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Katrina Kosec
Jie Song

Development Strategy and Governance Division
INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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AUTHORS

Katrina Kosec (k.kosec@cgiar.org) is a Senior Research Fellow in the Development Strategy and Governance Division of the International Food Policy Research Institute (IFPRI), Washington, DC.

Jie Song (jie.song@cgiar.org) is a Research Analyst in the Development Strategy and Governance Division of IFPRI, Washington, DC.

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The Effects of Income Fluctuations on Rural Health and Nutrition

Katrina Kosec*  Jie Song
IFPRI         IFPRI

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Abstract

This study explores the effects of fluctuations in household income on health and nutrition outcomes from birth to adulthood. We analyze data from a nationally representative, 13 year rolling panel dataset from Kyrgyzstan spanning 2004–2016. We address the endogeneity of income by instrumenting for income with predicted income, obtained using the household’s initial period share of income from different sources and aggregate growth rates over time in each source. Young children (age 0-5) exposed to reductions in income experienced reductions in height that were largest for girls and those under age two—groups that additionally experienced increases in stunting. Reduced consumption of healthy foods, reduced dietary diversity, and less expenditure on health may help explain the results. A channel possibly offsetting negative impacts is a decrease in fertility. At the same time, older children and adults saw decreases in BMI and—for adults—decreases in the incidence of overweight.

Keywords: child health; nutrition; income fluctuations; overweight; Central Asia

*Katrina Kosec is a Senior Research Fellow and Jie Song is a Research Analyst at the International Food Policy Research Institute (IFPRI), 1201 Eye Street, NW Washington, DC 20005. Comments and suggestions are welcome and may be emailed to k.kosec@cgiar.org. This research was part funded by the CGIAR Research Program on Policies, Institutions, and Markets led by IFPRI and the Ministry of Finance of the Russian Federation under IFPRI’s Collaborative Research and Capacity Strengthening Program for Enhancing Agricultural Productivity and Food and Nutrition Security in Central Asia. We are grateful to Kamiljon Akramov, Brian Dillon, Olivier Ecker, Bilge Erten, Jessica Heckert, Brian Holtemeyer, Jessica Leight, Roman Mogilevskii, Phuong Hong Nguyen, Giordano Palloni, and Kanat Tilekeyev for comments and helpful discussions. All remaining errors are the sole responsibility of the authors.
1 Introduction

How do income fluctuations affect health and nutrition outcomes, and how do these effects vary by gender and across the life cycle? Studies looking both across and within countries reveal strong correlations between income and health (Cutler et al., 2006; Adda et al., 2009; Currie, 2009; Banerjee et al., 2010; Bengtsson, 2010; Baird et al., 2011; Ebenstein et al., 2015). The seminal work of Preston (1975) revealed that a country’s average life expectancy is growing in income. Pritchett and Summers (1996) further showed that infant and child mortality are declining in income. Within both developed (Rogot et al., 1992) and developing countries (Gwatkin et al., 2007), the poor almost unambiguously have worse health outcomes than the better-off. Yet, establishing a causal link can be elusive; at the micro level, healthier individuals are more productive and earn higher incomes, and at the macro level, omitted variables such as the quality and efficiency of public investments simultaneously affect incomes and health (Cutler et al., 2006). Some of the best identified studies of the impacts of income on health thus consider either extreme events that provide natural experiments—such as droughts (Lohmann and Lechtenfeld, 2015; Hyland and Russ, 2019), blights (Banerjee et al., 2010), prolonged blackouts (Burlando, 2014), war and armed conflict (Akresh et al., 2012; Minoiu and Shemyakina, 2014), recessions (Bhalotra, 2010), or financial crises (Cutler et al., 2002; Van den Berg et al., 2006; Bozzoli and Quintana-Domeque, 2014; Hidrobo, 2014)—or randomized control trials of cash transfer programs. However, extreme events can have behavioral impacts, such as reduced life satisfaction (Luechinger and Raschky, 2009), increased risk aversion (Cameron and Shah, 2015), and reduced aspirations for the future (Kosec and Mo, 2017), which smaller fluctuations in income do not bring about. And findings from cash transfer programs may not generalize to populations not targeted by such programs. Further, evidence on the health impacts of transfers is mixed (Evans et al., 2019).

