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True Price of a Pack: Tobacco Expenditure and Height-for-Age in Indonesia

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Tobacco Expenditure and Height-for-Age in Indonesia

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Abstract

While the negative impact of tobacco on the health of smokers is well known, the ways in which smoking impacts the health of the smoker's children is less understood. This study explores whether tobacco expenditure increases the risk of stunting among children under the age of five in Indonesia, where smoking and stunting rates are among the highest in Southeast Asia. Given the severe income constraints faced by poor Indonesian households, large tobacco expenditure potentially "crowds-out" spending on nutrition, worsening the nutritional health of children in smoking households. To examine this relationship, I use a sample of children under the age of 5 from the 2007 and 2014 rounds of the Indonesian Family Life Survey (IFLS). The IFLS reports extensive health, expenditure, and socio-demographic information for over 30,000 households representing 83% of the population. The longitudinal nature of the IFLS allows me to implement subdistrict fixed effects to control for time-invariant characteristics common to the subdistrict. Additionally, I use cigarette price as an instrument to circumvent the potential endogeneity of tobacco consumption. This study contributes to the health economics literature by revealing how addictive behavior interacts with budgetary decisions to produce external effects on children living in the household. Furthermore, this study illustrates additional health benefits for Indonesian tobacco control, as such policy may impact not only smokers, but children living in smoking households as well.

[1] I am grateful to Professor Shrestha for advising this project. I am also grateful to Professor Mellor and Dr. Obasanjo for serving on my committee.

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I. Introduction

Indonesia has one of the highest rates of smoking in the world (WHO 2019). With smokers comprising of 62.9% of men and 4.8% of women, tobacco places an immense burden on the public health of the country. Tobacco-related illnesses are estimated to cost Indonesia $45.9 billion USD, leading many to argue for stricter tobacco control (Kosen et al. 2017). Yet many of Indonesia's policy makers hesitate to make any large changes to tobacco legislation, fearing that the economic costs of penalizing such a large industry may outweigh the benefits of improved health in the nation (Astuti et al. 2020).

However, there is increasing evidence that the prevalence of tobacco in Indonesia is harming its youngest citizens. Growing evidence suggests that children living in tobacco consuming households face a disproportionately higher risk of stunting, a condition caused by chronic malnutrition and marked by a permanent reduction in height of 2 or more standard deviations below the international standard set by the WHO (Block & Webb 2009; Best et al. 2008; Semba et al. 2007). Establishing the links between tobacco consumption and stunting becomes critical; stunting is believed to transmit poverty across generations, as stunted children typically obtain lower levels of education, lower lifetime earnings, and are more likely to give birth to stunted children (Rokx et al. 2018). This intergenerational effect thus holds significant ramifications for development efforts and highlights the importance of understanding stunting's risk factors in all its forms (Rokx et al. 2018).

Using a nationally representative, longitudinal survey of Indonesian households in 2007 and 2014, I implement a subdistrict fixed effects approach to explore whether children living in tobacco consuming households experience lower height-for-age and higher risks of stunting. I also attempt to account for the potential endogeneity of tobacco expenditure using an instrument of community cigarette price, and present treatment effects using a regression adjustment strategy. I additionally investigate the mechanisms underlying such risks, exploring whether the risk of stunting increases at higher levels of tobacco expenditure. From this analysis, I find a strong, statistically significant, and positive relationship between household tobacco consumption status and child stunting risk. I find that this risk increases at higher levels of tobacco expenditure, suggesting that that households reallocate funding away from food expenditures to afford tobacco products. While ultimately my findings are far from causal, my estimates suggest that improved tobacco control may create positive externalities for child health.

This thesis is organized as follows. Section II discusses the existing body of literature on stunting and tobacco consumption. Section III describes the data and sample used in this study. Section IV discusses the conceptual framework and methodological approach. Section V presents the results, and Section VI discusses the conclusion.

II. Literature Review

The current body of evidence suggests that the effects of chronic malnutrition and stunting are felt life-long (Black et al. 2017). Stunted children are believed to experience deficits in cognitive and neurological development, which have been linked to reduced educational attainment and lifetime earnings in adulthood (Rokx et al. 2018). While some catch-up does occur, these opportunities are generally limited (Black et al. 2017). Thus, stunting permanently impacts a child's life course, and reduces their life's potential within the first 5 years of life.

Due to the persistent, negative implications of stunting for human capital, researchers and policy makers have made it a priority to identify the socioeconomic and social factors related to stunting risk. Although poor children face almost twice the risk of stunting, increasing evidence suggests that stunting is not merely an issue of poverty (Rokx et al. 2018; De Silva & Sumarto 2018).[2] A range of child-level characteristics have been identified as risk factors for stunting, such as male sex, higher birth order, shorter birth interval, and low birthweight (De Silva & Sumarto 2018; Mani 2013). Community infrastructure also plays a significant role in explaining nutritional outcomes, as water and sanitary conditions, access to healthcare, electricity access, presence of paved roads, and local prices have been linked to stunting outcomes (De Silva & Sumarto 2018; Mani 2013; Christiaensen & Alderman 2004; Thomas, Strauss, & Henriques 1990). Unsurprisingly, children living in rural communities and Indonesia's outer islands face a higher risk of stunting, where access to these resources is poorest. Finally, parental height and education are believed to exhibit the strongest influence on child height-for-age, illustrating the strong intergenerational nature of stunting risk and related implications for poverty (De Silva & Sumarto 2018; Christiaensen & Alderman 2004; Mani 2013; Thomas, Strauss, & Henriques 1990; Alderman & Headey 2017).

The role of household tobacco expenditure in explaining stunting risk is somewhat less studied, although several papers exist within the context of Indonesia. For instance, Semba et al. (2007) use the Indonesian Ministry of Health's nutritional surveillance system (NSS) for the period 1999 to 2003 and find that paternal smoking is associated with an increased risk of stunting, severe stunting, severe wasting, and severe underweight in urban slums. Best et al. (2008) also examine paternal smoking, although they concentrate

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[2] De Silva & Sumarto (2018) find stunting occurs even in children living in the wealthiest households of Indonesia. Additionally, they note that despite rising incomes, stunting prevalence persisted in the country. Therefore, income may play less of a role than previously thought.

exclusively on rural households. Using a cross-section from the Indonesian Nutrition and Health Surveillance System for 2000 to 2003, they find that paternal smoking is associated with increased risk of stunting, underweight, severe stunting, and severe underweight. Block and Webb (2009) use nutrition surveillance system data from rural central Java for the years 1998 to 2001 in a semi-parametric approach and find a negative relationship between paternal smoking and child height-for-age similar to that of Semba et al. (2007) and Best et al. (2008). Furthermore, they find that higher levels of cigarette expenditure are also associated with lower height-for-age. Notably, all three studies rely heavily on cross-sectional data and OLS methodology, with no direct examination of the underlying links between household smoking behavior and child height-for-age. Therefore, this study seeks to build upon the existing literature by presenting a more robust set of controls and by exploring the potential mechanisms through which household tobacco usage affects child height.

Household tobacco consumption could affect child height through several different biological and environmental channels. For example, the incidence of low birthweight due to in utero tobacco exposure could produce negative impacts on height-for-age.[3] Research has shown that children born low birthweight often report lower height at 6 months, 3 years, 7 years, 11 years, and as adults (Datta Gupta, Deding, & Lausten 2013; Behrman & Rosenzweig 2004). A vast body of economic and medical literature has established that maternal smoking increases the risk of low birthweight significantly through in utero exposure (Lien & Evans 2005; Fertig 2010; Markowitz 2013; Faber et al. 2017). Direct exposure to cigarette smoke in utero could plausibly contribute to child height and therefore

[3] Low birthweight is defined as a birthweight below 2500 grams.

stunting through increased risk of low birthweight. However, only 3.6-3.8% of women surveyed in my dataset reported ever consuming tobacco. Therefore, direct in utero exposure to tobacco is not a likely channel within the context of Indonesia, as tobacco consumption among women is extremely low.

Notably, household tobacco use may still influence birthweight through exposure to secondhand smoke. Studies have linked environmental tobacco exposure to pre-term birth, small for gestational age, low birthweight, and congenital anomalies, using both self-reported and biological measures for secondhand smoke exposure (Salmasi et al. 2010; Nui et al. 2016; Faber et al. 2017). Nui et al. (2016) provide evidence that environmental tobacco exposure primarily lowers birthweight through maternal inflammation and lower placental weight.[4] Through these mechanisms, secondhand smoke could lower birthweight, and thus increase the risk of stunting later in life. Unfortunately, due to data constraints, exploring this channel is beyond the scope of this paper.

Another potential mechanism is the impact of tobacco consumption on food expenditure. Several US studies have found that increased consumption of tobacco lowers overall expenditure on food, primarily by crowding out available funds in the household budget. Busch et al. (2004) find that tobacco spending displaces a range of other expenditures, with the severest impact on food. They discover that the substitution effect between tobacco and food expenditure is particularly pronounced in the face of changing cigarette prices, as they find that food expenditure is cross-price elastic with respect to tobacco. Mellor (2011) extends these findings to identify the ramifications for child health outcomes. Using a child fixed-effects approach, she finds that increases in state excise tax

[4] This primarily occurs through elevation of inflammatory markers TNF-α and IL-1ß (Nui et al. 2018).

and average retail prices for cigarettes increased BMI in children of smoking mothers. She argues that her findings likely arise from resulting shifts in budget allocation. Cutler-Triggs et al. (2008) also find that children are impacted by tobacco expenditure, finding that children living in smoking households report higher levels of food insecurity.[5]

Studies in developing countries have found similar trends as those based in the United States. For example, Sreeramareddy and Ramakrishnareddy (2018) find that Nepali households with male tobacco users experience a much higher rate of household food insecurity. In the Indonesian literature discussed previously, Semba et al. (2007), Best et al. (2008), and Block and Webb (2009) all find that tobacco consuming households dedicated a significantly smaller share of their household income to food expenditure. Additionally, they find tobacco consuming households spend a much higher share of the household budget on rice, and much lower share on nutrient-rich foods such as meats and vegetables. Block and Webb (2009) find that this displacement persists even after controlling for differences in income. Following the literature, this study will also explore whether tobacco consumption generates negative effects on child height by displacing available household income for food expenditure.

While the literature discussed above provides significant evidence of the nutritional impacts of tobacco expenditure in Indonesia, there are several key weaknesses. The papers described above almost exclusively focus on households living in central Java, neglecting much of the non-urban population in Sumatra and the Outer Islands.[6] I rectify this weakness

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[5] Cutler-Triggs et al. (2008) define food insecurity as "the inability to access enough food in a socially acceptable way for every day of the year."

[6] Best et al. (2008) present data from 7 of Indonesia's 27 provinces, 4 of which are on the island of Java. Block & Webb (2009) rely on data solely for the province of Central Java, and Semba et al. (2007)'s data represents 5 cities, 3 of which are in Java.

by using the Indonesian Family Life Survey (IFLS), which is nationally representative of 83% of the Indonesian population. With data representing a larger share of the population, I am also able to explore how the effects of tobacco expenditure varies between rural and urban households.

