The Effects of Cigarette Expenditure on Children Growth Outcomes: Evidence from the Indonesian Family Life Survey

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Abstract

Indonesia has one of the highest tobacco consumption rates globally. Studies have consistently confirmed the negative impacts on health and the economy, including the effect of parental smoking behaviors on children growth outcomes. However, we have little knowledge on the effect of cigarette expenditures on children growth outcomes including the likelihood of stunting. We contribute to the literature by estimating the causal effect of cigarette expenditures on children's height, weight, and their likelihood of stunting. We use an instrumental variable approach to tackle the endogeneity issue plaguing households' cigarette expenditures. Our estimates suggest that a 0.100 standard deviation or about a 7 percent increase in cigarette expenditures would lower height by 9.65 percent and increase the likelihood of stunting by 8.96 percentage points or 25.6 percent. The estimated effects are higher among poor than non-poor households and are significant only among households with boys. Analysis of potential mechanisms shows that cigarette expenditures put a higher burden on households' finances, particularly on education and health expenditures. A higher cigarette expenditure is also linked to a higher likelihood of premature and extremely premature births. Our findings provide further evidence to support more progressive and comprehensive tobacco control efforts in Indonesia.

1. Background

Globally, and in Southeast Asia, Indonesia has one of the highest tobacco consumption rates (WHO, 2020, 2021). In Indonesia, about one-third of adults consume tobacco products, primarily kretek cigarettes (Palipudi et al, 2015). Over the past ten years, Indonesia has had a high prevalence of tobacco use, and the incidence has been increasing among youth (WHO, 2020). Additionally, nearly 60 percent of adults are exposed to secondhand smoke at home, and about 45% of individuals are exposed to tobacco smoke at work (Global Adult Tobacco Survey, 2021). The high incidence of tobacco usage in Indonesia is mostly caused by cigarette products that are inexpensive and readily available (Ratanachena & Dorotheo, 2012; Zheng et al., 2018).

These facts are concerning since tobacco usage has negative impacts on both health and the economy, especially in Indonesia, which faces a double burden of disease. Smoking and tobacco use are known risk factors for communicable and non-communicable diseases such as cancer, diabetes, cardiovascular diseases, and chronic respiratory illnesses; and communicable diseases such as tuberculosis, HIV, and SARS-CoV (Heriyani et al., 2013; Liew & Hsu, 2009; Soewondo & Pramono, 2011; Sumartono & Herawati, 2010, Jiang 2020). Nearly 22% of all cases of chronic diseases were caused by smoking-related diseases overall (Kristina et al., 2018). Moreover, exposure to smoking by secondhand smokers raises the risk of developing several types of cancer as well as cancer mortality (Kristina et al., 2019). The economic costs of smoking and the healthcare burden are estimated to be significantly large (Kosen, 2017; Meilissa et al., 2022).

Moreover, smoking has negative impacts on children. Children are particularly vulnerable to tobacco smoke exposure which in turn affects their health outcomes (Lando, 2010; Chao 2018). Children are most impacted by their parents' tobacco use through secondhand smoke and a reduced share of household expenditures on food, and other forms of human capital spending (World Bank, 2018), and negatively associated with health-promoting behaviors (Nadhiroh et al. 2020; Chen, 2021). Much evidence suggests that parental smoking behaviors cause children to experience adverse effects, such as

an increased risk of infant and under-5 child mortality and child malnutrition (Beal et al., 2018; Best et al., 2007; 2008; Semba et al., 2007; 2008) and stunting (Dartanto et al., 2018; Bella et al., 2022). These consequences put children at risk for detrimental long-term effects on their cognitive growth, labor productivity, and income. Despite these findings, we know very little about the causal effect of cigarette expenditures on children's growth outcomes, particularly stunting.

We contribute to the growing literature by analyzing the causal effect of cigarette expenditure on children's growth outcomes in the context of a large middle-income country. We use Wave 4 and 5 of the Indonesian Family Life Survey to identify the cigarette expenditure effect on height-for-age z-scores (HAZ), weight-for-age z-scores (WAZ), weight-for-height z-scores (WHZ), and more importantly the likelihood of stunting. We use the instrumental variable approach to tackle the issue of endogeneity of cigarette expenditure owing to measurement errors and omitted variable bias.

We find that cigarette expenditure has negative effects on children's growth outcomes. A 0.100 standard deviation increase in cigarette expenditures—or about a 7 percent increase from the mean cigarette expenditure—is associated with a lower height by 0.087 standard deviations, a lower weight by 0.096 standard deviations, and a lower weight-for-height by 0.071 standard deviations. Our estimates suggest that a 0.100 standard deviation increase in cigarette expenditures is associated with a higher likelihood of stunting by 8.960 percentage points or about a 25.600 percent increase from the average stunting rate among smoking households. We also find that the effects of cigarette expenditures on the likelihood of stunting were higher among poor households than non-poor households and that the effect was significant among boys but not among girls. The analysis of potential mechanisms shows that cigarette expenditures put a higher burden on households' finances, particularly on education and health expenditures, and that a higher cigarette expenditure is linked to a higher likelihood of premature and extremely premature births.

Evidence on the effect of cigarette expenditure on children's growth outcomes, particularly stunting, is essential in the context of developing countries including

Indonesia. Indonesia has an alarming level of stunting incidence compared to other countries. According to data released by the Ministry of Health in 2021, 24.4 percent of children aged five and younger are stunted (Ministry of Health, 2021). Given the significant prevalence of stunting and its effects on children's cognitive growth, it is estimated that Indonesia's next generation will be just half as productive as it could be.

Therefore, as stated in the Indonesia Medium-Term Development Goals 2015-2019 and 2020-2024, the government remains strongly committed to combating child stunting. Reducing tobacco consumption through various tobacco control policies, including a progressive tobacco taxation policy, should be one of the intermediate outcomes toward stunting reduction. Evidence shows that higher cigarette prices would allow households to avoid catastrophic expenditures and improve their quality of life (Wu, 2020; Nguyen, 2021, Raei, 2021). Studies from the global and Indonesian contexts show that tobacco taxation is progressive (Fuchs et al., 2019; Fuchs & Meneses, 2017; Fuchs and Del Carmen, 2018).

As suggested by Prasetyo and Adrison (2019), increases in tobacco taxes must be significant to push tobacco prices sufficiently to significantly reduce tobacco consumption. A study on consumer intention suggests that one-third of smokers intended to quit in response to a significant increase in cigarette prices (Nurhasana et al., 2019). Therefore, the proposed 10% increase in tobacco excise tax in 2022 may not be effective in reducing smoking behaviors.