Consideration of the theory of change surrounding income fluctuations and health provides insight into why there are mixed findings in the literature. In developing countries,
Increases in income tend to increase consumption of nutritious foods and important micronutrients (Cornia, 1994; Steckel, 1995; Jensen and Richter, 2004; Currie, 2009; Ali et al., 2018; Hoang, 2018; Chaijaroen, 2019), and can additionally increase other investments in children, from purchasing children shoes to sending them to school (Jensen, 2000; Ferreira and Schady, 2009; Maccini and Yang, 2009; Evans et al., 2019). Negative economic shocks can even lower parental aspirations for their children’s futures (Kosec and Mo, 2017). Aggregate shocks that lower incomes can also physically disrupt access to healthcare, worsening health outcomes.

At the same time, health-related behaviors are often counter-cyclical for both adult (Ruhm, 2000, 2003; Deaton and Paxson, 2004) and child health (Dehejia and Lleras-Muney, 2004; Miller and Urdinola, 2010; Page et al., 2019). For example, with declining wages, mothers smoke and drink alcohol less, and parents may have more time to seek prenatal and antenatal care, take children to health clinics, breastfeed, cook nutritious food, teach children sanitary habits and monitor their hygiene, and access clean water. This may explain work showing negative effects of increases in household income on short-run child health status (Skoufias, 1998) and adult mortality (Snyder and Evans, 2006), and positive impacts of unemployment on babies’ health (Dehejia and Lleras-Muney, 2004; Page et al., 2019). Reductions in income may also reduce risk-taking behaviors; for example, economic stress and poverty have been shown to lead to higher levels of risk aversion (Haushofer and Fehr, 2014). Finally, reductions in income may lower fertility (Alam and Pörtner, 2018), allowing additional investments in existing children.²

The relationship between income and over-nutrition is similarly nuanced. The current global rise in the prevalence of overweight and obesity poses a major global health challenge given their well-established links with diabetes mellitus, coronary heart disease, certain forms of cancer, and sleep-breathing disorders (Kopelman, 2000). These

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¹Behrman and Deolalikar (1989) importantly point out that, at low levels of per capita income, income elasticities of calorie intake are substantially less than food expenditure elasticities with respect to income given the poor’s increasing demand for food variety.

²In contrast, if reductions in income spur migration as some studies suggest (Skoufias, 2003; Dillon et al., 2011; Mueller et al., 2014; Kosec and Holtmeyer, 2019), non-migrants—often women (Mueller et al., 2018; Kosec and Holtmeyer, 2019)—may face new time burdens, reducing investments in children.
raise healthcare expenditures, reduce productivity, and lead to premature mortality (Withrow and Alter, 2011; Dee et al., 2014). Childhood and adolescent obesity also negatively affect social and emotional well-being and academic performance (Sahoo et al., 2015). Nonetheless, public health campaigns have largely failed to curb over-nutrition (Swinburn et al., 2011; Ng et al., 2014). These trends have been attributed to technological change which has lowered the cost of calories—especially that of refined grains, added sugars, and added fats, which are now among the lowest-cost sources of dietary energy (Drewnowski and Darmon, 2005)—while making work more sedentary and raising the cost of physical activity (Cutler et al., 2003; Lakdawalla et al., 2005; World Health Organization, 2009; Finkelstein and Strombotne, 2010). Low-income individuals in some settings are also more likely to be overweight or obese (Drewnowski and Darmon, 2005), and some research has linked economic insecurity to the consumption of foods that cause weight gain (Gundersen and Kreider, 2009; Smith, 2011). Nonetheless, other research finds no relationship (Alaimo et al., 2001; Bhargava et al., 2008) or a negative relationship (Jimenez-Cruz et al., 2003; Rose and Bodor, 2006) between economic insecurity and obesity. And empirical evidence from Sweden shows that winning the lottery increases children’s health care utilization and may reduce obesity risk (Cesarini et al., 2016). The net impact of changes in income on the incidence of overweight and obesity is somewhat ambiguous.

