expenses (lntotexp)	14,973	15	-3,6	-1,12	0,263	0,75*
Household Members	4,6597	4,6568	0,2	0,06	0,955	0,90*

'* If variance ratio outside [0.92;1.09]

Ps R2	LR chi2	p>chi2	*MeanBias*	*MedBias*	B	R	%Var
0,001	3,37	0,761	1,9	1,9	5,6	0,78	100

'* if B>25%, R outside [0.5 ; 2]
Source: IFLS 2014, processed

The balanced test results in Table 5 show the assumption of late covariate balance is satisfactorily met. The Difference in characteristics between both of groups have been minimized, within Rubin's B-value below 25 percent and Rubin's variance ratio R between 0.5 and 2. Thus, the comparison between both groups becomes more valid.

This result explains that propensity scores matching process effectively balanced the characteristics between the two groups, eliminating significant differences between the treatment group and control group for most of the observed variables. Consequently, it is possible estimating the impacts of using clean fuel for cooking more accurately, as the bias caused by the imbalance of characteristics between treatment group and control group in the model has been reduced.

Common Support Before and After Matching

In addition to evaluate the balance between treatment group and control group, the quality of Matching is further assessed by examining the overlap in the propensity score (p-score) between the treatment and control groups. The overlap assumption test ensures sufficient overlap with covariate characteristics between treatment and control groups. Figure 4.3a presented the distribution of the score before Matching. Overall, the treatment group has a significantly higher score than the control group. Figure 4.3b shows the score distribution after Matching. A comparison of the two figures reveals the Propensity Score Matching has successfully corrected the score deviation between the treatment and control groups.

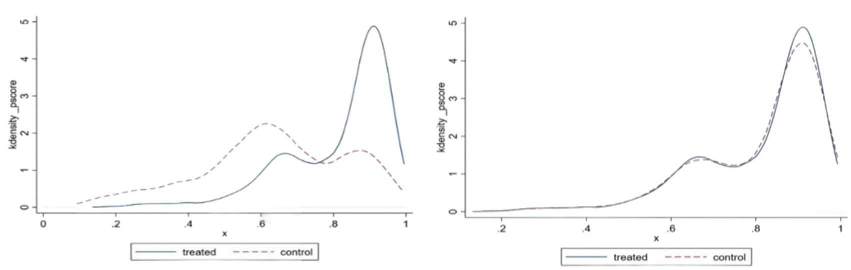

Figure 3. *Propensity Score Distributions* (a: *before matching*; b: *post matching*)
Source: IFLS 2014, processed

Furthermore, the assumption that must be met in using the Propensity Score Matching (PSM) method in this study is the standard support assumption. Joint support is a condition in which the distributions values of the two groups overlap. The joint support area focuses on the similarity of characteristics between the two groups based on the distribution of their propensity scores. Figure 4 explains the distribution of covariates and the expected support assumption: individuals located below the line are children living in households that do not use clean cooking fuel (control group). In contrast, individuals above the line are children who live in households that use clean cooking fuel (treatment group).

Based on the graph in Figure 4, most of the observations used in the model find their match in the control group, although three individuals are in the off-support area and cannot be included in the model. Figure 4 explains that the propensity score distribution between groups has a good overlap, which means the model can be used to observe combinations of covariates in treatment group with the control group.

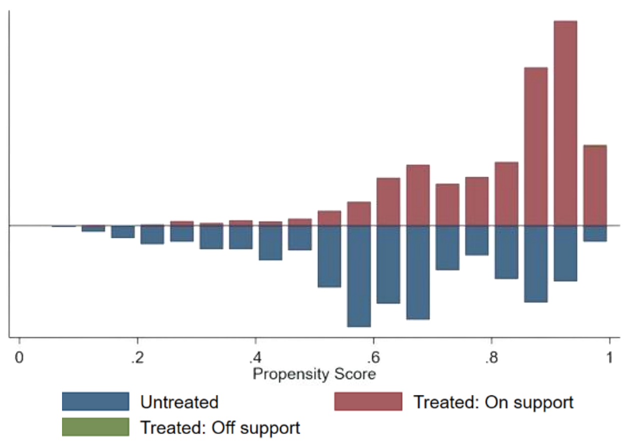

Figure 4. *Propensity Score* Distribution (*psgraph*)
Source: IFLS 2014, processed

Estimating the Impact of Clean Cooking Fuel Use on *Stunting*

This study uses Propensity Score Matching to estimate the impact of clean cooking fuel use on stunting risk. After completing the Matching process, this study evaluates the impact of clean cooking fuel use on stunting by calculating the average treatment effect of treated (ATT), which is estimated as the average difference in outcome variables between the treatment and control groups after Matching.