In the next section, we discuss the empirical strategy and data for the estimation of the effect of tobacco expenditure on children's growth outcomes. We then discuss the results of the estimation in Section 3. We conclude and elaborate on policy implications in Section 4.

2. Methodology

Econometric Model

We aim to evaluate the effect of cigarette expenditure on children's growth as measured by height-for-age *z*-score (HAZ), weight-for-age *z*-score (WAZ), weight-for-height *z*-score

(WHZ), and whether a child is stunted. We utilize pooled cross-section data of children between the age of 0 and 59 months in various households. The model specification to evaluate the effect of cigarette expenditure on children's growth is:

$$growth_{iht} = \alpha + \beta tobexp_{ht} + \delta X_{iht} + \mu M_{ht} + \phi P_{ht} + e_{iht}. \quad (1)$$

The variable $growth_{iht}$ refers to children *i*'s growth outcome in household *h* in period *t*, and it is measured by HAZ, WAZ, and WHZ. The variable *tobexp* is monthly household expenditure for cigarettes, which is adjusted with wave and province-specific consumer price index. We standardized tobacco expenditure for ease of interpretation of the regression coefficients. Thus, the estimated cigarette expenditure effect, $\hat{\beta}$, indicate the change in children's growth indicators in standard deviation for a standard deviation increase in cigarette expenditure.

For binary dependent variables, such as whether a child is stunted, we run a probit regression with the following specification:

$$P(stunted_{iht} = 1|X) = G(\alpha + \beta tobexp_{ht} + \delta X_{iht} + \mu M_{ht} + \phi P_{ht} + e_{iht}). \quad (2)$$

The function *G* is the CDF of the standard normal distribution. Since the estimated coefficients of a probit regression cannot be directly interpreted, we estimate average marginal effects for each variable in the specification.

We note that households' cigarette expenditure variable is an endogenous variable owing to measurement errors and omitted variable bias. First, respondents may not perfectly recall their cigarette consumption, hence cigarette expenditure, in the past month. If such recall bias is systematic, then the estimated cigarette expenditure effect can be biased downward.

Second, households with unobserved healthy behaviors can be less likely to smoke and spend less on cigarettes, and at the same time, these households can have healthier children. To mediate the issue, we use an instrumental variable (IV) approach using average *kretek* cigarette prices at the province level. Average *kretek* prices at the province level should be correlated with prices of cigarettes that households purchase, which in turn would be correlated with households' cigarette expenditure. To test this

claim, we run the first-stage regression of household cigarette expenditure and average *kretek* prices at the province level. The specification of the first-stage regression is the following:

$$growth_{iht} = \alpha + \beta tobexp_{ht} + \delta X_{iht} + \mu M_{ht} + \phi P_{ht} + e_{iht}. \qquad (2)$$

Indeed, we find that average *kretek* price is a relevant instrument of household cigarette expenditure. In Table A1 of the Appendix, we show that average *kretek* prices at the province level are a significant predictor of monthly household expenditure on cigarettes at the household level. The F-statistics exceed the critical values of the weak instrument test, which confirms that the instrument fulfills the relevance assumption.

We argue that average *kretek* prices at the province level are not correlated with unobserved characteristics at the household level that would affect stunting such as households' health behaviors, parents' knowledge, and parents' motivation. We also argue that average *kretek* prices at the province level are not directly correlated with children's growth at the household level. So far, no study has established the relationship between aggregate cigarette prices and children's growth including stunting (Beal et al, 2018).

Given this assumption, we run a reduced-form regression to test the direct causal effect of the instrument—average *kretek* prices at the province level—on children's growth outcomes. Results from the reduced-form regression would provide preliminary insights of the effect of household tobacco expenditure on children's growth outcomes. For the reduced-form regression, we regress the outcome variables on average *kretek* prices at the province level and control variables. We present the results in Table A2 in the appendix. We find that higher average *kretek* prices at the province level lead to lower growth outcomes as measured by HAZ, WAZ, and WHZ. This finding is suggestive evidence of the burden of smoking.

We estimate the IV model using a two-stage least square method. The first-stage regression specification is:

$$tobexp_{ht} = \alpha + \gamma kretek_t + \pi X_{iht} + \tau M_{ht} + \kappa P_{ht} + u_{iht}. \quad (3)$$

The predicted $\widehat{tobexp}$ is then used in the second-stage regression using Equation 1 and Equation 2. We include in the regression specification vectors of covariates which are shown to be significant determinants of stunting (Beal et al., 2018). The covariates include a vector of children-specific characteristics (*X*) which includes whether a child was born a twin, the child's birth weight, a dummy on whether the child was born premature, age in months, the child's gender, dummies for the child's diet; a vector of household-specific characteristics (*M*) which includes standardized total expenditure per capita, the share of food consumption, a dummy for sanitation, a dummy for a water source for drinking, household size, a dummy for urban residence; and a vector of parents' characteristics (*P*) which includes father's years of education, mother's years of education, whether the mother has hypertension, whether father smokes, and whether the mother smokes. We also include a time-fixed effect dummy to control for common time trends.

We note that there are control variables with missing observations. For each of these variables, we first create a dummy of missingness. We then impute zeroes for every missing observation in each control variable (Allison, 2009; Cohen et al., 2013; Wooldridge, 2009). We cluster the standard errors at the household level to account for the correlation of unobservable characteristics within a household (Cameron & Miller, 2015).

Data

The Indonesian Family Life Survey (IFLS) is a longitudinal survey in Indonesia that allows us to study various outcomes particularly parental smoking behaviors and children's growth outcomes. We combine Wave 4 IFLS and Wave 5 IFLS to obtain a pooled cross-section of data from households in Indonesia between 2007 and 2014 (Strauss et al., 2009, 2016). The unit of analysis in this study is at the child level within households.

The IFLS provides measures of children's growth outcomes such as height-for-age (HAZ), weight-for-age (WAZ), and weight-for-height *z*-scores (WHZ). We focus on HAZ and whether a child is stunted as the main growth outcome. More importantly, the IFLS provides rich information on parental smoking behaviors and spending on cigarettes. In

addition, we can obtain children's characteristics, parents' characteristics, and household characteristics that are relevant in explaining children's growth as previously discussed.