In this paper, we use individual-level data from a 13-year, nationally-representative rotating panel survey of Kyrgyzstan to estimate the effects of fluctuations in the incomes of agriculture-dependent households on the heights and weights of young children (age 0–5) and on the incidence of overweight and obesity among children and adults. Our focus on departures of income from trend is distinct from analysis of the effects of long-term changes in income. It offers insights into how health responds to income fluctuations that are ubiquitous in developing countries rather than the impacts of global shifts in a country’s prosper-

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3 Between 1975 and 2016, the share of adults worldwide that were overweight or obese (body-mass index of 25 kg/m²) rose from 18.7 to 38.5 percent for men and from 21.7 to 39.7 percent for women. The incidence of overweight and obesity for children and adolescents (age 5–19) rose from 4.1 in 1975 to 19.3 percent in 2016 for boys, and from 4.6 to 17.5 percent for girls (World Health Organization, 2017)
ity. Our focus on a low-income, developing country is motivated by research showing that poor households tend to under-insure against reductions in income (Townsend, 1994, 1995; Jalan and Ravallion, 1999; Dercon, 2002; Yang, 2008), making them more vulnerable to such fluctuations. The poor also face a higher arrival rate of health shocks (Currie and Stabile, 2003), and their negative health impacts accumulate over time (Case et al., 2002). As poorer households’ inability to smooth their consumption over time has been shown to disproportionately affect women (Dercon and Krishnan, 2000), we estimate health impacts by gender.

We address the endogeneity of income to health and consumption using an instrumental variables approach; we instrument for income with predicted income, obtained using the household’s initial period share of income from six different revenue sources, and agricultural production costs from two different sources (crop and livestock), and aggregate growth rates of each of these eight revenues and costs over time.

Our paper extends existing literature in several ways. First, we focus on the impacts of recurring fluctuations in income—in our case due to price shifts—as opposed to either extreme shocks that form natural experiments or targeted cash transfer programs. This helps isolate the health and nutrition consequences of income fluctuations from the trauma of extreme shocks, and increases the external validity of the findings beyond individuals targeted by transfer programs. Second, by exploiting not only time but also spatial variation in exposure to macroeconomic shocks to income and shifts in the costs of agricultural inputs, we are able to separate the effects of reductions in household income from other country-wide or region-wide shocks. These include everything from the quality of public services to the relative prices of different foods and essential nutrients. Third, we address identification challenges related to the simultaneity of income and health using an instrumental variables approach following Bartik (1991). Showing causal relationships is broadly challenging. Some efforts to achieve identification have included instrumenting for income with five-year changes in terms of trade (Pritchett and Summers, 1996) and past rainfall (Bengtsson, 2010); we build on these efforts. Fourth, we add to a scant literature on the impacts of fluctuations in
income on the incidence of overweight and obesity—two phenomena currently experiencing a rapid (Popkin et al., 2012) and costly (Thorpe et al., 2004) rise worldwide.\footnote{Thorpe et al. (2004) find that 27 percent of the rise in per capita health care spending in the United States between 1987 and 2001 was due to increased spending on obese people.} Fifth, relatively little attention has been paid to the differential impacts of fluctuations in income across the life cycle. The focus has generally been on young children—often disaggregated by gender—while ignoring potentially important impacts on older children and adult women and men. When studies do consider adults, they often consider the impacts of negative shocks in utero or during early childhood on subsequent adult health, rather than the impacts of contemporaneous fluctuations in income. Finally, we explore potential causal channels related to consumption, dietary diversity, expenditure on healthcare, and fertility.

We find that young children (age 0-5) exposed to reductions in household income experienced reductions in height and height-for-age z-scores that were largest for girls and those under age two—groups that additionally experienced increases in stunting. Both girls and boys experienced reductions in weight, weight-for-age z-scores, and weight-for-height z-scores. Reduced consumption of healthy foods, reduced dietary diversity, and less expenditure on healthcare may help explain the results. A channel possibly offsetting negative impacts is a decrease in fertility. At the same time, older children and adults saw decreases in BMI following reductions in income and—for adults—decreases in the incidence of overweight. The effects of reductions in income on the BMIs of older children and youth appear to be mostly driven by men; we find no evidence that fluctuations in income affect the BMI or incidence of overweight in older female children (age 5–18) or female youth (age 18–35). In contrast, reductions in income among older adults (age 35 and older) lower BMIs and reduce the incidence of overweight among both men and women.