Additionally, existing studies present largely correlational evidence, with few controls for household and community characteristics associated with child health. Relying primarily on OLS specifications with few available controls, the estimates provided by such studies are likely biased due to omitted variables. To estimate a stronger link between tobacco expenditure and child health, I make use of the rich array of information provided by the IFLS, and control for a wide range of factors associated with the child, mother, household, and community. Additionally, the larger spatial coverage of the IFLS allows me to implement subdistrict fixed effects, thus controlling for time invariant, unobserved community-specific characteristics associated with child health. With these methods and improved data, I present arguably stronger estimates of the impacts of tobacco expenditure on child height-for-age in Indonesia.

III. Data

In this study, I use the 2007 and 2014 rounds of the Indonesian Family Life Survey (IFLS). The IFLS is a longitudinal survey representing 83% of the national population. It contains 5 rounds, reporting health and demographic information for 1993, 1997, 2000, 2007, and 2014. The first round of the IFLS (IFLS1) surveyed 7,224 households living in 13 of Indonesia's 26 provinces. Subsequent rounds report very high recontact rates, with responses from 93.6% and 90.5% of IFLS1 dynasty households in 2007 and 2014 (IFLS4 and IFLS5). While the IFLS provides an impressive amount of information at the individual, household, and community level across survey rounds, I restrict my analysis to the IFLS4 and IFLS5, as they are the only survey rounds that include community price information.

I obtain a final sample of 8,846 children under the age of 5 from the IFLS, with 4,137 children from 2007, and 4,709 children from 2014. For each child, I match information on child anthropomorphic traits, mother characteristics, household characteristics, monthly expenditure, and community infrastructure. Using the 2006 WHO child growth standards, I calculate the height-for-age z-score for each child. Stunting is then defined according to these international standards (WHO 2006). Height-for-age 2-3 standard deviations below the international mean is considered moderate stunting, and height-for-age 3 or more standard deviations below the international mean is considered severe stunting. Based on recommendations provided by the WHO, observations with height-for-age 6 standard deviations below the mean were flagged and removed from the analysis (WHO 2019). An additional 692 observations were missing height information and were dropped from the analysis. To account for outliers, households within the top 2% of tobacco expenditure and the top and bottom 2% of per capita expenditure were flagged and removed from the sample. After removing additional missing values, I obtain a final sample of 8,846 children under the age of five. Descriptive statistics for this sample are included in Table 2.

Despite the longitudinal nature of the IFLS, very few households and mothers are present in both years of my sample of children. The panel is highly unbalanced: 85% of mothers were present in only one survey round. Furthermore, roughly 822 observations were missing mother information, and thus were removed from the analysis.[7] One concern is that the excluded children may differ fundamentally from the children remaining in the final sample. Therefore, I include descriptive statistics of the two subsamples in Table S1 of the appendix. While height-for-age, tobacco expenditure, and household socioeconomic status are roughly similar between the two groups, interpretation of my findings will remain limited to children with their mother present in the household.

Tobacco consumption and expenditure information were obtained from the household expenditure module of the IFLS. While the IFLS contains a module on smoking behavior, attrition from the questionnaire was quite high; over half of the total observations present in the household roster of the IFLS were missing from the smoking module.[8] Therefore, I rely on tobacco expenditure as a more consistent measure of actual household tobacco consumption. Using monthly household tobacco expenditure, I define tobacco consuming households to be any household with a monthly tobacco expenditure greater than zero. I additionally define budget share of tobacco as the percentage of monthly household expenditure dedicated to tobacco products, such as cigarettes and chewing tobacco.[9] Finally, using community information provided by the IFLS, I calculate the average cigarette price in the survey community as reported by local market and shop vendors.[10]

[7] 29 mothers were reported as deceased and 178 lived in a separate household from their child. Of the remaining missing mother observations, 479 were missing education information, 403 were missing height measurements, and 12 were missing age information.
[8] Roughly 33,000 of the 62,000 observations present in the IFLS4 household roster and 41,000 of the 75,000 observations of the IFLS5 household roster were missing from the smoking module.
[9] More specifically, the budget share of tobacco is calculated as total monthly tobacco expenditure divided by gross monthly expenditure.
[10] Missing values of cigarette price were imputed using the median cigarette price at the subdistrict level.

Table 1 describes household tobacco expenditure over the sample period. While the price per cigarette increased by almost 150 rupiah between the two periods, the budget share of tobacco decreased only slightly from 6.3% to 6.1% of total expenditure. The proportion of households that reported tobacco expenditure also decreased from 69.5% to 67.6% of households, along with the number of tobacco users per household. Tobacco use is also higher among poorer households, and households living in rural areas (See Figure S2 and Table S2 in the appendix).[11]

Table 1: Tobacco consumption 2007-2014

	2007			2014		
	count	mean	sd	count	mean	sd
Household reports tobacco expenditure	3629	0.695	0.460	4204	0.676	0.468
Log of monthly tobacco expenditure	3629	8.106	5.425	4204	8.384	5.851
Budget share of tobacco	3629	6.252	6.717	4204	6.143	6.552
Price per cigarette	3625	866.024	91.945	4204	1000.068	119.471
Number in household with tobacco habit	3629	0.791	0.694	4204	0.784	0.663

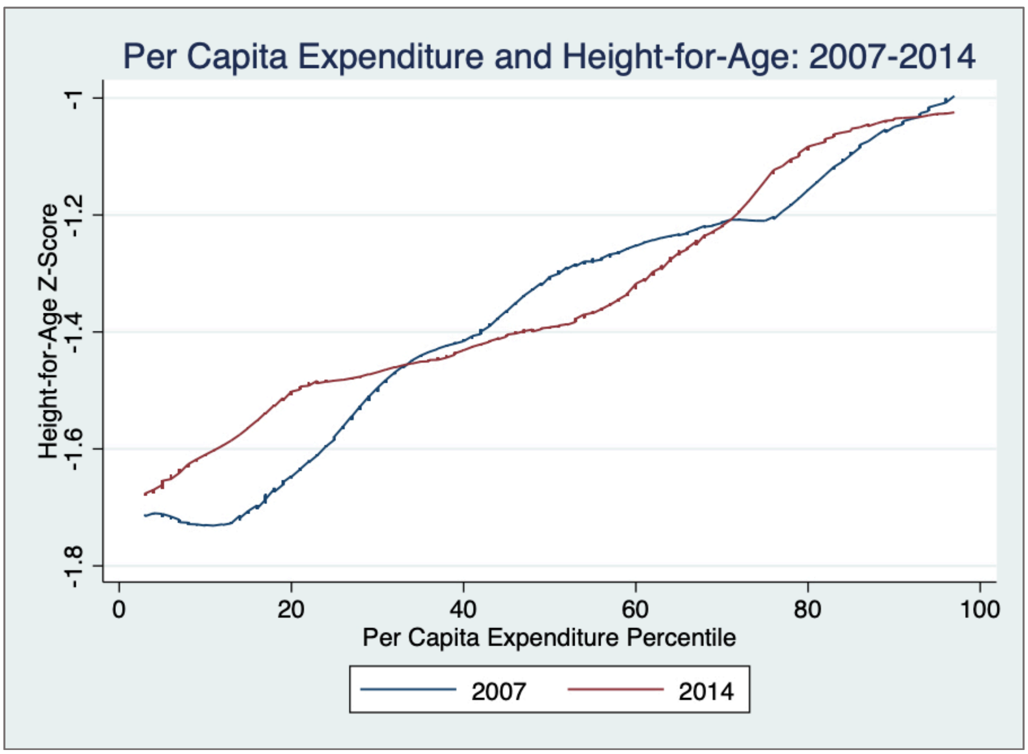
Note: Table depicts trends in tobacco consumption and price for households present in the 2007 and 2014 rounds of my sample of children under 5. Prices are converted to 2014 Indonesian rupiah by dividing by the cumulative inflation rate between 2007 and 2014 (50.47%).

At first glance, nutrition seems to have improved between the two survey rounds. As indicated in Table 2, the prevalence of stunting decreased by 1 percentage point between the two periods. Reductions in stunting prevalence largely occurred for the severest cases of stunting, which decreased by 2 percentage points. Meanwhile, the share of moderate cases increased by roughly 1 percentage point. Mean height-for-age z-scores also decreased slightly by .003 between 2007 and 2014, although a t-test reveals that this difference is not statistically significant.

[11] Indonesia underwent several excise tax regimes between 2007-2014. Amalia et al. (2019) found no change in smoking behavior between the 2007 and 2014 rounds of the IFLS, and an increase in tobacco expenditure. Their findings are somewhat contrary to the trends observed in the under-five sample here.

As seen in Figure 1, changes in height-for-age between the two periods differed significantly for households of different socioeconomic status. Households in the bottom 30% of per capita expenditure experienced significant gains in height-for-age, with increases in z-score as large as 0.1. The reverse is true for middle income households, who observed a decline in height-for-age between the two periods. Therefore, while the overall prevalence of stunting and cases of severe stunting has declined, the height-for-age of children under the age of five has not increased uniformly across the distribution of household expenditure.

Figure 1: Per Capita Expenditure and Height-for-Age: 2007-2014



Note: Values on the x-axis represent the percentiles of household per capita expenditure, representing levels of income. Values on the y-axis represent height-for-age z-score, calculated using the 2006 WHO international growth standards.

Table 2: Descriptive statistics 2007-2014

	2007		2014	
	mean	sd	mean	sd
Height-for-age z-score	-1.407	1.673	-1.404	1.560
Moderately or severely stunted	0.366	0.482	0.360	0.480
Moderately stunted	0.227	0.419	0.236	0.425
Severely stunted	0.139	0.346	0.123	0.329
Household reports tobacco expenditure	0.698	0.459	0.676	0.468
Log of monthly tobacco expenditure	8.163	5.419	8.398	5.850
Budget share of tobacco	6.312	6.743	6.083	6.504
Male	0.514	0.500	0.521	0.500
Age in months	29.559	17.552	30.025	17.575
Mother's years of school	9.307	3.586	10.090	3.533
Mother's age at birth	26.934	5.865	27.786	5.902
Mother's height	150.976	9.424	151.737	5.435
Log per capita expenditure	12.857	0.591	13.595	0.570
Poor household	0.386	0.487	0.389	0.488
Household insured	0.170	0.376	0.491	0.500
Household size	5.968	3.047	4.718	1.669
Number in household 15 years and under	2.072	1.082	2.034	0.957
Rural	0.461	0.499	0.420	0.494
Sumatra	0.240	0.427	0.261	0.439
Outer Islands	0.266	0.442	0.303	0.460
Dirt flooring	0.065	0.246	0.031	0.174
Purchases water	0.281	0.449	0.440	0.496
Owns toilet	0.747	0.435	0.827	0.379
Dirt road	0.039	0.193	0.015	0.123

Notes: Table depicts the descriptive statistics for the final sample of children under the age of 5 from the IFLS. There are 4,137 observations for 2007, and 4,709 for 2014 respectively.