We obtain data for the IV, the average *kretek* prices at the provincial level, from the Statistics Indonesia report (Statistics Indonesia, 2015a; Statistics Indonesia, 2009). We use average *kretek* prices instead of average white cigarette prices because most smokers in Indonesia consume *kretek*. The first limitation of the proposed IV in our study is that it is the average prices of hand-made and machine-made *kreteks*. The distinction is important because the average price of hand-made *kretek* is lower than the average price of machine-made *kretek*. Even if we obtain average prices of the *kretek* types, we do not observe in IFLS whether the *kretek* consumed by households is hand-made or machine-made. The second limitation of the proposed IV is that it is a simple and not weighted average of *kretek* prices.

We also obtain a wave-specific consumer price index at the province level from the Statistics Indonesia's consumer price index report (Statistics Indonesia, 2015b; Statistics Indonesia, 2008). We then use the wave-specific consumer price index data to calculate real variables such as real cigarette expenditure and real household expenditure. We combine the Statistics Indonesia data and the IFLS pooled cross-section using province indicators as the identifier.

We conduct descriptive analyses of variables in the regression sample, and we report summary statistics in Table 1. A typical child in the sample is a boy living in an urban area who was around 30 months during the time of the surveys. A typical household in the sample had around 6 family members. A typical father in the sample completed about 8.6 years of schooling, while the typical mother in the sample completed around 9.4 years of schooling.

Monthly household cigarette expenditure in real terms was quite large, about Rp240,492 or US$59.68 in PPP in 2014.[1] In percentage terms, the share of household cigarette expenditure was close to 10 percent of total monthly household expenditures. This is

[1] The purchasing power parity (PPP) for 2014 was Rp4,030.775/US$ (OECD, 2022).

close to the national estimate of 12 percent by Statistics Indonesia (Statistics Indonesia, 2022). We note that a standard deviation increase in cigarette expenditure among smokers was quite large at about Rp170,775 or a 71 percent increase. Therefore, when interpreting estimated, we will analyze a 0.100 standard deviation or about 7 percent increase in household monthly cigarette expenditure.

We also find that the share of household cigarette expenditure was also about a fifth of the share of household food expenditure. However, the share of cigarette expenditure was twice the share of household education expenditure and almost three times the share of household health expenditure. The results are consistent with reports from Statistics Indonesia that the share of cigarette expenditure exceeds the share of education and health expenditures (Statistics Indonesia, 2022). Overall, this finding highlights the costs of cigarette consumption.

Table 1. Summary Statistics

	Smoking households	Non-smoking households	Total
Height-for-age z-score	-1.461	-1.317	-1.409
	(1.524)	(1.566)	(1.541)
Weight-for-age z-score	-1.019	-0.917	-0.982
	(1.208)	(1.276)	(1.234)
Weight-for-height z-score	-0.255	-0.224	-0.244
	(1.438)	(1.484)	(1.455)
1 if stunted	0.365	0.323	0.350
	(0.482)	(0.468)	(0.477)
Monthly cigarette expenditure, real terms	240,492.7	.	150,189.9
	(170,775.9)	.	(178,259.0)
Child's birth weight	2.822	2.575	2.730
	(1.189)	(1.328)	(1.249)
1 if born premature	0.768	0.685	0.737
	(0.422)	(0.465)	(0.440)

Child's age in months	29.89 (17.43)	29.81 (17.12)	29.86 (17.31)
1 if female	0.485 (0.500)	0.485 (0.500)	0.485 (0.500)
1 if child consumes 1 meal per day	0.0472 (0.212)	0.0437 (0.204)	0.0459 (0.209)
1 if child consumes 2 meal per day	0.132 (0.339)	0.124 (0.330)	0.129 (0.336)
If child consumes 3 meal per day	0.321 (0.467)	0.281 (0.449)	0.306 (0.461)
Father's years of education	9.073 (4.033)	7.758 (5.910)	8.580 (4.865)
Mother's years of education	9.226 (3.955)	9.769 (4.396)	9.430 (4.134)
1 if mother has hypertension	0.101 (0.301)	0.0947 (0.293)	0.0987 (0.298)
HH share of food consumption	0.500 (0.166)	0.515 (0.183)	0.505 (0.172)
1 if urban	0.531 (0.499)	0.592 (0.492)	0.554 (0.497)
1 if source of drinking water from mineral water, well, or spring	0.945 (0.227)	0.949 (0.221)	0.946 (0.225)
1 if HH owns toilet with septic tank	0.670 (0.470)	0.748 (0.434)	0.700 (0.458)
HH size	6.145 (3.164)	6.417 (3.416)	6.247 (3.264)

Observations	6,225	3,729	9,954

Notes: standard deviations are in the parentheses.

In Figure 1, we first look at distributions of HAZ, WAZ, and WHZ between non-smoking and smoking households. In general, we find that children from smoking households have lower means of HAZ, WAZ, and WHZ. The differences in the means of HAZ and WAZ are significantly lower among children in smoking households than those in non-smoking households (*p*-values of 0.0000 and 0.0001, respectively), but we find no significant difference in the means of children's WHZ across household groups. Analyses using tests of difference in medians yield similar results.