This paper adds to a growing literature employing shift-share instruments, following Bartik (1991). For example, Card (2001) studies the effects of immigrant inflows on labor market outcomes by interacting initial immigrant composition of a place with immigration flows from origin countries. Acemoglu and Linn (2004) investigate the effect of potential mar-
ket size on entry of new drugs and pharmaceutical innovations by constructing an instrumental variable that is the interaction of age-group spending patterns with demographic changes. Dube and Vargas (2013) consider how income shocks affect armed conflict by instrumenting for the product of hectares of coffee grown in a base year and internal coffee prices in the current year with the product of hectares grown in the base year and current year international prices; they do a similar calculation involving oil production. Acemoglu et al. (2013) examine the effects of income on health expenditures by instrumenting for local area income with time series variation in oil prices interacted with local oil reserves. Nunn and Qian (2014) study the effects of US food aid on conflict in recipient countries by instrumenting for US food aid shipments with the interaction of lagged US wheat production and a country’s average tendency to receive US food aid over a 36-year period. Erten et al. (2019) investigate the impact of tariff reductions on labor market outcomes using the predicted exposure to tariff reduction, constructed from the average tariffs across all industries, weighted by baseline industry employment shares. Erten and Leight (2019) study how China’s accession to the World Trade Organization affects local structural transformation using a measure of tariff uncertainty constructed using the gap between tariff rates for countries with Normal Trade Relations (NTR) status and those with non-NTR tariffs in each industry, weighted by the baseline composition of employment by industry prior to WTO accession. And Leight (2016) estimates the impacts of shocks to labor demand in the secondary (industrial and mining) sector in China on local economic outcomes using a shock constructed from the baseline composition of county employment and national employment fluctuations.

The paper is organized as follows. Section 2 provides background on Kyrgyzstan’s economy, healthcare system, and levels of health. Section 3 describes our data, empirical strategy, and method for identifying the causal effects of fluctuations in household income. Section 4 presents results, while Section 5 explores potential causal mechanisms driving them. Section 6 shows the robustness of our findings to several alternative specifications and provides evidence to support the assumption of parallel trends. Finally, Section 7 concludes.
2 Background

Kyrgyzstan declared its independence from the Soviet Union in August 1991, and joined the Commonwealth of Independent States in May 1993. It is a land-locked, mountainous, low-income country in Central Asia. The period of our study spans 2004–2016, a time during which income per capita grew only modestly; in 2004, the Kyrgyz Republic had a GDP per capita of $757 (in constant 2010 USD) which grew to a still modest $1,042 by 2016. In 2016, 25.4 percent of people lived below the national poverty line, with even higher rates of poverty in rural areas (World Bank, 2019a,b). In total, about three quarters of the poor and four fifths of the extreme poor live in rural areas (FAO, 2015).

As in many developing countries, agricultural production is a central part of the economy of Kyrgyzstan. Throughout 2004–2016, over 64 percent of the population has lived in rural areas (World Bank, 2019b). Agriculture’s share in GDP was 33 percent in 2004, but it declined to 13 percent by 2016 (World Bank, 2019b). Nonetheless, 39 percent of employment in 2004 and 27 percent in 2016 was in agriculture, despite the fact that only 7 percent of the land is arable. The vast majority of agricultural production occurs on small individual farms (FAO, 2015). In our sample for analysis, about 28 percent of agricultural income comes from livestock and meat production and about 67 percent comes from harvested crops, with the remainder coming from meat production and food processing.

Kyrgyzstan has achieved significant progress over the last two decades on an array of measures of child health and nutrition. Stunting (height-for-age Z-scores, or HAZs, of -2 or less) affected nearly one third (32.6 percent) of children under age 5 in 1997, but this dropped to 22.6 percent by 2009 and to 12.9 percent by 2014—a 40 percent decline over 17 years. While rates of underweight are comparatively low, at 8.2 percent in 1997 and only 2.8 percent by 2014, they show evidence of a similarly-sloped decline over the last 17 years (World Bank, 2019b). In contrast to the improving trend in child anthropometrics, the incidence of overweight (BMI over 25) among adults has remained consistently high over the last 25 years—at 48.1 percent in 1990 and 50.8 in 2013 (Helble and Francisco, 2017).
adult prevalence of obesity (BMI over 30) in Kyrgyzstan was 15.5 percent in 2008, but rose to 16.6 percent by 2016 (CIA, 2016).

Health insurance has been compulsory in Kyrgyzstan since 1997. The Mandatory Health Insurance Fund serves as the single-payer for health services under the state-guaranteed benefit package. Since 2006, it has pooled revenue at the national level with the aim of ensuring greater equity in access to healthcare across regions (known in Kyrgyzstan as oblasts); prior to that, it was pooled at the oblast level (Ibraimova et al., 2011). As a result of these reforms, the country experienced a significant increase in access to healthcare during the 2000s and a reduction in reports of unofficial, informal payments for healthcare. Nonetheless, informal payments for some services (e.g., anesthesia) reportedly persist in some places, makingaffording healthcare still problematic for the poorest (Falkingham et al., 2010). As of 2016, domestic private health expenditure was about 58 percent of total health expenditure (World Bank, 2019b). Obtaining high-quality healthcare is also a challenge—particularly in rural areas. Knowledge levels of healthcare providers are also generally low. For example, on a 52-question test related to maternal care, rural physicians scored an average of 55.2 percent, and nurses and midwives scored under 50 percent (Wiegers et al., 2010).