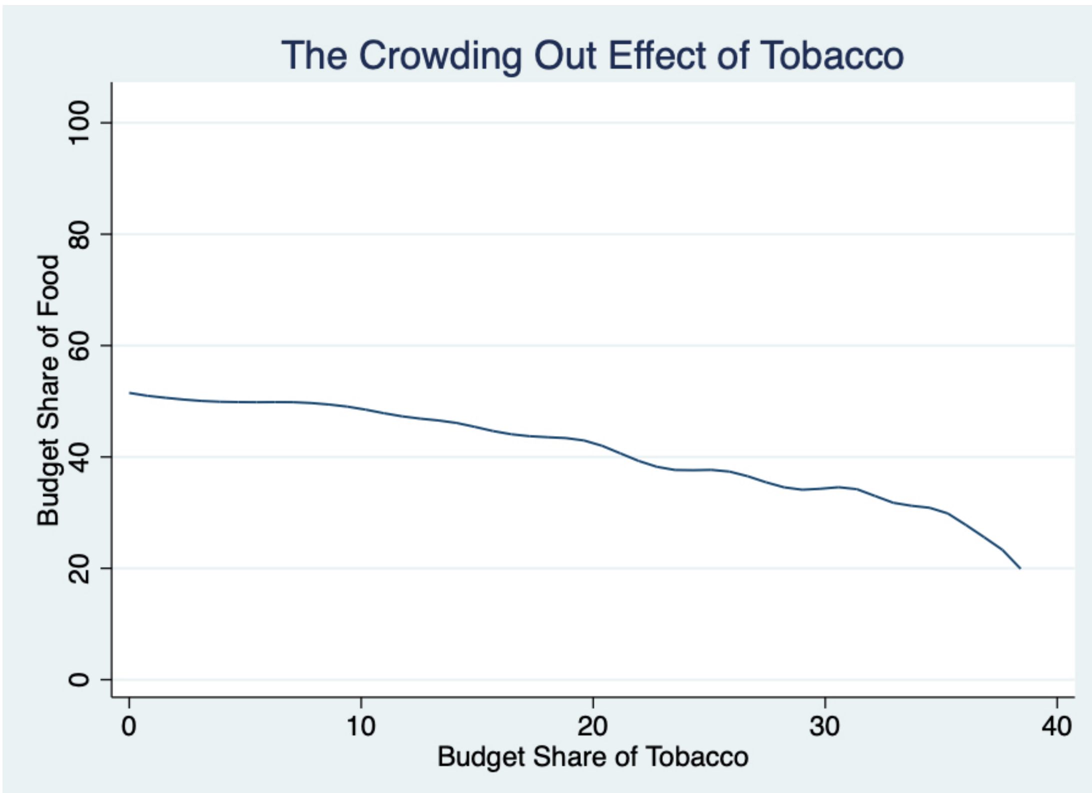
A question central to this study is whether households with higher budget shares of tobacco dedicate less of their income to food expenditure. Demonstrating this relationship descriptively proves to be a challenge, as the level of available income likely confounds this relationship. Engel's Law suggests that as incomes rise, the expenditure share of food in the budget will decrease; thus, if tobacco is positively elastic with respect to income, the relationship between the two variables will be negative, regardless of actual household preferences for budget allocation. To rectify this, I estimate a semi-parametric model of food share as a function of tobacco share, which is depicted in Figure 2.[12] After controlling for a vector of household and community characteristics, I find that households that dedicate a higher share of their budget to tobacco spend a proportionally lower share on food expenditure. Therefore, I find that tobacco expenditure "crowds out" food expenditure in my sample in a similar fashion to that found by Block & Webb (2009).

While Figure 2 provides evidence of decreased food expenditure in tobacco consuming households, the question remains whether this decrease in food expenditure leads to an increase in child malnutrition and stunting. Notably, the rate of substitution between tobacco and food is relatively flat, and thus it is unclear whether the observed negative relationship is large enough to affect child nutritional status. Additionally, tobacco-consuming members of the household may protect children from crowd-out effects by reducing their own food intake in response to restricted food expenditure.

[12] More precisely, I estimate a partially linear model in which I estimate the share of the budget dedicated to food as a function of the budget share of tobacco, controlling for mother characteristics, household size, household per capita expenditure, household infrastructure, community infrastructure, province, and rural locality. The advantage of the partially linear model is that it allows me to estimate a non-linear relationship between the budget shares of food and tobacco expenditure, while also controlling for other associated characteristics.

Therefore, regression analysis is needed to confirm whether increased tobacco expenditure produces negative impacts on child health, which I discuss in the next section.

Figure 2: The Crowding Out Effect of Tobacco



Note: Figure 2 is generated semi-parametrically using a partially linear model, where budget share of food is estimated as a function of the budget share of tobacco, after controlling for mother characteristics, household size, household per capita expenditure, household infrastructure, community infrastructure, province, and rural locality. The sample is restricted to tobacco consuming households.

IV. Methodology

i. Conceptual Framework

The conceptual framework of this study is based on the static child health production model presented by De Silva and Sumarto (2018) and Strauss and Thomas (2008). Consider the parent's utility, represented as

$$\max_{H,T,C} U = U(H, T^L, C, \phi)$$

(1)

where H represents child health, T^L represents leisure time, C represents consumption, and ϕ represents preferences. Utility is then maximized with respect to a child health production function, a budget constraint, and a time constraint. The child health production function is written as

$$H = F(M, T^c, X^i, X^h, X^p, X^v, \varphi_i)$$

(2)

where M is defined as market-purchased health inputs, T^c as time spent in childcare, X^i as a vector of child characteristics, X^h as a vector of household characteristics, X^p as a vector of parental characteristics, X^v as a vector of community or village characteristics, and φ_i as a child-health error term capturing unobservable influences. The budget constraint and the time constraint are then represented as

$$p^c C + p^M M = wT^W + v$$

(3)

$$T = T^L + T^w + T^c$$

(4)

where p^c is the price of consumption goods, p^M is the price of market health inputs, w is the earned wage, v is non-labor income, and T^W is time spent working. It is important to note here that the consumption represented in C does not enter the child health production function, as health-related expenditures such as nutrition and healthcare are instead captured in M. Expenditures captured in C, such as tobacco expenditure, will only impact the child health production function through their influence on market-purchased health inputs M in equation (3). For example, if we suppose prices and income to be fixed, then an increase in tobacco expenditure, represented in C, will necessitate a decline in M, which may take the form of decreased spending on nutritious food. This decrease would then be observed in equation (2), leading to a decline in child health captured by H.

Solving the optimization problem and the first-order conditions yields the conditional market and non-market health demand functions, written here as

$$M^* = m(p^c, p^m, w, E, X^i, X^h, X^p, X^v, \varphi_i, \theta)$$
$$T^{c^*} = m(p^c, p^m, w, E, X^i, X^h, X^p, X^v, \varphi_i, \theta) \tag{5}$$

where demand for market and non-market health inputs are represented as a function of prices, earnings, household per capita expenditure (E), child characteristics, household characteristics, parental characteristics, community characteristics, and the error terms φ_i and θ.

Finally, we substitute (5) into equation (2) and obtain our conditional child health demand function, represented as

$$H^* = h(p^c, p^m, w, E, X^i, X^h, X^p, X^v, \varphi_i, \theta) \tag{6}$$

Equation (6) will then motivate the empirical specification discussed in the next section.

ii. Empirical Framework

<u>Ordinary Least Squares</u>

To examine how tobacco consumption influences child height and stunting risk, I estimate the following equation:

$$H_{i,j} = \beta_0 + \beta_1 tobac_j + \beta_2 X_i^c + \beta_3 X_i^m + \beta_4 X_j^h + \beta_5 X_j^s + \beta_6 X_j^v + \varepsilon_{i,j} \tag{7}$$

$H_{i,j}$ represents the anthropomorphic dependent variables of interest: height-for-age z-score and stunting occurrence. The independent variables of interest are household tobacco consumption status and the log of household tobacco expenditure, captured by $tobac_j$. X_i^c is a vector of child characteristics, including gender and age measured in months. X_i^m captures mother characteristics, such as the mother's reported height, age at birth, and years of schooling. X_j^h and X_j^s are vectors of household characteristics and socioeconomic status respectively, including controls for household size, number of children under 15, log of per capita expenditure, and the presence of a toilet in the home. Finally, X_j^v measures community factors contributing to child anthropometry, such as rural and urban status, region, and the prevalence of dirt roads in the local community.

Omitted variable bias is a concern with basic OLS estimates of the above specification, as there are likely unobservable characteristics associated with both tobacco use and child nutrition. Therefore, I implement a subdistrict-time fixed-effects approach of the following form

$$H_{i,j} = \beta_0 + \beta_1 tobac_j + \beta_2 X_i^c + \beta_3 X_i^m + \beta_4 X_j^h + \beta_5 X_j^s + \beta_6 X_j^v + \delta_{i,j} + t_{i,j} + \varepsilon_{i,j} \quad (8)$$

where $\delta_{i,j}$ and $t_{i,j}$ represent the subdistrict and time fixed effect respectively. With this approach, I remove time-invariant, unobservable characteristics associated with the subdistrict or the survey year. This will control for factors associated with both household tobacco consumption and child height, such as general economic conditions, the level of local infrastructure, and the strength of community public health programs and awareness.

It is important to note that many unobservable characteristics associated with the mother or household may still be unaccounted for in my estimation strategy. While equations (7) and (8) control for a myriad of household and parental characteristics, factors such as risk tolerance and general preferences for child health and tobacco consumption will likely not be captured in estimation. Ideally, a mother or household fixed effect could be implemented to control for such factors, assuming they are time invariant. However, as mentioned in the previous section, the panel of mothers and households in the sample is highly unbalanced, and thus there may be too little variation to support mother or household fixed effects. The resulting estimates from both approaches are reported in Table S4 of the appendix; however, the reported coefficients are likely unreliable estimators of the true impact of tobacco usage on child height-for-age and stunting risk.

To further build upon the above specifications, I implement a regression adjustment (RA) approach to estimate the average treatment effects (ATE) and average treatment effects among the treated (ATET) of exposure to a tobacco consuming household. Regression adjustment allows me to predict a counterfactual outcome for each observation by adjusting for observed covariates, thus imitating an experimental approach in a treatment effects framework. For instance, if we define H_1 to be the potential anthropometric outcome if a household consumed tobacco, and H_0 to be the potential outcome if a household did not consume tobacco, then the difference $E[H_1] - E[H_0]$ will represent the average treatment effect (ATE). Suppose we estimate the mean difference $E[H_1 | D = 1] - E[H_0 | D = 0]$, or in other words, by simply differencing the average outcomes for the treatment and control groups. In an experimental context where treatment is randomly assigned, this estimate will represent the average treatment effect, as on average the characteristics of the treatment and control groups will look similar. However, with observational data, selection into treatment suggests that the characteristics of a tobacco consuming household will likely differ slightly from a non-tobacco consuming household, compromising estimation of the average treatment effect.