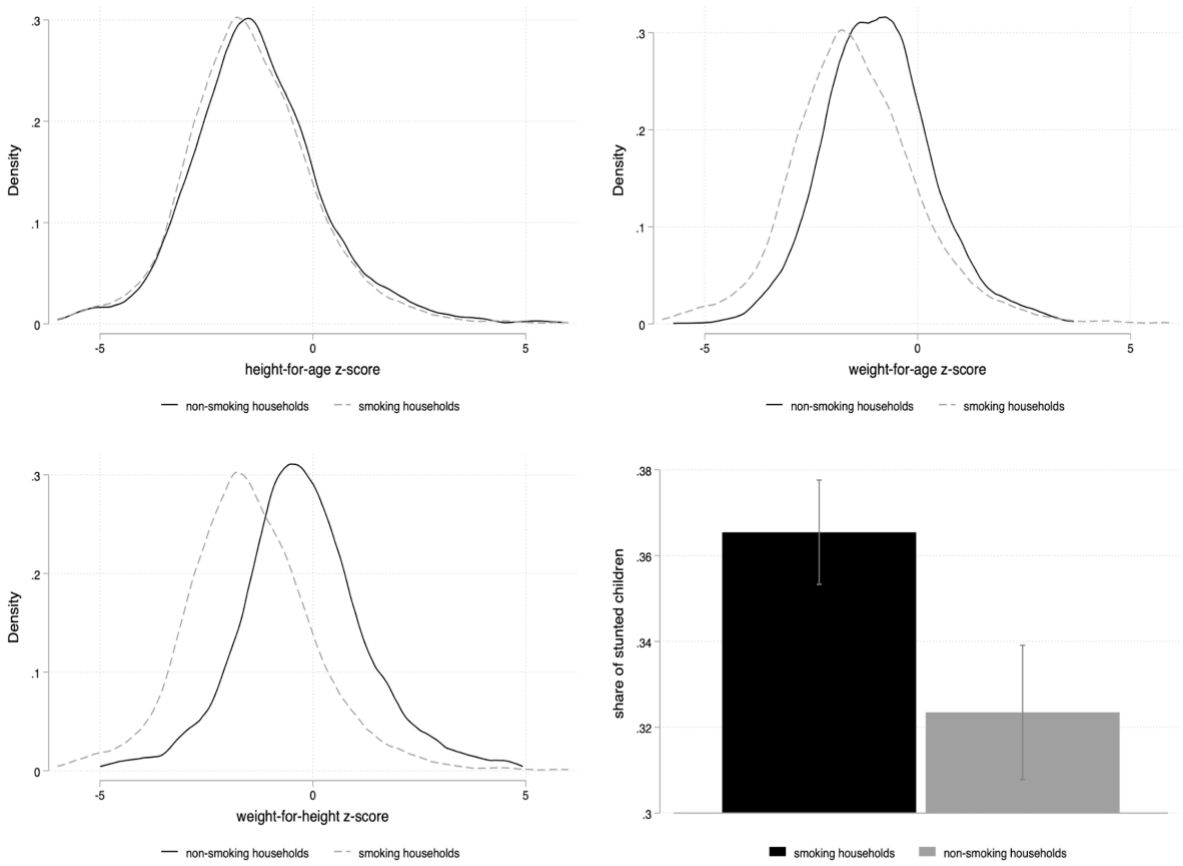

Figure 1. Comparisons of children's growth indicators between smoking and non-smoking households

We also depict the sample proportion of children who are stunted in smoking and non-smoking households. We find that the proportion of stunted children in smoking households is significantly larger than that in non-smoking households (proportion test, *p*-values of 0.0000). The results from the descriptive statistics and graphical analyses suggest a burden from smoking. Note that the statistical results from simple comparisons are confounded by many observable and unobservable characteristics. Thus, while these analyses show important cross-group differences, we need to take caution in concluding the impact of smoking on children's growth outcomes.

3. Results

We report IV estimates on the effects of cigarette expenditures on children's growth indicators and the probability of stunting in Table 1.[2] The estimates show negative effects of cigarette expenditures on children's growth indicators and a positive effect on the probability of stunting, which is further evidence of the burden of smoking. Assuming linearity, a 0.100 standard deviation increase in cigarette expenditures—or about a 7 percent increase from the mean cigarette expenditure—is associated with a lower height by 0.136 standard deviations, a lower weight by 0.134 standard deviations, and a lower weight-for-height by 0.088 standard deviations. In percentage terms, a 0.100 standard deviation increase in cigarette expenditures corresponds to a lower height by 9.652 percent, a lower weight by 13.645 percent, and a lower weight-for-height by 36.065 percent.

A 0.100 standard deviation increase in cigarette expenditures is associated with a higher likelihood of stunting by 8.960 percentage points or about a 25.600 percent increase from the average stunting rate. For comparison, a recent study by Bella et al. (2022) shows that children whose father is considered a moderate or heavy smoker have a higher likelihood of stunting by about 3.47 percentage points.

[2] For a comparison, Table A3 shows estimation results using OLS. We find no significant correlation between household expenditure and children growth outcomes, suggesting underestimation of OLS estimates. The result is consistent with the issue of attenuation bias owing to measurement errors or omitted variable bias owing to an omitted variable measuring health knowledge.

These results are obtained from estimations using a sample of smoking and non-smoking households. The estimated negative effects of cigarette expenditures on children's growth indicators can be partially induced by the fact that non-smoking households have zero cigarette expenditures. For sensitivity analyses, we estimate the effects of cigarette expenditures on the outcomes using a sub-sample of only smoking households. We report the results in Table A4 in the appendix. The estimated signs on the effects of cigarette expenditures are still consistent with the estimated signs from the full sample IV estimation, but the magnitudes are lower.

Table 1. IV estimates on the effects of cigarette expenditure on children growth indicators

	HAZ	WAZ	WHZ	1 if stunting, average marginal effects
monthly household cigarette expenditure, standardized	-1.361***	-1.344***	-0.883**	0.896***
	(0.478)	(0.416)	(0.421)	(0.140)
1 if the child has a twin	-0.789***	-0.718***	-0.339**	0.453***
	(0.172)	(0.156)	(0.153)	(0.098)
birth weight in kgs	0.378***	0.419***	0.271***	-0.240***
	(0.045)	(0.041)	(0.033)	(0.046)
1 if born premature	0.031	0.066	0.082	-0.010
	(0.059)	(0.052)	(0.052)	(0.036)
child age in months	-0.009***	-0.008***	-0.004***	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
1 if female	0.078**	0.017	-0.010	-0.060**
	(0.039)	(0.034)	(0.034)	(0.028)
1 if consumes food once a day	0.501***	0.271**	0.239*	-0.248**
	(0.156)	(0.136)	(0.142)	(0.117)
1 if consumes food twice a day	0.092	-0.093	-0.169	-0.048
	(0.126)	(0.115)	(0.108)	(0.084)
1 if consumes food thrice a day	0.115	-0.066	-0.187*	-0.047
	(0.124)	(0.113)	(0.107)	(0.083)
share of food expenditure to total expenditure	-1.162***	-0.901***	-0.384	0.694***

	(0.283)	(0.249)	(0.244)	(0.089)
household total expenditure per capita, standardized	0.051*	0.028	-0.000	-0.027**
	(0.026)	(0.022)	(0.023)	(0.013)
1 if lives in urban area	0.228***	0.210***	0.127***	-0.146***
	(0.055)	(0.048)	(0.048)	(0.029)
1 if source of drinking water from mineral water, well, or spring	0.261***	0.206***	0.065	-0.123**
	(0.084)	(0.075)	(0.071)	(0.055)
1 if HH owns toilet with septic tank	0.365***	0.279***	0.110	-0.221***
	(0.080)	(0.069)	(0.071)	(0.029)
household size at the current survey	-0.002	-0.002	0.002	-0.003
	(0.006)	(0.006)	(0.005)	(0.004)
father's years of education	0.020***	0.019***	0.010*	-0.011***
	(0.006)	(0.006)	(0.006)	(0.003)
mother's years of education	0.034***	0.037***	0.024***	-0.022***
	(0.006)	(0.006)	(0.006)	(0.004)
1 if mother has a hypertension	-0.058	0.069	0.150**	0.045
	(0.065)	(0.059)	(0.059)	(0.041)
1 if father smokes	1.684***	1.695***	1.138**	-1.126***
	(0.629)	(0.548)	(0.553)	(0.194)
1 if mother smokes	0.713**	0.974***	0.829***	-0.374**