Table 6. Estimation results of *Average Treatment Effect on the Treated* (ATT)

Variable	*sample*	*Treated*	*Controls*	*Difference*	*S.E.*	*t-stat*
stunting	*unmatched*	-1,38401483	-1,81163462	0,427619783	0,063134621	6,77
	ATT	-1,38392757	-1,63296844	0,249040868	0,086711012	2,87

Note: *S. E. does not take into account that the propensity score is estimated.*
Source: IFLS 2014, processed

Table 6 explains the results of estimating the average treatment effect on the treated group (ATT) for the Stunting variable. Average difference in stunting (ATT) between the treatment and control groups is 0.249040868. The average treatment effect on the treated (ATT) value is statistically significant (t-stat of 2.87). It can be concluded that households that use clean cooking fuel have a higher average HAZ value of 0.249 compared to households that do not use clean cooking fuel.

Heterogeneity Analysis

The primary analysis in section 4 shows that households that use clean cooking fuels have higher average HAZ scores than households that do not, meaning that using clean cooking fuels can reduce the risk of stunting in children aged 0-59 months. However, the impact of clean cooking fuel use on the risk of stunting in children aged 0-59 months may differ by sub-sample or sub-group. For example, individuals who spend long periods in the kitchen may be more susceptible to the positive effects of clean cooking fuel use due to the smaller level of exposure provided by the combustion of their cooking appliances. Therefore, for a comprehensive analysis, this study included a heterogeneity analysis of the impact of clean cooking fuel use on two sub-samples: groups by gender (girls and boys) and groups by region (rural and urban).

As shown in Table 4.7, it can be seen that in the sub-sample of girls aged 0-59 months, the use of cooking fuel shows a higher reduction in the risk of stunting in girls compared to boys; this is in line with research by (Liang et al., 2020) explained that the impact of indoor pollution due to the use of solid fuels on the risk of stunting in girls is higher than that of boys. However, the Difference is not statistically significant. This study's results align with research by (Liu et al., 2022) that women will be more sensitive to the use of cooking fuels because women are usually responsible for cooking and household chores, so they are exposed to indoor air pollution longer than men.

While the effect of heterogeneity in rural and urban sub-sample groups, the use of clean cooking fuel in rural areas will reduce the risk of stunting in children aged 0-59 months higher than in urban areas, for heterogeneity analysis in urban sub-sample groups has statistically insignificant results, which means that there is no effect of the use of clean cooking fuel on reducing the risk of stunting in children aged 0-59 months in urban areas.

Meanwhile, in the child age sub-sample group, using clean cooking fuel significantly influences the age range of 24-35 months. It can be explained that children aged 2 to 3 years who use clean cooking fuel show an increase in the average HAZ value, which is higher than the other age ranges. Thus, it can be concluded that children in the 2 to 3 years who use clean cooking fuel have a lower risk of stunting than children in households that do not use clean cooking fuel.

Table 7. Estimation Results on *Heterogeneity* Analysis

		Stunting
Gender	*female*	0,312**
		(0,133)
	Obs	1,331
	R^2	0,1806
	Male	0,240**
		(0,120)
	Obs	1,450
	R^2	0,1527
Region	*Urban*	0,201*
		0,118
	Obs	1,673
	R^2	0,0574
	Rural	0,261***
		(0,098)
	Obs	1,108
	R^2	0,0821
Age	*24-35*	0,441**
		(0,190)
	Obs	707
	R^2	0,148
	36-47	0,247
		(0,180)
	Obs	667
	R^2	0,178
	48-59	0,069
		(0,140)
	Obs	865
	R^2	0,168

Standard errors in parentheses, *p<*.1, **p<.05, ***p<.01*
Source: IFLS 2014, processed

The results of this study are in line with research by (Caleyachetty et al., 2022) explaining that the use of solid fuel will increase the risk of stunting in children in rural areas higher than in urban areas; this can also explain why the use of clean fuel in rural areas will further reduce the level of risk of stunting in rural areas, considering that (about) 20 percent of rural households in Indonesia use firewood cooking fuel. Other research conducted by (Tang et al., 2024) explained that using non-dense cooking fuels would reduce levels of stunting, wasting, and malnutrition in children. These results are in line with findings by (Mishra & Retherford, 2007); and (Amadu et al., 2021) which explain that improved access to clean cooking fuels can be an inclusive option to help reduce socioeconomic inequalities in terms of child nutrition outcomes, which is another factor that can influence the risk of child stunting.

CONCLUSION

Based on the study's results, the authors conclude that the growth of children aged 0-59 months is crucial for their future physical, cognitive, social, and emotional development and the foundation for learning, economics, and health. This study analyzes the impact of clean cooking fuel use on stunting risk using the 2014 Indonesian Family Life Survey (IFLS) data and the Propensity Score Matching (PSM) method. The results show that clean cooking fuel use increases children's average Height-for-Age z-score, reducing the risk of stunting. Television, average years of schooling, and total household expenditure positively affect clean fuel use, while electricity access is insignificant. Households in villages or with more members are less likely to use clean fuels. This study has limitations with data only from 2014 and rudimentary covariate variables. The government is advised to facilitate access to clean fuels and increase awareness of the benefits of clean fuels among rural communities. Further research using other methods is needed for more accurate estimation.

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