However, regression adjustment allows me to estimate the average treatment effect despite the differences of observed characteristics between tobacco consuming and non-tobacco consuming households. In this approach, I estimate separate regressions for the treatment and control groups. I then use the estimated coefficients to predict potential outcomes for each observation, regardless of treatment status. Thus, for a child in the treatment group, I predict the child's height-for-age given that they live in a tobacco consuming household *and* a separate, counterfactual height-for-age assuming they lived in a non-tobacco consuming household. This is repeated for the control group. For each observation in the sample, the difference $E[H_1 | X] - E[H_0|X]$ is calculated, where X represents a vector of observable characteristics. Averaging these differences across all observations of the sample then yields the average treatment effect (ATE) of living in a tobacco consuming household. The average treatment effect among the treated (ATET) is similarly calculated, except only the individual treatment effects derived from the treatment group are averaged.

One caveat of the RA approach is the conditional independence assumption; after controlling for associated covariates, selection into treatment must be independent of the potential outcomes. While the IFLS provides a significant number of available controls to help strengthen this assumption, concerns of omitted variable bias remain. Factors such as levels of risk tolerance and household preferences are likely uncaptured in this specification, and thus threaten the validity of the conditional independence assumption. While intuition suggests that such preferences may play a marginal role in the association between household tobacco consumption and child height-for-age after controlling for household characteristics, the validity of the conditional independence assumption cannot be assured.

Two-Stage Least Squares

Another approach used to account for the potential endogeneity of tobacco expenditure is to instrument tobacco consuming behavior using cigarette prices or excise taxes, as is commonly done in the maternal smoking literature (Lien & Evans 2005; Noonan et al. 2007). I follow this approach, and instrument tobacco expenditure using the cigarette price reported by local markets and shops in the survey community. I estimate the following first-stage and second-stage equations using a 2SLS approach

$$lntobac_j = \beta_0 + \beta_0 lnprice_j + \beta_2 X_i^c + \beta_3 X_i^m + \beta_4 X_j^h + \beta_5 X_j^s + \beta_6 X_j^v + \delta_{i,j} + t_{i,j} + \epsilon_{i,j} \quad (9)$$

$$H_{i,j} = \beta_0 + \beta_1 \widehat{lntobac}_j + \beta_2 X_i^c + \beta_3 X_i^m + \beta_4 X_j^h + \beta_5 X_j^s + \beta_6 X_j^v + \delta_{i,j} + t_{i,j} + \varepsilon_{i,j} \quad (10)$$

Equation (9) represents the first-stage estimates, where the log of household tobacco expenditure is estimated as a function of log community cigarette price, child characteristics, mother characteristics, household characteristics, socioeconomic status, and community characteristics. The predicted value of log household tobacco expenditure is then obtained from equation (9) and substituted into equation (10) to estimate the impact of household tobacco expenditure on child height-for-age and stunting risk. Subdistrict fixed effects ($\delta_{i,j}$) are also included in several specifications.

There are several reasons to believe that community cigarette price will be exogenous to the model of tobacco expenditure and child health, and thus will satisfy the exclusion restriction. Firstly, since price is measured at the community level, one household's demand and preferences for tobacco is unlikely to produce a large effect on the market demand and resulting market price. Given that the median population of survey communities in the IFLS is 5,836 for 2007 and 6,324 for 2014, the 12-18 households within each community is unlikely to influence cigarette demand to a strong enough degree to compromise the instrument (See Table S3 of the appendix).

This claim is further supported by Tables S4 and S5 of the appendix. Table S4 and S5 demonstrate that price varies significantly by location. The mean cigarette price in urban communities is higher than in rural communities, with a mean price of 821 rupiah compared to 776 rupiah per stick. These differences carry over to the province level as well; the Outer Islands report the highest mean cigarette price at 821 rupiah per stick, followed by Java-Bali (796 rupiah) and Sumatra (790 rupiah). Additionally, differences in mean community price were also observed between the two survey years in Table 1, indicating that cigarette price varies temporally as well. These trends indicate that spatial and temporal factors likely explain community cigarette price to a much larger degree than individual demand, and thus strengthen the assumption of the exogeneity of the instrument.

Notably, many of the papers using this approach rely on state-level variation in cigarette prices for identification. While Indonesia underwent several tax regime changes over the sample period, there is evidence to suggest that consumers were relatively unresponsive to the rise in prices; therefore, weakness of the instrument is a concern (Adrison & Putranto 2018; Amalia et al. 2019). Additionally, existing evidence also suggests that tobacco is generally price inelastic (Chaloupka & Warner 2000).[13] If

[13] One exception is Witoelar, Rukumnauykit, and Strauss (2005), who estimate a price elasticity of tobacco of 1.2 for households below median per capita expenditure.

community cigarette price is only weakly correlated with household tobacco expenditure in equation (9), then the predicted effect of tobacco expenditure on child height in equation (10) will be positively biased compared to OLS estimates (Murray 2006). To test the weakness of community cigarette price, F-statistics obtained from Stock and Yogo (2005) tests will be included with the 2SLS estimation results.

While the estimates presented in this paper are likely non-causal, they still build upon those presented in the literature in several ways. By incorporating subdistrict fixed effects, this study moves beyond the correlational, multivariate OLS framework presented in the literature. Furthermore, by implementing an instrument of cigarette price, I explore the endogeneity of tobacco expenditure, and further move towards causality in my estimation approach. Finally, I present the first estimates of the ATT and ATET of household tobacco consumption on child height, capturing the treatment effect in a RA framework. By presenting estimates from a wide range of methodologies, I hope to provide a more detailed picture of the effects of household tobacco consumption on child height and stunting risk in Indonesia.

IV. Results

i. OLS and Sub-District Fixed Effects

Table 3 reports the regression results of both the OLS and subdistrict fixed effects specifications for height-for-age z-score and stunting risk.[14] The reported coefficients suggest a significant role for tobacco consumption in explaining child height outcomes. In

[14] All reported standard errors are robust standard errors. Errors clustered at the subdistrict level were attempted and were largely similar to the standard robust specification. The results of this specification can be found in Table S7 of the appendix.

columns (1) and (5), I estimate that living in a tobacco-consuming household is associated with a .103 reduction in height-for-age z-score and a 3-percentage point increase in the risk of stunting, both of which are significant at the 1% level. With the addition of subdistrict fixed effects in columns (2) and (6), the estimated effect drops somewhat in magnitude, but remains statistically significant at the 5% level.

Columns (3), (4), (7), and (8) present evidence of a positive correlation between household tobacco expenditure and child malnutrition. The estimated effect of increased tobacco expenditure is small yet statistically significant; in columns (3) and (7) I estimate that a 1% increase in monthly tobacco expenditure is associated with a decrease in height-for-age z-score of -.008 and an increase in stunting risk of .2 percentage points. Once again, the magnitude of the point estimates decreases with the introduction of subdistrict fixed effects in columns (4) and (8), but remains statistically significant at the 5% level.

The reported coefficients for the control variables present some interesting findings.[15] Notably, the coefficient for the 2014 survey year dummy is negative and statistically significant in columns (1)-(4), suggesting that height-for-age has worsened between the two survey rounds. This result holds for stunting risk as well, but is only statistically significant in the OLS specifications. Consistent with the literature, I identify positive associations for maternal education, maternal age at birth, maternal height, and household per capita expenditure. Similarly, I find negative influences for male gender, monthly age, and number of household members under 15 years of age. Living in a rural community, and in Sumatra or the Outer Islands is also associated with lower height-for-

[15] Table S3 of the appendix reports coefficients for the full regression model.

Table 3: Effects of household tobacco consumption on child height

	Height-for-age z-score				Moderately or severely stunted			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Household reports tobacco expenditure	-0.103**	-0.0893*			0.0303**	0.0276*		
	(0.0367)	(0.0410)			(0.0109)	(0.0117)		
Log monthly tobacco expenditure			-0.00844**	-0.00695*			0.00235**	0.00201*
			(0.00301)	(0.00335)			(0.000890)	(0.000960)
Year 2014	-0.155***	-0.131*	-0.153***	-0.129*	0.0399**	0.0239	0.0393**	0.0234
	(0.0432)	(0.0542)	(0.0432)	(0.0542)	(0.0131)	(0.0146)	(0.0131)	(0.0146)
Log per capita expenditure	0.209***	0.166***	0.212***	0.168***	-0.0558***	-0.0418***	-0.0567***	-0.0425***
	(0.0339)	(0.0405)	(0.0340)	(0.0407)	(0.00984)	(0.0111)	(0.00985)	(0.0111)
Rural	-0.100**	-0.0402	-0.101**	-0.0408	0.0268*	0.0130	0.0270*	0.0132
	(0.0387)	(0.0756)	(0.0387)	(0.0756)	(0.0119)	(0.0243)	(0.0119)	(0.0243)
Observations	8846	8846	8846	8846	8846	8846	8846	8846
R^2	0.090	0.072	0.090	0.072	0.063	0.038	0.063	0.037
Subdistrict fixed effects	N	Y	N	Y	N	Y	N	Y

Standard errors in parentheses

Notes: Reported standard errors are robust. Controls for child, mother, household, socioeconomic, and community characteristics are included.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

age and a higher risk of stunting. Contrary to Mani (2013), I find no role for community electricity access or dirt roads in explaining height-for-age.

Surprisingly, I predict no statistically significant association between household insurance status and child height. None of the coefficients for the presence of a dirt floor in the household are statistically significant, although the point estimates are in the expected direction. Whether the household purchases water and the presence of midwives in the community were positively associated with height-for-age z-scores, but not stunting risk, and point estimates were only statistically significant with the addition of the subdistrict fixed effect. The reverse is true for the presence of a toilet within the home, which was negatively associated with stunting risk with the addition of subdistrict fixed effects, but statistically insignificant in the OLS regressions.

In Table 4, I estimate my regressions separately for the rural and urban samples to explore how the correlation between tobacco consumption on child height and stunting risk varies by location. While there is a considerable loss of precision, my coefficients remain similar in sign and magnitude to those presented in Table 3. I find tobacco consumption is associated with a slightly lower height-for-age and a slightly higher risk of stunting in rural households as compared to urban households.

In Table 5, I examine whether the association between tobacco expenditure and child height varies with the severity of stunting. As before, I follow the WHO (2006) growth standards and define moderate stunting as being 2-3 standard deviations below the international mean height-for-age, and severe stunting as being 3 or more standard deviations below the international mean height for age. In columns (1)-(4), I regress severe

Table 4: Effects of household tobacco consumption on child height, rural vs urban households

	Height-for-age z-score				Moderately or severely stunted			
	Urban		Rural		Urban		Rural	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Household reports tobacco expenditure	-0.0451		-0.144*		0.0233		0.0290	
	(0.0550)		(0.0655)		(0.0154)		(0.0201)	
Log of monthly tobacco expenditure		-0.00362		-0.0108*		0.00164		0.00205
		(0.00445)		(0.00547)		(0.00125)		(0.00169)
Year 2014	-0.116	-0.115	-0.138	-0.135	0.0285	0.0282	0.0221	0.0214
	(0.0687)	(0.0686)	(0.0920)	(0.0919)	(0.0189)	(0.0190)	(0.0251)	(0.0251)
Log per capita expenditure	0.139*	0.140**	0.211**	0.216***	-0.0320*	-0.0325*	-0.0606***	-0.0614***
	(0.0540)	(0.0541)	(0.0643)	(0.0647)	(0.0146)	(0.0146)	(0.0178)	(0.0179)
Observations	4959	4959	3887	3887	4959	4959	3887	3887
R^2	0.056	0.056	0.105	0.105	0.031	0.031	0.058	0.058
Subdistrict fixed effect	Y	Y	Y	Y	Y	Y	Y	Y

Standard errors in parentheses

Notes: Reported standard errors are robust. Controls for child, mother, household, socioeconomic, and community characteristics are included.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

stunting outcomes on household tobacco consumption, with the inclusion of subdistrict fixed effects in columns (2) and (4). The resulting coefficients are close to 0 and statistically insignificant, suggesting that household tobacco consumption is not strongly related with the risk of being severely stunted.[16] In columns (5)-(8), I regress moderate stunting outcomes on household tobacco consumption, and include subdistrict fixed effects in columns (6) and (8). In columns (5), I find that living in a tobacco consuming household is associated with a 3-percentage point increase in the likelihood of being moderately stunted. The coefficients decline in magnitude with the addition of subdistrict fixed effect in column (6); however, I still estimate that living in a tobacco consuming household is associated with an increased risk of stunting of 2.7-percentage points.