	(0.302)	(0.304)	(0.288)	(0.152)
1 if wave 5	0.121	0.269	0.270	-0.126
	(0.188)	(0.165)	(0.165)	(0.101)
First-stage estimations				
Average cigarette prices at the province level, standardized	0.043***	0.043***	0.043***	0.043***
	(0.009)	(0.009)	(0.009)	(0.009)
Wu-Hausmann *F*-statistics/AR-statistics for IV probit	21.387	21.444	21.520	16.26
p-value of *F*-statistics/ *p*-value of AR-statistics	0.000	0.000	0.000	0.000
R-squared	0.421	0.421	0.421	0.421
Observations	9,449	9,572	9,427	9,449

Notes: the signs *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. For brevity, we exclude first-stage regression coefficients from the table. We cluster the SE at the household level.

Table 2. Average marginal effects from IV probit estimates on the effects of cigarette expenditures on the likelihood of stunting

	all sample	poor households	non-poor households	girls	boys	urban households	rural households
monthly household cigarette expenditure, standardized	0.896***	1.379***	0.961***	0.405	1.120***	1.029***	0.614**
	(0.140)	(0.528)	(0.128)	(0.334)	(0.090)	(0.140)	(0.266)
1 if the child has a twin	0.453***	0.694***	0.310***	0.684***	0.295**	0.551***	0.390***
	(0.098)	(0.211)	(0.114)	(0.149)	(0.130)	(0.163)	(0.143)
birth weight in kgs	-0.240***	-0.207*	-0.210***	-0.314***	-0.135**	-0.184***	-0.310***
	(0.046)	(0.125)	(0.054)	(0.053)	(0.058)	(0.066)	(0.052)
1 if born premature	-0.010	-0.072	-0.016	-0.010	-0.042	-0.052	0.045
	(0.036)	(0.100)	(0.038)	(0.052)	(0.049)	(0.046)	(0.055)
child age in months	0.001*	0.004	0.000	0.003**	0.000	-0.000	0.003***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
1 if female	-0.060**	-0.085	-0.042	0.000	0.000	-0.068*	-0.050
	(0.028)	(0.069)	(0.031)	(.)	(.)	(0.039)	(0.040)
1 if consumes food once a day	-0.248**	-0.369	-0.167	-0.399**	-0.060	-0.173	-0.362**
	(0.117)	(0.287)	(0.130)	(0.157)	(0.156)	(0.158)	(0.163)
1 if consumes food twice a day	-0.048	0.318	-0.088	-0.192	0.078	-0.060	-0.039
	(0.084)	(0.214)	(0.093)	(0.118)	(0.116)	(0.113)	(0.124)
1 if consumes food thrice a day	-0.047	0.114	-0.049	-0.201*	0.082	-0.088	-0.025
	(0.083)	(0.207)	(0.092)	(0.118)	(0.112)	(0.111)	(0.125)
share of food expenditure to total expenditure	0.694***	0.749***	0.586***	0.463**	0.777***	0.612***	0.743***
	(0.089)	(0.216)	(0.089)	(0.181)	(0.104)	(0.115)	(0.164)

household total expenditure per capita, standardized	-0.027**	-0.820	-0.022*	-0.007	-0.025	-0.017	-0.030
	(0.013)	(1.753)	(0.012)	(0.023)	(0.018)	(0.018)	(0.022)
1 if lives in urban area	-0.146***	-0.164**	-0.150***	-0.182***	-0.113***	.	.
	(0.029)	(0.066)	(0.033)	(0.043)	(0.036)		
1 if source of drinking water from mineral water, well, or spring	-0.123**	-0.045	-0.114*	-0.206**	-0.044	-0.166*	-0.149**
	(0.055)	(0.208)	(0.059)	(0.085)	(0.068)	(0.098)	(0.074)
1 if HH owns toilet with septic tank	-0.221***	-0.156***	-0.210***	-0.240***	-0.205***	-0.192***	-0.186***
	(0.029)	(0.060)	(0.032)	(0.050)	(0.036)	(0.048)	(0.052)
household size at the current survey	-0.003	-0.040***	-0.015***	0.003	-0.003	-0.002	-0.004
	(0.004)	(0.011)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)
father's years of education	-0.011***	-0.021***	-0.009***	-0.003	-0.013***	-0.014***	-0.006
	(0.003)	(0.007)	(0.003)	(0.006)	(0.004)	(0.004)	(0.006)
mother's years of education	-0.022***	-0.009	-0.018***	-0.028***	-0.014**	-0.019**	-0.020***
	(0.004)	(0.008)	(0.006)	(0.006)	(0.006)	(0.008)	(0.006)
1 if mother has a hypertension	0.045	0.141	0.042	0.040	0.015	0.043	0.045
	(0.041)	(0.118)	(0.044)	(0.065)	(0.052)	(0.055)	(0.062)
1 if father smokes	-1.126***	-1.227**	-1.301***	-0.532	-1.407***	-1.449***	-0.620*
	(0.194)	(0.521)	(0.192)	(0.440)	(0.141)	(0.207)	(0.323)
1 if mother smokes	-0.374**	-0.479**	-0.419**	-0.295	-0.431**	-0.605***	-0.130
	(0.152)	(0.234)	(0.183)	(0.241)	(0.210)	(0.223)	(0.186)
1 if wave 5	-0.126	-0.337	-0.147	0.156	-0.325***	-0.089	-0.095

	(0.101)	(0.268)	(0.111)	(0.159)	(0.119)	(0.123)	(0.166)
First-stage estimations							
Average cigarette prices at the province level, standardized	0.043***	0.021	0.038***	0.051***	0.034***	0.034***	0.058***
	(0.009)	(0.014)	(0.009)	(0.012)	(0.012)	(0.011)	(0.012)
AR-statistics for IV probit	16.26	2.27	15.850	1.210	20.50	12.270	3.750
p-value of AR-statistics	0.000	0.132	0.000	0.271	0.000	0.000	0.053
R-squared	0.421	0.448	0.425	0.428	0.417	0.449	0.395
Observations	9,449	1,782	7,667	4,557	4,892	5,231	4,218

Notes: the signs *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. For brevity, we exclude first-stage regression coefficients from the table. We cluster the SE at the household level.