3 Empirical Strategy

We hypothesize that fluctuations in household income will influence households’ consumption and various other decisions—with implications for health and nutrition outcomes. To test this, we estimate the following fixed effects model:

\[ O_{ijkt} = \beta_0 + \beta_1 \log(H_{jk,t-s}) + \beta_2 X_{j,k,t=0} + \beta_3 Y_{ijkt} + \alpha_k + \mu_t + \epsilon_{ijkt} \]  

(1)

where \( i \) indexes individuals, \( j \) indexes households, \( k \) indexes the oblast (i.e. region) in which the household resides, \( t \) indexes years, and \( s \) is the chosen lag structure in years (either 1 or 2). \( O_{ijkt} \) is a health or nutrition outcome in our main analysis, which is measured in the
first quarter of the year (January–March). We consider several other outcomes, described in Section 3.4 and analyzed in Section 5, when we explore the mechanisms driving our main results; these relate to consumption, dietary diversity, healthcare expenditure, and fertility. $H_{jkt}$ is total annual household income; it includes non-agricultural income (paid employment, self employment, one-time work, pensions and other benefits, and capital income) and five types of agricultural incomes (crop production, livestock sales, meat production, hunting/gathering, and production of processed food)—all net of the costs of agricultural production (crop production and livestock rearing). We log the total annual household income, but also present robustness checks showing similar results when using the level of income, described in Section 6.3. $X_{j,k,t=0}$ is a vector of household-level controls, taken from the first year the household $j$ entered the sample, and $Y_{ijkl}$ is a vector of individual-level controls, both described in Section 3.5. $\alpha_k$ are oblast fixed effects while $\mu_t$ are year fixed effects. If all variation in $H_{jkt}$ were random, $\beta_1$ would provide the causal effect of an increase in total household income on health and nutrition-related outcomes. In Section 3.2, we explain how we account for the likely endogeneity of this variable.

We consider both specifications in which we use lagged household income, $H_{jk,t-1}$ as well as specifications in which we instead consider a two year lagged value, $H_{jk,t-2}$. The former examines impacts in the first quarter (January–March) following the calendar year over which annual income is measured. The latter allows an additional year for impacts to materialize. The speed with which impacts materialize may depend on the particular outcome in question and age group, motivating analysis of both. We do not consider longer lags given the short number of years (four at the median) that households appear in our sample; the sample and it selection are described in detail in Sub-section 3.1.

### 3.1 Data

Our data source is the Kyrgyzstan Integrated Household Survey (KIHS), a nationally-representative, rotating panel household survey carried out quarterly starting in 2003. These
data were collected by the National Statistical Committee (NSC) of Kyrgyzstan, with financial and technical support from the UK Department for International Development (DFID) and Oxford Policy Management (in round 1); they are described in detail by Esenaliev et al. (2011). The panel gradually rotated new households in and old households out—though it has not been officially detailed how this was done, motivating our analysis of attrition in Subsection 3.3. The panel replaced up to 25 percent of the sample every year until 2013, when an entirely new sample was selected; Figure 1 visually depicts the distribution of years of entry of households into our final sample for analysis (described in detail below). The KIHS is a multi-topic household survey for which the primary respondent is typically the household head or most knowledgeable household member—with the exception of modules about women’s health and fertility, which are completed by all female household members aged 15–49. Income data were collected quarterly, but for several years, we could only obtain annual aggregates; we thus aggregated income data across quarters in each year. Data on child anthropometrics were only available starting in 2005, which means our unbalanced panel analysis ultimately includes outcomes for 2005–2016 and—since we lag income—exploits income data for 2004–2015.5

We include in our sample for analysis households earning at least some income from agriculture during their first year in the sample. Households not initially earning income from agriculture that subsequently earn it enter the sample. 61.8 percent of household-year observations from the KIHS sample are thus included in our main sample. As this is a non-restrictive definition of dependence on agriculture, Table A11 explores the robustness of the results to omitting urban households, and to only considering households earning a substantial share of income from agriculture (specifically, those earning over 10, 20, 30, 40, and 50 percent of income from agriculture during their first year in the sample). In total, we have 35,961 unique individuals from 8,845 households in our main sample for analysis.6