In Table 6, I examine whether estimates for household tobacco expenditure varies by age group. I split the sample into groups of 0-2 year-olds and 3-5 year-olds and re-run my regressions for each cohort separately. In columns (1)-(4), I find no statistically significant relationship between household tobacco consumption and child height-for-age for either cohort. In columns (5)-(8), however, I identify a statistically significant, positive relationship between household tobacco consumption and stunting risk, but only for children under the age of 3 in columns (5) and (6). While there are fewer 3-5 year old observations and some loss of precision from separating the sample, this suggests that children 0-2 years old are more sensitive to household tobacco consumption.[17]

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[16] Only 13% (1,156) children in my sample fall in the severely stunted category; therefore, the estimates in columns (1)-(4) of Table 5 may reflect a lack of statistical power rather than a lack of an association between household tobacco consumption and the risk of severe stunting.

[17] Alternatively, the stronger association between household tobacco consumption and child stunting risk for children under the age of 3 could suggest a role for low birthweight in explaining the association between household tobacco expenditure and child height. Unfortunately, examining this channel is beyond the scope of this paper.

Table 5: Effects of household tobacco consumption on moderate and severe stunting risk

	Severely stunted				Moderately stunted			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Household reports tobacco expenditure	0.00865	0.00642			0.0275**	0.0267*		
	(0.00768)	(0.00833)			(0.0106)	(0.0118)		
Log of monthly tobacco expenditure			0.000782	0.000532			0.00203*	0.00189*
			(0.000630)	(0.000681)			(0.000869)	(0.000960)
Year 2014	0.00599	0.00131	0.00579	0.00117	0.0406**	0.0235	0.0402**	0.0230
	(0.00921)	(0.0113)	(0.00921)	(0.0114)	(0.0129)	(0.0145)	(0.0129)	(0.0146)
Log per capita expenditure	-0.0267***	-0.0218*	-0.0270***	-0.0220**	-0.0424***	-0.0276*	-0.0431***	-0.0283**
	(0.00690)	(0.00845)	(0.00692)	(0.00847)	(0.00966)	(0.0107)	(0.00967)	(0.0107)
Rural	0.0104	0.00357	0.0105	0.00359	0.0206	0.00429	0.0208	0.00452
	(0.00867)	(0.0181)	(0.00867)	(0.0181)	(0.0120)	(0.0256)	(0.0120)	(0.0256)
Observations	8846	8846	8846	8846	7690	7690	7690	7690
R^2	0.023	0.012	0.023	0.012	0.053	0.035	0.053	0.035
Subdistrict fixed effect	N	Y	N	Y	N	Y	N	Y

Standard errors in parentheses

Notes: Reported standard errors are robust. Controls for child, mother, household, socioeconomic, and community characteristics are included. Moderate stunting and severe stunting are defined according to WHO Growth Standards, where a height 2-3 standard deviations below the mean is considered moderate stunting and a height 3 standard deviations below the mean is considered severe stunting.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Effects of household tobacco consumption on child height by age group

	Height-for-age z-score				Moderately or severely stunted			
	Age 0-2 years		Age 3-5 years		Age 0-2 years		Age 3-5 years	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Household reports tobacco expenditure	-0.0891		-0.0674		0.0334*		0.0190	
	(0.0608)		(0.0473)		(0.0155)		(0.0192)	
Log of monthly tobacco expenditure		-0.00730		-0.00458		0.00273*		0.000985
		(0.00497)		(0.00391)		(0.00128)		(0.00158)
Year 2014	-0.0553	-0.0536	-0.195**	-0.194**	0.00233	0.00170	0.0499*	0.0495*
	(0.0786)	(0.0785)	(0.0669)	(0.0670)	(0.0203)	(0.0203)	(0.0249)	(0.0250)
Log per capita expenditure	0.0959	0.0990	0.203***	0.204***	-0.0251	-0.0262	-0.0568**	-0.0571**
	(0.0602)	(0.0607)	(0.0477)	(0.0478)	(0.0148)	(0.0149)	(0.0188)	(0.0188)
Observations	5283	5283	3563	3563	5283	5283	3563	3563
R^2	0.115	0.115	0.057	0.057	0.064	0.064	0.052	0.052
Subdistrict fixed effects	Y	Y	Y	Y	Y	Y	Y	Y

Standard errors in parentheses

Notes: Reported standard errors are robust. Controls for child, mother, household, socioeconomic, and community characteristics are included.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The estimates discussed above suggest that children living in tobacco consuming households face a disproportionally higher risk of stunting and lower height-for-age; a risk that increases with higher levels of monthly tobacco expenditure. However, intuition suggests that the influence of tobacco consumption on child height may be non-linear. To explore this, I binned tobacco expenditure, and created dummy variables for households that report 0%, <5%, 5-10%, 10-15%, and >15% budget shares of tobacco. I then estimated child height-for-age z-score and stunting risk as a function of these dummies.

The results in Table 7 suggests that tobacco expenditure exhibits some degree of non-linearity. In column (1), I estimate that 10% and 15% budget shares of tobacco are associated with a statistically significant decline in height-for-age z-score. With the addition of subdistrict fixed effects in column (2), only the 10% budget share of tobacco remains statistically significant. The coefficient for over 15% budget share of tobacco flips in sign, although it is statistically insignificant. In column (2), 5%, 10%, and 15% share of tobacco are predicted to increase stunting risk, while over 15% tobacco budget share presents a coefficient close to 0. With the addition of the subdistrict fixed effect in column (4), only 5% and 15% budget shares of tobacco remain statistically significant. Notably, in all specifications the magnitude of the estimated coefficient grows until it exceeds 15% budget share of tobacco; therefore, tobacco expenditure likely influences child nutrition and height-for-age in a non-linear fashion.

Table 7: Non-linearity of tobacco expenditure

	Height-for-age z-score		Moderate or severely stunted	
	(1)	(3)	(2)	(4)
<5% share	-0.0657	-0.0951	0.0288*	0.0386*
	(0.0477)	(0.0541)	(0.0142)	(0.0151)
5-10% share	-0.1399**	-0.1358**	0.0306*	0.0270
	(0.0457)	(0.0483)	(0.0138)	(0.0148)
10-15% share	-0.1231*	-0.1009	0.0460**	0.0412*
	(0.0532)	(0.0576)	(0.0161)	(0.0176)
>15% share	-0.0653	0.0363	0.0097	-0.0108
	(0.0593)	(0.0652)	(0.0184)	(0.0189)
Year 2014	-0.1552***	-0.1363*	0.0403**	0.0259
	(0.0433)	(0.0543)	(0.0131)	(0.0147)
Observations	8846	8846	8846	8846
R^2	0.090	0.073	0.063	0.038
Subdistrict fixed effect	N	Y	N	Y

Standard errors in parentheses
Notes: Reported standard errors are robust. Controls for child, mother, household, socioeconomic, and community characteristics are included. Bins of budget share of tobacco are defined for <5%, 5-10%, 10-15%, and >15% budget shares of tobacco. The dummy variable for 0% budget share of tobacco is omitted to avoid perfect collinearity.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

ii. Regression Adjustment

To expand upon the OLS and subdistrict fixed effects framework reported above, I implement a regression adjustment approach to estimate the treatment effects of living in a tobacco consuming household. From this approach, I obtain the average treatment effect (ATE) and the average treatment effect on the treated (ATET), which are reported in Table 8.

Table 8: Regression adjustment results

	Stunted or severely stunted		Height-for-age z-score	
	ATE	ATET	ATE	ATET
Household reports tobacco expenditure	0.0305**	0.0307**	-0.1006**	-0.0989*
	(0.0112)	(0.0118)	(0.0374)	(0.0392)
N	8.8e+03	8.8e+03	8.8e+03	8.8e+03

Standard errors in parentheses
Notes: Controls for child, mother, household, socioeconomic, and community characteristics are included.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results in Table 8 are remarkably similar to the OLS and subdistrict fixed effects estimators in Table 3. For the ATE, I estimate that living in a tobacco consuming household is associated with a 3.05 percentage point increase in the risk of stunting. For ATET estimates, the estimated increased risk of stunting is only marginally higher, with a 3.07 percentage point increase in stunting risk. The estimated ATE effect of household tobacco consumption on height-for-age z-score is also very similar to the OLS estimates. The ATE of living in a tobacco consuming household is a -0.101 reduction in height-for-age z-score. When the ATET is estimated by averaging the treatment effects over tobacco consuming households, the estimator decreases only slightly to -0.099, although it reduces in statistical significance as well.

iii. Two-Stage Least Squares

While the OLS, subdistrict fixed effects, and RA analysis suggests a strong positive role for household tobacco consumption and expenditure in explaining child stunting risk, the presented estimators will face an issue of omitted variable bias if tobacco expenditure is endogenous to the model of child height. According to the Durbin-Wu-Hausman (DWH) test presented in appendix Table S11, tobacco expenditure is likely endogenous to my regressions. To rectify this, I instrument tobacco expenditure using local community cigarette price and implement a two-stage least squares approach (2SLS).

The first and second stage results are presented in Table 9 and Table 10 respectively. While community cigarette price is predicted to positively influence monthly tobacco expenditure, the reported standard errors are quite large in both the OLS and subdistrict fixed effects specifications. Therefore, the first stage estimators are statistically insignificant. We observe similar issues in the second-stage results presented in Table 10;

the standard errors are large, and the reported coefficients are many times larger than the OLS and subdistrict fixed effects estimates. The large increase in magnitude of reported coefficients and lack of strong first-stage estimates suggests that community cigarette price may be a weak instrument. To test this theory, I run a Stock and Yogo (2005) test for weak instruments and present the resulting F-statistics in Table 10. With a F-statistic of 2.966 well below the recommended F-statistic of 10, cigarette price is likely a very weak instrument for tobacco expenditure.