A 0.100 standard deviation increase in cigarette expenditures—or about a 7 percent increase from the mean cigarette expenditure—is associated with a lower height by 0.087 standard deviations, a lower weight by 0.096 standard deviations, and a lower weight-for-height by 0.071 standard deviations. In percentage terms, a 0.100 standard deviation increase in cigarette expenditures is associated with a lower height by 5.954 percent, a lower weight by 9.048 percent, and a lower weight-for-height by 27.843 percent. A 0.100 standard deviation increase in cigarette expenditures is associated with a higher likelihood of stunting by 5.500 percentage points or about a 15.068 percent increase from the average stunting rate among smoking households.

Motivated by findings in the literature that the burden of smoking is different across households, and particularly higher among poor households (Rahim et al., 2016), we conduct subgroup analyses on the effects of cigarette expenditures. Specifically, we estimate the effects of cigarette expenditures on the likelihood of stunting by poverty status, child's gender, and households' urban or rural residence status. We present the results of the IV probit estimates for these subgroups in Table 2.

We find that the effects of cigarette expenditures on the likelihood of stunting were higher among poor households than non-poor households. A 0.100 standard deviation increase in cigarette expenditures is associated with a higher likelihood of stunting by 33.069 percent among poor households, but only by 28.686 percent among non-poor households. While significant, we note the issue of precision when estimating the effects among poor households owing to the relatively smaller number of poor households in the sample.

We find a significant cigarette expenditure effect on the likelihood of stunting among boys, but not among girls. Among boys, a 0.100 standard deviation increase in cigarette expenditures is associated with a higher likelihood of stunting by 0.112 percentage points or about 30.85 percent. Lastly, we find that cigarette expenditure affects the likelihood of stunting among urban and rural households, but the estimated effect is higher among urban households than among rural households. Among urban households, a 0.100 standard deviation increase in cigarette expenditures is associated with a higher

likelihood of stunting by 0.103 percentage points or about 36.601 percent. The estimated effect among rural households for a similar increase in cigarette expenditure is lower, which is a higher likelihood of stunting by 0.061 percentage points or 15.160 percent.

We also find that correlation between control variables and the outcome variables is consistent with findings in the literature. Focusing on the IV estimates on stunting, we find that children born with higher birth weight are associated with a lower risk of stunting, while children born with a twin are associated with a higher risk of stunting. A higher household total expenditure per capita, living in urban areas, access to adequate sources of water, and adequate sanitation are also associated with a lower risk of stunting. Parents with higher education are also associated with a lower risk of stunting.

The negative effects of cigarette expenditure on children's growth outcomes complement established findings in the literature on the effects of paternal smoking on children's undernutrition status (Best et al., 2007, 2008; Block & Webb, 2009; Semba et al., 2007; Wijaya-Erhardt, 2019), lower HAZ (Block and Webb, 2009), the likelihood of children being stunted, underweight, and wasting (Bella, 2022; Dartanto et al., 2018; Best et al., 2008; Semba et al., 2007). These studies focus on the effect of smoking behavior—an extensive margin—on children's growth outcomes. Our study focuses on the intensive margin of smoking as measured by cigarette expenditures, which is also a proxy of smoking intensity.

We have little evidence of potential mechanisms by which smoking affects children's growth outcomes and malnutrition (Bella et al., 2022). We further contribute to the literature by analyzing potential mechanisms through which cigarette expenditure affects children's growth outcomes. We do so by implementing the same IV strategies on several intermediate outcomes. First, reports suggest that smoking behaviors put a significant burden on households' finances (Statistics Indonesia, 2019). Studies also show that cigarette expenditure may crowd out other essential expenditures (Jumrani & Birthal, 2017; Sreeramareddy & Ramakrishnareddy, 2017) including expenditures for food (Djutaharta et al., 2021; Block and Webb, 2009).

Therefore, we run IV estimations on the share of smoking expenditure, the share of food expenditure, the share of non-food expenditure, and the share of staple expenditure. We report the findings in Table 3. We find that a higher cigarette expenditure leads to a higher share of cigarette expenditure and higher real expenditure per capita, but we find no effect of cigarette expenditure on the share of food expenditure, the share of non-food expenditure, and the share of staple expenditure. However, we find negative effects of cigarette expenditure on the share of education and health expenditures. While in practice education expenditures do not affect children's growth outcomes, health expenditures may.

Table 3. IV estimates on potential mechanisms

	Expenditure p.c.	share of smoking exp	share of food exp.	share of non-food exp.	share of staple exp.
Monthly household cigarette expenditure, standardized	0.457*	0.025*	0.034	-0.034	-0.011
	(0.256)	(0.015)	(0.046)	(0.046)	(0.028)
Observations	9,917	9,917	9,917	9,917	9,917
	share of education exp.	share of health exp.	1 if low birthweight, AME	1 if premature, AME	1 if ext. premature, AME
Monthly household cigarette expenditure, standardized	-0.046**	-0.056***	0.574	1.143***	1.111***
	(0.022)	(0.020)	(0.364)	(0.047)	(0.059)
Observations	9,917	9,917	8,526	9,124	9,124

Notes: the signs *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. Abbreviation AME indicates average marginal effects. We cluster the SE at the household level.

Another potential mechanism is that children are born from smoking parents. In the context of America, a systematic review by Pereira et al. (2017) shows that maternal smoking during pregnancy is associated with low birth weight. As discussed, our findings show that birth weight is positively correlated with children's growth outcomes including

HAZ, WAZ, and WHZ. Passive smoking among women also affects their offspring's birth weight (Rubin et al., 1986). Studies have also shown that smoking during pregnancy increases the likelihood of preterm birth (Dahlin et al., 2016; Shah and Bracken, 2000; McIntosh, 1984), while another study discusses potential mechanisms through which smoking may affect preterm birth (Ion and Bernal, 2015).

We run IV probit estimations to estimate the effects of cigarette expenditures on the probability of low birth weight, premature birth, and extremely premature birth. We report the estimates in Table A4 of the Appendix. We find no significant effect of cigarette expenditures on the likelihood of low birth weight, partially due to the low precision of the estimate. However, we find that cigarette expenditures affect the likelihood of premature birth as well as extremely premature birth. A 0.100 standard deviation increase in cigarette expenditure is associated with a higher likelihood of premature birth by 0.114 percentage points.

Summarizing the analyses of potential mechanisms, we find that cigarette expenditures put a higher burden on households' finances, particularly on education and health expenditure. Our findings also suggest that a higher cigarette expenditure is linked with a higher likelihood of premature and extremely premature births.