Table 9: IV results—1st stage

	(1) Log of monthly tobacco expenditure	(2) Log of monthly tobacco expenditure
Log of community cigarette price	0.6453	0.8547
	(0.3708)	(0.7446)
Year 2014	0.0396	-0.2381
	(0.2537)	(0.4626)
Log per capita expenditure	0.6862^{***}	0.8216^{***}
	(0.1211)	(0.1429)
Rural	0.4860^{***}	0.6322^{*}
	(0.1385)	(0.3113)
Observations	8839	8839
R^2	0.060	0.032
Subdistrict fixed effects	No	Yes

Standard errors in parentheses
Notes: Reported standard errors are robust. Controls for child, mother, household, socioeconomic, and community characteristics are included. Community cigarette price is obtained from interviews with local market and shop vendors and is represented as price per cigarette.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: IV results—2nd stage

	(1) Height-for-age z-score	(2) Stunted or severely stunted	(3) Height-for-age z-score	(4) Stunted or severely stunted
Log of monthly tobacco expenditure	-0.3083	0.0996	-0.5559	0.1818
	(0.2284)	(0.0712)	(0.4751)	(0.1623)
Year 2014	-0.0343	0.0008	0.0037	-0.0201
	(0.1084)	(0.0340)	(0.1648)	(0.0554)
Log per capita expenditure	0.4207*	-0.1245*	0.6181	-0.1899
	(0.1672)	(0.0520)	(0.3999)	(0.1357)
Rural	0.0412	-0.0190	0.3009	-0.0987
	(0.1220)	(0.0380)	(0.3579)	(0.1234)
Observations	8839	8839	8839	8839
R^2	.	.	.	.
F(1,8818)	2.966	2.966	.	.
Subdistrict fixed effects	No	No	Yes	Yes

Standard errors in parentheses
Notes: Reported standard errors are robust. Controls for child, mother, household, socioeconomic, and community characteristics are included. F-statistics are obtained from the Stock & Yogo test but are unavailable for the subdistrict fixed effect specifications.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In tables S12 and S13 of the appendix, I repeat the 2SLS regression for subsamples of my dataset, examining the instrument strength of cigarette price for poorer households, richer households, tobacco consuming households, rural households, households in which the father smokes, and households with one or more members with a tobacco habit.[18] While the F-statistic varies among subsamples, in no specification does it reach the suggested F-statistic of 10. Therefore, the results of my IV analysis are ultimately inconclusive, and I am not fully able to account for the endogeneity of tobacco expenditure.

iv. Discussion

The results of my analysis point to a strong, negative effect of household tobacco consumption status on child height and nutritional status. I additionally find a small yet

[18] Poorer and richer households are defined as those within the top and bottom 50th percentile of per capita expenditure respectively.

statistically significant role for tobacco expenditure in explaining this association, as increases in tobacco expenditure are associated with lower height-for-age and nutritional status. As evidenced by the binned regressions in Table 7, the association between expenditure and nutrition is likely non-linear.

It is critical to note that my estimates are largely non-causal; I am unable to account for the endogeneity of tobacco expenditure and time-invariant, unobservable characteristics associated with the mother or household. The validity of my estimation thus hinges on the size of the expected omitted variable bias. There are very few observable characteristics that are not controlled for in my model, with controls ranging from household assets to maternal characteristics to community programs and infrastructure. While I am not able to explicitly control for household and parental preferences for expenditure and child health, it is plausible that the controls for household socioeconomic status, composition, and infrastructure may indirectly capture health preferences to a degree. However, without a stronger mother or household fixed effect specification to fully control for such time invariant, unobservable preferences, it is hard to know for certain the size of omitted variable bias present my analysis.

Another critical consideration is whether tobacco expenditure is endogenous to the estimated child health equation due to household selection bias. While the DWH test in appendix table S6 suggests that tobacco expenditure is endogenous, I reject the hypothesis of exogeneity at the 5% significance level. Existing evidence of the endogeneity of tobacco in the infant health literature is also mixed; while Fertig (2010) finds evidence for selection bias, Lien and Evans (2005) find that 2SLS estimates are roughly similar to those produced by OLS, which suggests a minimal role for endogeneity. Regardless of its size, endogeneity would indicate that my results overestimate the impact of tobacco expenditure on child height, as estimators would misattribute the effect of household preferences or risk tolerance on child height as the effect of tobacco expenditure.

V. Conclusion

With nearly 1 in 3 children under 5 suffering from chronic malnutrition, addressing stunting is a critical focus of Indonesian development policy (Rokx et al. 2018). However, my findings suggest that the current state of tobacco control policy in the country works against these aims. With a nationally representative dataset and a more robust regression framework than previously used in the literature, I estimate that a child living in a smoking household faces a 3-percentage point increase in the risk of stunting. I additionally find that this negative impact increases at higher levels of tobacco expenditure, as I predict that a 1% rise in monthly tobacco expenditure is associated with a .2-percentage point increase in the risk of stunting. This suggests that tobacco expenditure crowds out funding necessary for much needed health investments and contributes to the increased risk of malnutrition associated with living in a tobacco consuming household.

Unfortunately, I am ultimately unable to account for the endogeneity of tobacco consumption in my analysis, as locally reported cigarette price proved to be a weak instrument of tobacco expenditure. Additionally, there remains a significant amount of potential for unobserved heterogeneity at the mother and household level, as my panel is too unbalanced to support a mother or household fixed effects framework. For these reasons, some caution is warranted in interpreting my results, as my findings are likely non-causal. Nonetheless, I argue my estimates present stronger evidence of the association between household tobacco consumption and child stunting risk than previously presented in the literature. Additionally, I argue my study provides a strong foundation for future research to explore the true causal effect of tobacco on child health outcomes in Indonesia.

While my findings suggest that reducing tobacco consumption in Indonesia could generate positive externalities for child health, there is some need for caution in extending my findings to tobacco control policy recommendations. While increases in cigarette taxation between 2007 and 2014 failed to reduce tobacco consumption and expenditure, it is unclear whether increasing tobacco taxes further would generate improvements in child health (Amalia et al. 2019). If an increased tax raised cigarette prices and produced no effect on the quantity of tobacco consumed, then my findings would suggest that the resulting rise in tobacco expenditures would increase the incidence of stunting.[19] While the potential effects of control policies such as public smoking bans, advertising regulation, and smoking cessation assistance is less ambiguous, identifying the influence of such policies on child health will be the task of future research.

While no clear direction for policy emerges, my findings do suggest that some action to reduce tobacco consumption in Indonesia is warranted. The increased risk of stunting a child faces from living in a tobacco consuming household will likely carry into the rest of their life cycle. This is likely to perpetuate poverty and impede the growth of human capital across the country and across generations. Therefore, the costs of tobacco in Indonesia are likely much higher than current estimates, suggesting that the social benefits of improved tobacco control outweigh the costs.

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[19] I thank Professor Mellor for suggesting this.

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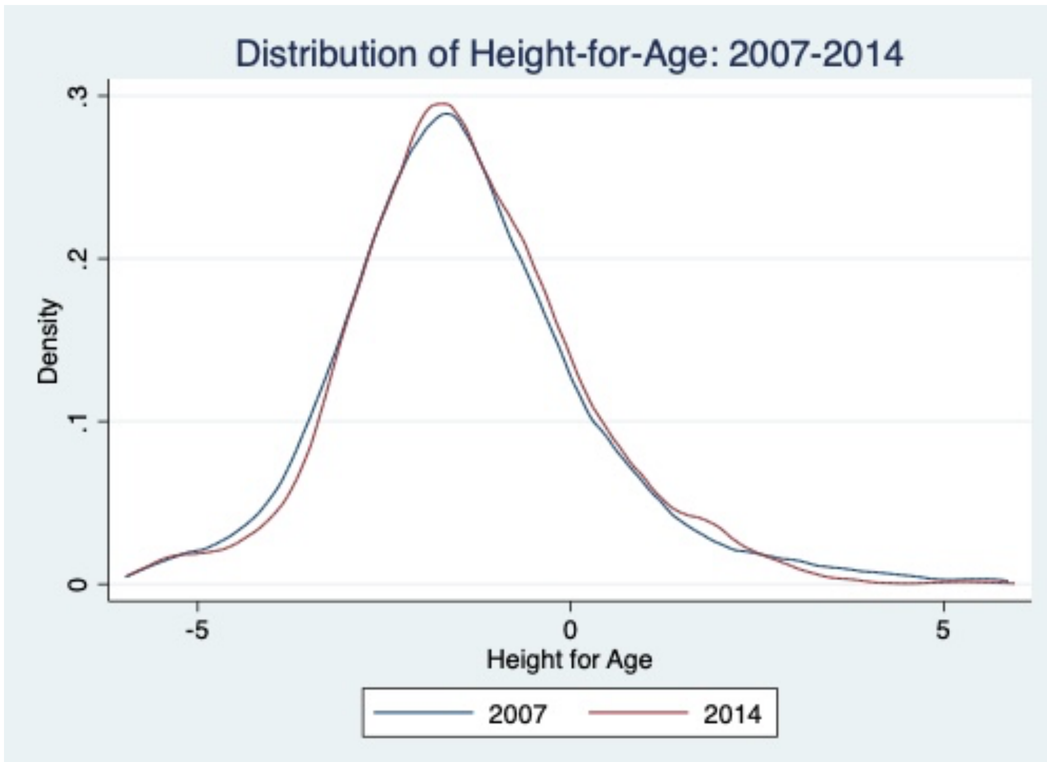
VI. Appendix

Table S1: Summary statistics for observations included and omitted from analysis

	Omitted			Included		
	count	mean	sd	count	mean	sd
Height-for-age z-score	639	-1.417	1.666	8846	-1.406	1.614
Moderately or severely stunted	639	0.352	0.478	8846	0.362	0.481
Moderately stunted	639	0.208	0.406	8846	0.232	0.422
Severely stunted	639	0.144	0.351	8846	0.131	0.337
Household reports tobacco expenditure	597	0.687	0.464	8846	0.687	0.464
Log of monthly tobacco expenditure	597	8.182	5.598	8846	8.288	5.654
Budget share of tobacco	597	5.789	6.643	8846	6.190	6.617
Male	639	0.543	0.499	8846	0.518	0.500
Monthly age	639	34.491	17.351	8846	29.807	17.565
Mother years of school	119	10.597	4.055	8846	9.724	3.579
Mother age at birth	394	28.036	6.583	8846	27.388	5.900
Mother height	192	150.997	8.149	8846	151.381	7.576
Log per capita expenditure	639	13.171	0.745	8846	13.250	0.687
Poor household	639	0.440	0.497	8846	0.388	0.487
Household insured	639	0.365	0.482	8846	0.341	0.474
Household size	639	6.163	3.013	8846	5.303	2.493
Number in household under 15 years	639	2.156	1.089	8846	2.052	1.017
Rural	639	0.501	0.500	8846	0.439	0.496
Sumatra	639	0.186	0.390	8846	0.251	0.434
Outer Islands	639	0.326	0.469	8846	0.286	0.452
Dirt flooring	639	0.070	0.256	8846	0.047	0.211
Purchases water	639	0.358	0.480	8846	0.366	0.482
Owns toilet	639	0.775	0.418	8846	0.789	0.408
Dirt road	625	0.041	0.197	8846	0.026	0.160
Year 2014	639	0.473	0.500	8846	0.532	0.499

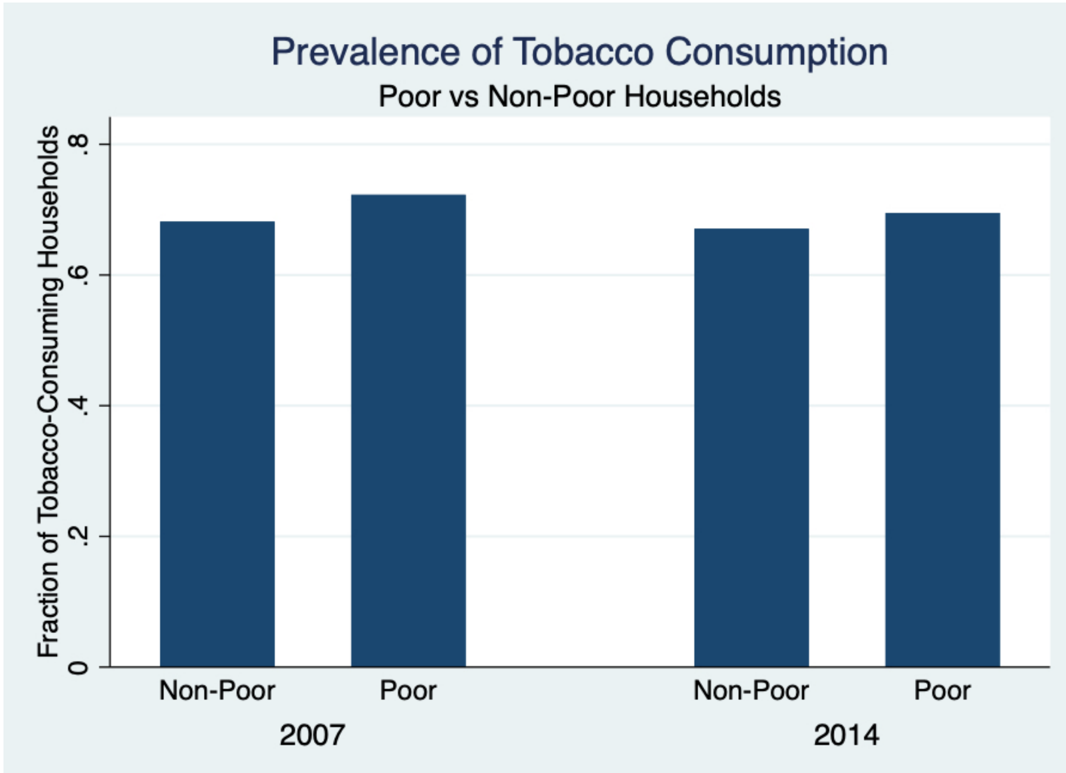
Notes: Table compares descriptive statistics between observations included and excluded in the final under-5 sample used for analysis. Data is obtained from the 2007 and 2014 rounds of the IFLS. Missing mother information and missing height information are the two largest reasons for omission. Children are considered stunted if their height-for-age is 2 or more standard deviations below the international mean reported by the WHO (2006). Stunting is considered moderate if children are 2-3 standard deviations below, and severe if children are 3 or more standard deviations below the mean height for age.

Figure S1: Distribution of Height-for-Age: 2007-2014



Note: Figure S1 reports the probability density distribution of height-for-age z-scores in 2007 and 2014. Z-scores are calculated relative to the WHO 2006 international growth standards.

Figure S2: Prevalence of Tobacco Consumption: Poor vs Non-Poor



Note: Bars represent the mean of household tobacco consumption status for poor and non-poor households over 2007 and 2014. Poor households are defined as those within the bottom 30th percentile of per capita expenditure. Households are considered tobacco-consuming if they report tobacco expenditure greater than zero.

Table S2: Tobacco consumption in urban and rural households

	Urban		Rural	
	mean	sd	mean	sd
Household reports tobacco expenditure	0.641	0.480	0.738	0.440
Log of monthly tobacco expenditure	7.817	5.890	8.799	5.310
Budget share of tobacco	5.660	6.348	6.856	6.905
Number with tobacco habit in household	0.743	0.688	0.842	0.661
Observations	4339		3494	

Notes: Table compares trends in household tobacco expenditure between urban and rural households. Data is obtained from the 2007 and 2014 rounds of the IFLS. Budget share of tobacco is calculated by dividing total monthly tobacco expenditure by total monthly expenditure.

Table S3: Community size and representation in child sample

	2007			2014		
	mean	median	sd	mean	median	sd
Number of child observations in each community	18.71	18.00	15.37	15.95	12.00	15.49
Community population	9443.51	5836.00	13119.04	12055.44	6324.00	17491.63
Number of child observations in each subdistrict	25.46	24.00	19.11	24.52	22.00	20.09
Observations		4137			4709	

Notes: Table presents descriptive statistics for community and sample population for the under-5 sample obtained from the 2007 and 2014 rounds of the IFLS. Community population figures are reported by the village head.

Table S4 : Cigarette prices in rural and urban communities

	Urban			Rural		
	mean	median	sd	mean	median	sd
Price of cigarettes	821.891	864.583	234.925	776.824	750.000	238.245
Observations		4954			3885	

Notes: Table represents variation in community cigarette prices in rural and urban communities from the 2007 and 2014 rounds of the IFLS. Price per stick is collected from surveys of local market and shop vendors, and is represented in Indonesian rupiah. Missing prices were imputed using the median cigarette price at the subdistrict level.

Table S5: Cigarette price across different regions

	Java-Bali			Sumatra			Outer Islands		
	mean	median	sd	mean	median	sd	mean	median	sd
Price of cigarettes	796.342	708.333	232.370	790.771	787.500	233.604	821.290	916.667	247.626
Observations	4098			2213			2528		

Notes: Table represents variation in community cigarette prices over the major regions of Indonesia reported in the 2007 and 2014 rounds of the IFLS. Price per stick is collected from surveys of community market and shop vendors, and is represented in Indonesian rupiah. Missing prices were imputed using the median cigarette price at the subdistrict level.

Table S6: Effects of household tobacco consumption on child height—Full specification

	(1) Height-for-age z-score	(2) Height-for-age z-score	(3) Height-for-age z-score	(4) Height-for-age z-score	(5) Stunted or severely stunted	(6) Stunted or severely stunted	(7) Stunted or severely stunted	(8) Stunted or severely stunted
Household reports tobacco expenditure	-0.103**	-0.0893*			0.0303**	0.0276*		
	(0.0367)	(0.0410)			(0.0109)	(0.0117)		
Log of monthly tobacco expenditure			-0.00844**	-0.00695*			0.00235**	0.00201*
			(0.00301)	(0.00335)			(0.000890)	(0.000960)
Year 2014	-0.155***	-0.131*	-0.153***	-0.129*	0.0399**	0.0239	0.0393**	0.0234
	(0.0432)	(0.0542)	(0.0432)	(0.0542)	(0.0131)	(0.0146)	(0.0131)	(0.0146)
Male	-0.0664*	-0.0851*	-0.0664*	-0.0850*	0.0248*	0.0315**	0.0248*	0.0314**
	(0.0328)	(0.0346)	(0.0328)	(0.0346)	(0.00992)	(0.0110)	(0.00992)	(0.0110)
Monthly age	-0.0180***	-0.0189***	-0.0180***	-0.0189***	0.00256***	0.00255***	0.00256***	0.00255***
	(0.000994)	(0.00106)	(0.000994)	(0.00106)	(0.000275)	(0.000311)	(0.000275)	(0.000311)
Mother years of school	0.0265***	0.0155*	0.0264***	0.0156*	-0.00840***	-0.00532**	-0.00840***	-0.00535**
	(0.00521)	(0.00605)	(0.00521)	(0.00606)	(0.00163)	(0.00193)	(0.00163)	(0.00193)
Mother age at birth	0.0108***	0.00825*	0.0108***	0.00826*	-0.00402***	-0.00335***	-0.00402***	-0.00337***
	(0.00304)	(0.00327)	(0.00304)	(0.00328)	(0.000919)	(0.000986)	(0.000920)	(0.000986)
Mother height	0.0237***	0.0215***	0.0237***	0.0215***	-0.00761***	-0.00700***	-0.00761***	-0.00700***
	(0.00435)	(0.00482)	(0.00435)	(0.00482)	(0.00116)	(0.00150)	(0.00116)	(0.00150)
Log per capita expenditure	0.209***	0.166***	0.212***	0.168***	-0.0558***	-0.0418***	-0.0567***	-0.0425***
	(0.0339)	(0.0405)	(0.0340)	(0.0407)	(0.00984)	(0.0111)	(0.00985)	(0.0111)
Household insured	-0.0251	-0.0426	-0.0254	-0.0430	0.00359	0.0115	0.00370	0.0116
	(0.0364)	(0.0448)	(0.0364)	(0.0449)	(0.0114)	(0.0139)	(0.0114)	(0.0140)
Household size	0.0340***	0.0335***	0.0343***	0.0337***	-0.0110***	-0.0109***	-0.0111***	-0.0109***
	(0.00863)	(0.00944)	(0.00864)	(0.00943)	(0.00248)	(0.00275)	(0.00248)	(0.00275)
Number under 15 in household	-0.114***	-0.0884***	-0.114***	-0.0882***	0.0313***	0.0260***	0.0312***	0.0259***
	(0.0209)	(0.0239)	(0.0209)	(0.0239)	(0.00630)	(0.00702)	(0.00630)	(0.00702)

Rural	-0.100**	-0.0402	-0.101**	-0.0408	0.0268*	0.0130	0.0270*	0.0132
	(0.0387)	(0.0756)	(0.0387)	(0.0756)	(0.0119)	(0.0243)	(0.0119)	(0.0243)
Sumatra	-0.127**	0	-0.125**	0	0.0184	0	0.0183	0
	(0.0421)	(.)	(0.0422)	(.)	(0.0129)	(.)	(0.0129)	(.)
Outer Islands	-0.217***	0	-0.217***	0	0.0615***	0	0.0614***	0
	(0.0406)	(.)	(0.0406)	(.)	(0.0123)	(.)	(0.0123)	(.)
Dirt flooring	-0.0463	-0.0548	-0.0480	-0.0560	0.00641	0.0245	0.00691	0.0249
	(0.0772)	(0.0884)	(0.0772)	(0.0884)	(0.0254)	(0.0312)	(0.0254)	(0.0312)
Purchases water	0.0159	0.0928*	0.0162	0.0928*	-0.0107	-0.0193	-0.0108	-0.0194
	(0.0363)	(0.0434)	(0.0363)	(0.0435)	(0.0110)	(0.0129)	(0.0110)	(0.0129)
Owns toilet	0.0644	0.0486	0.0645	0.0489	-0.0416**	-0.0309	-0.0417**	-0.0310
	(0.0436)	(0.0512)	(0.0436)	(0.0513)	(0.0137)	(0.0163)	(0.0137)	(0.0164)
Percentage of households with power	0.00133	0.00112	0.00134	0.00112	-0.000310	-0.000242	-0.000310	-0.000239
	(0.00128)	(0.00179)	(0.00128)	(0.00179)	(0.000389)	(0.000550)	(0.000389)	(0.000550)
Midwives present	0.0159	0.137*	0.0162	0.138*	0.00554	-0.0248	0.00542	-0.0250
	(0.0450)	(0.0668)	(0.0450)	(0.0668)	(0.0132)	(0.0189)	(0.0132)	(0.0189)
Dirt road	0.0961	0.214	0.0947	0.214	-0.0620	-0.123	-0.0617	-0.123
	(0.103)	(0.161)	(0.103)	(0.161)	(0.0327)	(0.0683)	(0.0327)	(0.0683)
Constant	-7.580***	-6.747***	-7.626***	-6.789***	2.337***	2.066***	2.351***	2.079***
	(0.742)	(0.873)	(0.742)	(0.873)	(0.204)	(0.264)	(0.204)	(0.264)
Observations	8846	8846	8846	8846	8846	8846	8846	8846
R^2	0.090	0.072	0.090	0.072	0.063	0.038	0.063	0.037
Subdistrict fixed effects	No	Yes	No	Yes	No	Yes	No	Yes