4. Conclusions

Lowering the high incidence of stunting in developing countries, including Indonesia, is a global and national policy priority. Studies have shown various determinants of children's growth and stunting, and several studies have shown the adverse effects of parental smoking on children's malnutrition and stunting. This study contributes to the growing literature on the burden of tobacco by analyzing the impact of cigarette expenditure on children's growth outcomes, such as height, weight, and the likelihood of stunting. This study's findings further confirm the burden of smoking on human capital development and future earnings and provide evidence of the potential mechanisms of smoking on children's growth outcomes.

The results further strengthen the call for a more aggressive, progressive, and comprehensive tobacco control policy. Such broad policy would include higher tobacco excise taxes, earmarking of tobacco excise tax revenues for smoking cessation, and pictorial health warnings that would induce a significant decrease in cigarette consumption and expenditure. Such a policy—with tobacco excise tax at the heart of the policy—has the potential to reduce the prevalence and the intensity of smoking, households' tobacco expenditures, and eventually improve outcomes including children's growth outcomes. Future studies should evaluate the causal effect of raising tobacco taxes on tobacco consumption and children's growth outcomes.

While higher tobacco taxes effectively reduce smoking prevalence, we should note that proponents against higher tobacco taxes would argue that raising tobacco taxes is regressive. These anti-tax parties argue that raising the tobacco tax would increase cigarette expenditures among the poor. This narrative can be countered by evidence from studies that show raising tobacco prices is progressive. Households would benefit from higher tobacco prices that lead to cessation or significantly reduced consumption because of improved productivity, lower tobacco-related medical expenditure, and higher human capital related spending. Importantly, lower-income households would benefit disproportionately more as they are more responsive to changes in tobacco prices (Fuchs et al., 2019; Fuchs & Meneses, 2017; Fuchs and Del Carmen, 2018).

The government can also earmark a share of the tobacco excise tax revenue to fund programs aimed at lowering the prevalence of stunting. These programs are particularly important for lower-income households, and the eligibility of the programs can be tied to smoking cessation. Lastly, tobacco control policies to reduce stunting should also include strategies to reduce secondhand smoking among children and pregnant women. These policies can include mass media public education campaigns, which are effective in promoting messages to reduce secondhand smoking (Kosir and Gutierrez, 2009) among other pro-health and anti-tobacco behaviors.

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Appendix

Table A1. Estimates from first-stage regressions

	without covariates	with covariates
Average cigarette prices at the province level, standardized	0.080***	0.043***
	(0.012)	(0.009)
1 if the child has a twin		-0.160**
		(0.065)
birth weight in kgs		0.028*
		(0.016)
1 if born premature		0.058***
		(0.022)
child age in months		-0.001
		(0.000)
1 if female		-0.013
		(0.017)
1 if consumes food once a day		-0.101
		(0.068)
1 if consumes food twice a day		-0.076
		(0.060)
1 if consumes food thrice a day		-0.111**
		(0.056)
share of food expenditure to total expenditure		-0.519***
		(0.060)
household total expenditure per capita, standardized		0.016
		(0.012)
1 if lives in urban area		0.061***
		(0.021)
1 if source of drinking water from mineral water, well, or spring		0.015
		(0.038)

1 if HH owns toilet with septic tank		0.137***
		(0.021)
household size at the current survey		0.002
		(0.003)
father's years of education		0.009***
		(0.002)
mother's years of education		0.005*
		(0.003)
1 if mother has a hypertension		-0.034
		(0.029)
1 if father smokes		1.310***
		(0.019)
1 if mother smokes		0.500***
		(0.110)
1 if wave 5		0.307***
		(0.054)
Observations	9,461	9,449
Wu-Hausmann *F*-statistics	54.905	21.387
p-value of *F*-statistics	0.000	0.000
Adj. R-sq	0.006	0.420

Notes: the signs *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. We cluster the SE at the household level.

Table A2. Reduced-form estimates

	HAZ	WAZ	WHZ
Average cigarette prices at the province level, standardized	-0.058***	-0.058***	-0.038**
	(0.016)	(0.013)	(0.016)
1 if the child has a twin	-0.572***	-0.492***	-0.198*
	(0.123)	(0.102)	(0.120)
birth weight in kgs	0.340***	0.381***	0.247***
	(0.035)	(0.030)	(0.028)
1 if born premature	-0.048	-0.008	0.030
	(0.040)	(0.032)	(0.039)
child age in months	-0.008***	-0.007***	-0.003***
	(0.001)	(0.001)	(0.001)
1 if female	0.096***	0.036	0.001
	(0.031)	(0.024)	(0.030)
1 if consumes food once a day	0.639***	0.409***	0.329***
	(0.116)	(0.092)	(0.121)
1 if consumes food twice a day	0.196**	0.018	-0.101
	(0.088)	(0.076)	(0.089)
1 if consumes food thrice a day	0.267***	0.088	-0.089
	(0.082)	(0.071)	(0.084)
share of food expenditure to total expenditure	-0.456***	-0.197**	0.075
	(0.104)	(0.082)	(0.100)
household total expenditure per capita, standardized	0.029	0.008	-0.014
	(0.021)	(0.017)	(0.020)
1 if lives in urban area	0.145***	0.131***	0.072**
	(0.035)	(0.028)	(0.033)
1 if source of drinking water from mineral water, well, or spring	0.241***	0.185***	0.052

	(0.066)	(0.055)	(0.063)
1 if HH owns toilet with septic tank	0.178***	0.097***	-0.011
	(0.037)	(0.029)	(0.036)
household size at the current survey	-0.005	-0.004	0.000
	(0.005)	(0.004)	(0.005)
father's years of education	0.009**	0.007**	0.003
	(0.004)	(0.003)	(0.004)
mother's years of education	0.028***	0.030***	0.020***
	(0.005)	(0.004)	(0.005)
1 if mother has a hypertension	-0.012	0.107**	0.179***
	(0.049)	(0.042)	(0.050)
1 if father smokes	-0.098***	-0.069**	-0.018
	(0.033)	(0.027)	(0.032)
1 if mother smokes	0.032	0.257**	0.388***
	(0.148)	(0.129)	(0.148)
1 if wave 5	-0.297***	-0.141**	-0.001
	(0.082)	(0.070)	(0.083)
Observations	9,449	9,572	9,427
Adj. R-sq	0.071	0.089	0.022

Notes: the signs *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. We cluster the SE at the household level.