Standard errors in parentheses

Notes: Table reports the full specification of the regression models for height-for-age z-score and stunting. Reported standard errors are robust. Height-for-age z-score and stunting are defined according to WHO (2006) growth standards.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table S7: Clustered vs robust standard errors—Height-for-age

	Height-for-age z-score			
	(1)	(2)	(3)	(4)
Household reports tobacco expenditure	-0.1026**		-0.1026**	
	(0.0367)		(0.0377)	
Log of monthly tobacco expenditure		-0.0084**		-0.0084**
		(0.0030)		(0.0031)
Year 2014	-0.1551***	-0.1531***	-0.1551***	-0.1531***
	(0.0432)	(0.0432)	(0.0449)	(0.0449)
Mother years of school	0.0265***	0.0264***	0.0265***	0.0264***
	(0.0052)	(0.0052)	(0.0054)	(0.0054)
Log per capita expenditure	0.2086***	0.2121***	0.2086***	0.2121***
	(0.0339)	(0.0340)	(0.0369)	(0.0370)
Rural	-0.1000**	-0.1006**	-0.1000*	-0.1006*
	(0.0387)	(0.0387)	(0.0426)	(0.0426)
Observations	8846	8846	8846	8846
R^2	0.090	0.090	0.090	0.090
Clustered SE	No	No	Yes	Yes

Standard errors in parentheses

Notes: Table compares robust and clustered standard errors for regressions of height-for-age on household tobacco status and tobacco expenditure. Clustered errors are clustered at the subdistrict level. All estimates include subdistrict fixed effects. Controls for child, mother, household, socioeconomic, and community characteristics are included.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table S8: Clustered vs robust standard errors—Stunting risk

	Moderately or severely stunted			
	(1)	(2)	(3)	(4)
Household reports tobacco expenditure	0.0303**		0.0303**	
	(0.0109)		(0.0109)	
Log of monthly tobacco expenditure		0.0023**		0.0023**
		(0.0009)		(0.0009)
Year 2014	0.0399**	0.0393**	0.0399**	0.0393**
	(0.0131)	(0.0131)	(0.0125)	(0.0126)
Mother years of school	-0.0084***	-0.0084***	-0.0084***	-0.0084***
	(0.0016)	(0.0016)	(0.0017)	(0.0017)
Log per capita expenditure	-0.0558***	-0.0567***	-0.0558***	-0.0567***
	(0.0098)	(0.0099)	(0.0099)	(0.0099)
Rural	0.0268*	0.0270*	0.0268*	0.0270*
	(0.0119)	(0.0119)	(0.0132)	(0.0132)
Observations	8846	8846	8846	8846
R^2	0.063	0.063	0.063	0.063
Clustered SE	No	No	Yes	Yes

Standard errors in parentheses

Notes: Table compares robust and clustered standard errors for regressions of stunting on household tobacco status and tobacco expenditure. Clustered errors are clustered at the subdistrict level. All estimates include subdistrict fixed effects. Controls for child, mother, household, socioeconomic, and community characteristics are included.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table S9: Mother and household fixed effects estimates

	Mother fixed effects				Household fixed effects			
	Height-for-age z-score		Stunted or severely stunted		Height-for-age z-score		Stunted or severely stunted	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Household reports tobacco expenditure	-0.0095		0.0227		0.0514		0.0366	
	(0.1268)		(0.0374)		(0.1244)		(0.0398)	
Log of monthly tobacco expenditure		-0.0026		0.0014		0.0014		0.0030
		(0.0104)		(0.0031)		(0.0104)		(0.0033)
Year 2014	0.1612	0.1523	-0.0810	-0.0836	-0.0267	-0.0297	0.0315	0.0306
	(0.5013)	(0.5016)	(0.1609)	(0.1611)	(0.1443)	(0.1440)	(0.0463)	(0.0463)
Mother years of school	0.0766	0.0769	-0.0134	-0.0133	0.0678	0.0680	-0.0226*	-0.0226*
	(0.0635)	(0.0635)	(0.0177)	(0.0177)	(0.0363)	(0.0364)	(0.0112)	(0.0112)
Log per capita expenditure	-0.1652	-0.1633	0.0257	0.0254	-0.1028	-0.1008	0.0191	0.0181
	(0.1063)	(0.1065)	(0.0339)	(0.0340)	(0.1184)	(0.1189)	(0.0356)	(0.0357)
Rural	0.0537	0.0535	-0.0158	-0.0156	0.1316	0.1335	-0.0354	-0.0352
	(0.1712)	(0.1711)	(0.0490)	(0.0490)	(0.1887)	(0.1885)	(0.0533)	(0.0533)
Observations	8846	8846	8846	8846	8846	8846	8846	8846
R^2	0.067	0.067	0.031	0.031	0.071	0.071	0.035	0.035
Fixed effect	Mother	Mother	Mother	Mother	Household	Household	Household	Household

Standard errors in parentheses

Notes: Table depicts regression results for mother and household fixed effects estimation. Reported standard errors are robust. Controls for child, mother, household, socioeconomic, and community characteristics are included.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table S10: Effects of tobacco consumption on stunting risk—Interactions

	Moderately and severely stunted			
	(1)	(2)	(3)	(4)
Household reports tobacco expenditure	0.0417*		0.0486*	
	(0.0182)		(0.0203)	
Log of monthly tobacco expenditure		0.0035*		0.0040*
		(0.0015)		(0.0017)
Poor household	0.0063	0.0077	0.0111	0.0148
	(0.0226)	(0.0225)	(0.0245)	(0.0243)
Year 2014	0.0467*	0.0474*	0.0378	0.0378
	(0.0207)	(0.0207)	(0.0250)	(0.0248)
Interaction tobacco household & year	-0.0182		-0.0335	
	(0.0232)		(0.0258)	
Interaction tobacco household & poor	-0.0116		-0.0199	
	(0.0260)		(0.0276)	
Interaction tobacco household, year, & poor	0.0146		0.0235	
	(0.0252)		(0.0268)	
Interaction log tobacco expenditure & year		-0.0017		-0.0028
		(0.0019)		(0.0021)
Interaction log tobacco expenditure & poor		-0.0012		-0.0021
		(0.0022)		(0.0024)
Interaction log tobacco expenditure, year, & poor		0.0013		0.0019
		(0.0021)		(0.0022)
Observations	8846	8846	8846	8846
R^2	0.063	0.063	0.038	0.038
Subdistrict fixed effect	No	No	Yes	Yes

Standard errors in parentheses

Notes: Table reports estimators for interaction terms of household tobacco consumption, expenditure, 2014-year dummy, and a poverty dummy. Poor households are those within the bottom 30th percentile of per capita expenditure. Households are considered tobacco consuming households if they report tobacco expenditure. All standard errors are robust, and fixed effects are at the subdistrict level. Controls for child, mother, household, socioeconomic, and community characteristics are included.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table S11: Durbin-Wu-Hausman test for endogeneity of tobacco expenditure

H0: Variables are exogenous	
Robust score chi2(1)	4.26947 (p = 0.0388)
Robust regression F(1,8817)	4.31361 (p = 0.0378)

Notes: Table depicts results of a Durbin-Wu-Hausman test for endogeneity of tobacco expenditure. P-values are depicted in parentheses.

Table S12: First-stage estimates across different subsamples

	Log monthly tobacco expenditure						
	(1) Full sample	(2) Lower income	(3) Higher income	(4) Rural	(5) Tobacco consuming	(6) Father smokes	(7) 1 or More smokers
Log community cigarette price	0.639	0.357	1.217*	1.060*	0.0784	0.0229	0.0677
	(0.371)	(0.453)	(0.610)	(0.482)	(0.0628)	(0.237)	(0.249)
Log per capita expenditure	0.691***	1.862***	-0.254	1.143***	0.646***	1.012***	1.119***
	(0.121)	(0.233)	(0.285)	(0.183)	(0.0214)	(0.0791)	(0.0852)
Year 2014	0.0401	-0.753*	0.491	-0.935**	0.256***	-0.0503	-0.277
	(0.254)	(0.345)	(0.450)	(0.354)	(0.0434)	(0.166)	(0.174)
Observations	8839	5565	3274	3885	6067	5320	5914
R^2	0.060	0.056	0.093	0.059	0.316	0.051	0.049

Standard errors in parentheses

Notes: The base specification for the instrumental variables approach is applied to several subsamples. I compare first stage estimates here for all sample observations, observations with per capita expenditure in the bottom 50th percentile, observations with per capita expenditure in the top 50 percentile, observations in rural areas, observations that report household tobacco expenditure, observations whose father reports tobacco consumption, and observations in households with one or more smoker. Reported F-statistics are from the Stock & Yogo test.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table S13: Second-stage estimates across different subsamples

	(1) Full sample	(2) Lower income	(3) Higher income	(4) Rural	(5) Tobacco consuming	(6) Father smokes	(7) 1 or more smokers
Log of monthly tobacco expenditure	0.101	0.282	-0.000253	0.0291	0.707	2.747	0.638
	(0.0724)	(0.369)	(0.0393)	(0.0420)	(0.734)	(28.29)	(2.381)
Log per capita expenditure	-0.125^{*}	-0.581	-0.0420	-0.101^{*}	-0.518	-2.831	-0.760
	(0.0531)	(0.690)	(0.0225)	(0.0514)	(0.475)	(28.62)	(2.666)
Year 2014	0.000126	0.187	0.0584	0.0368	-0.175	0.129	0.173
	(0.0342)	(0.215)	(0.0501)	(0.0256)	(0.221)	(1.093)	(0.574)
Observations	8839	5565	3274	3885	6067	5320	5914
R^2	.	.	0.043	.	.	.	.
Robust F	2.96618	.620675	3.98807	4.84153	1.5606	.009361	.074088

Standard errors in parentheses

Notes: The base specification for the instrumental variables approach is applied to several subsamples. I compare second stage estimates here for all sample observations, observations with per capita expenditure in the bottom 50th percentile, observations with per capita expenditure in the top 50 percentile, observations in rural areas, observations that report household tobacco expenditure, observations whose father reports tobacco consumption, and observations in households with one or more smoker. Reported F-statistics are from the Stock & Yogo test.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$