Table A3. OLS and probit estimates on the effect of cigarette expenditure

	HAZ	WAZ	WHZ	1 if stunted: AME
monthly household cigarette expenditure, standardized	0.003	0.025	0.029	-0.003
	(0.019)	(0.016)	(0.020)	(0.006)
1 if the child has a twin	-0.568***	-0.484***	-0.190	0.155***
	(0.123)	(0.102)	(0.120)	(0.036)
birth weight in kgs	0.341***	0.381***	0.247***	-0.110***
	(0.035)	(0.030)	(0.028)	(0.013)
1 if born premature	-0.061	-0.021	0.020	0.026**
	(0.040)	(0.032)	(0.039)	(0.013)
child age in months	-0.008***	-0.007***	-0.003***	0.000
	(0.001)	(0.001)	(0.001)	(0.000)
1 if female	0.094***	0.035	0.000	-0.036***
	(0.031)	(0.024)	(0.030)	(0.010)
1 if consumes food once a day	0.635***	0.407***	0.328***	-0.162***
	(0.116)	(0.092)	(0.121)	(0.031)
1 if consumes food twice a day	0.189**	0.012	-0.104	-0.058**
	(0.088)	(0.076)	(0.089)	(0.028)
1 if consumes food thrice a day	0.262***	0.086	-0.088	-0.074***
	(0.082)	(0.071)	(0.084)	(0.026)
share of food expenditure to total expenditure	-0.457***	-0.187**	0.088	0.116***
	(0.104)	(0.083)	(0.100)	(0.032)
household total expenditure per capita, standardized	0.028	0.006	-0.015	-0.006
	(0.021)	(0.017)	(0.020)	(0.006)
1 if lives in urban area	0.137***	0.122***	0.065**	-0.044***
	(0.035)	(0.027)	(0.033)	(0.011)

1 if source of drinking water from mineral water, well, or spring	0.234***	0.178***	0.047	-0.054**
	(0.066)	(0.055)	(0.063)	(0.021)
1 if HH owns toilet with septic tank	0.177***	0.094***	-0.015	-0.049***
	(0.037)	(0.029)	(0.036)	(0.012)
household size at the current survey	-0.005	-0.004	0.000	-0.001
	(0.005)	(0.004)	(0.005)	(0.002)
father's years of education	0.008**	0.006**	0.002	-0.001
	(0.004)	(0.003)	(0.004)	(0.001)
mother's years of education	0.028***	0.030***	0.020***	-0.009***
	(0.005)	(0.004)	(0.005)	(0.001)
1 if mother has a hypertension	-0.014	0.106**	0.179***	0.008
	(0.049)	(0.042)	(0.050)	(0.016)
1 if father smokes	-0.103**	-0.102***	-0.056	0.029**
	(0.042)	(0.034)	(0.041)	(0.013)
1 if mother smokes	0.026	0.239*	0.371**	0.042
	(0.149)	(0.129)	(0.146)	(0.046)
1 if wave 5	-0.314***	-0.164**	-0.021	0.082***
	(0.082)	(0.070)	(0.083)	(0.025)
Observations	9449	9572	9427	9449
Adj. R-sq	0.070	0.087	0.022	

Notes: the signs *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. We cluster the SE at the household level.

Table A4. IV estimates on the effects of cigarette expenditure on children growth among smokers

	HAZ	WAZ	WHZ	1 if stunting, average marginal effects
monthly household cigarette expenditure, standardized	-0.876**	-0.960***	-0.714**	0.550***
	(0.363)	(0.317)	(0.342)	(0.182)
1 if the child has a twin	-0.717***	-0.737***	-0.407**	0.440***
	(0.211)	(0.190)	(0.194)	(0.133)
birth weight in kgs	0.321***	0.362***	0.240***	-0.235***
	(0.050)	(0.045)	(0.037)	(0.047)
1 if born premature	0.046	0.089	0.106	0.011
	(0.070)	(0.062)	(0.066)	(0.052)
child age in months	-0.009***	-0.009***	-0.005***	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
1 if female	0.097**	0.033	-0.008	-0.077**
	(0.045)	(0.039)	(0.042)	(0.036)
1 if consumes food once a day	0.651***	0.404***	0.303*	-0.356***
	(0.170)	(0.148)	(0.169)	(0.136)
1 if consumes food twice a day	0.200	-0.057	-0.182	-0.133
	(0.134)	(0.126)	(0.127)	(0.101)
1 if consumes food thrice a day	0.184	-0.035	-0.173	-0.122
	(0.131)	(0.123)	(0.125)	(0.102)
share of food expenditure to total expenditure	-1.120***	-0.970***	-0.545*	0.648***

	(0.354)	(0.313)	(0.325)	(0.174)
household total expenditure per capita, standardized	0.064*	0.029	-0.012	-0.032*
	(0.033)	(0.033)	(0.032)	(0.018)
1 if lives in urban area	0.247***	0.203***	0.102*	-0.185***
	(0.062)	(0.055)	(0.058)	(0.036)
1 if source of drinking water from mineral water, well, or spring	0.241***	0.169**	0.027	-0.141**
	(0.093)	(0.084)	(0.087)	(0.071)
1 if HH owns toilet with septic tank	0.337***	0.284***	0.150*	-0.215***
	(0.089)	(0.077)	(0.084)	(0.043)
household size at the current survey	-0.003	-0.000	0.003	-0.004
	(0.007)	(0.007)	(0.007)	(0.005)
father's years of education	0.028***	0.031***	0.020**	-0.016***
	(0.008)	(0.008)	(0.008)	(0.005)
mother's years of education	0.023***	0.028***	0.023***	-0.020***
	(0.008)	(0.007)	(0.008)	(0.005)
1 if mother has a hypertension	-0.070	0.088	0.195***	0.046
	(0.074)	(0.067)	(0.071)	(0.054)
1 if father smokes	0.373**	0.401**	0.285*	-0.270***
	(0.182)	(0.163)	(0.170)	(0.099)
1 if mother smokes	0.248	0.507***	0.537***	-0.059

	(0.174)	(0.183)	(0.191)	(0.126)
1 if wave 5	0.042	0.234	0.249	-0.042
	(0.190)	(0.169)	(0.181)	(0.131)
First-stage estimations				
Average cigarette prices at the province level, standardized	0.066***	0.066***	0.066***	0.043***
	(0.014)	(0.014)	(0.014)	(0.009)
Wu-Hausmann *F*-statistics/AR-statistics for IV probit	21.023	21.312	20.915	6.12
p-value of *F*-statistics/ *p*-value of AR-statistics	0.000	0.000	0.000	0.013
R-squared	0.114	0.112	0.114	0.114
Observations	6,012	6,088	5,998	6,012

Notes: the signs *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively. For brevity, we exclude first-stage regression coefficients from the table. We cluster the SE at the household level.