5At the time of our analysis, 2017 KIHS data were not yet available.
6While household identifiers are unique and consistent across years, individual identifiers are not; to construct individual identifiers, we used the household identifier and the individual’s gender and exact birth date (day, month, and year). While such a strategy could result in us switching the identities of twins or
3.2 Identification

Reverse causality and omitted variables may bias ordinary least squares (OLS) estimates of the health and nutrition effects of income fluctuations. That improved health and nutrition are likely to mechanically raise incomes should bias upward OLS estimates of the effects of increases in income. However, a host of factors is likely to simultaneously affect incomes and health, and it is difficult to sign the bias that these may generate. For example, poor weather (e.g., droughts or flooding) may lower incomes from agriculture. It is also likely to reduce food production and thus food consumption—possibly leading to a deterioration in health. At the same time, poor weather may provide adults with more leisure time and thus ability to invest in child health. It may also spur contraceptive use and thus allow parents to invest more in existing children’s health as opposed to a child in utero. These effects would tend to downward bias OLS estimates. Similarly, reductions in sexism and prescribed gender roles may grow incomes by spurring women’s greater involvement in the labor force, and this may increase health through increased food consumption—thus leading to upward biased OLS estimates. But they may also lead to reductions in investments in children by increasing the opportunity cost of such investments by women—accordingly downward biasing OLS estimates. This makes it difficult to sign the bias in OLS estimates. It also makes it important to empirically examine the mechanisms driving our results.

We follow a large literature based on Bartik (1991) to identify the causal effects of fluctuations in income. Specifically, we predict logged total household income in year \( t = n \) by taking the baseline (year \( t = 0 \)) values of six sources of household revenue (income from the non-agricultural sector, crop production, livestock sales, meat production, hunting/gathering, and production of processed food) and two costs (crop production costs and livestock others who happen to be born on the same year, month, and day as another household member, this problem is likely to be minimal. In our raw data, for example, only 0.45 % observations (where an observation is an individual–year) are duplicates in terms of year, household identifier, gender, and exact birth date—on par with the 2015 twin birth rate in the U.S. (Martin et al., 2017).

\(^7\) Despite the difficulties of signing the direction of bias for OLS estimates, Christian and Barrett (2018) make compelling arguments for discussing its likely direction clearly in the context of shift-share and other interacted instruments.
production costs) that jointly sum to total income, and multiplying each by the oblast × area type (rural or urban) aggregate growth rate in this revenue (or cost) source between \( t \) and \( t + n \). Formally:

\[
A_{j,k,t} = \sum_{r=1}^{6} (\text{revenue}_{j,r,t=0} \times (1 + g_{j,k,r,t})) - \sum_{c=1}^{2} (\text{cost}_{j,c,t=0} \times (1 + g_{j,k,c,t}))
\]  

(2)

where \( g_{j,k,r,t} \) and \( g_{j,k,c,t} \) are the average growth rates of revenue source \( r \) and cost source \( c \), respectively, between year \( t = 0 \) and year \( t \) in the oblast × area type. We then use this predicted (i.e. “projected”) household income variable as an instrument for actual total household income.

Using this instrumental variables strategy, our first and second stage equations are:

\[
O_{ijkl} = \pi_0 + \pi_1 \log(H_{jkt}) + \pi_2 X_{j,k,t=0} + \pi_3 Y_{ijkl} + \gamma_k + \eta_t + u_{ijkl}
\]  

(3)

\[
\log(H_{jkt}) = \theta_0 + \theta_1 \log(A_{jkt}) + \theta_2 X_{j,k,t=0} + \theta_3 Y_{ijkl} + \delta_k + \sigma_t + v_{ijkl}
\]  

(4)

where \( \gamma_k \) and \( \delta_k \) (\( \eta_t \) and \( \sigma_t \)) are oblast (year) fixed effects in the second and first stages, respectively. Our year fixed effects absorb the impacts of nation-wide movements in revenues from different sectors over time, while our oblast fixed effects capture regional differences in the composition of income. Importantly, identification in no way comes from endogenous household decisions to change the household’s relative reliance on different sectors (e.g., the non-agricultural sector vs. crop agriculture) over time. We further control for the logged value of initial (year \( t = 0 \)) revenue, \( \text{revenue}_{j,r,t=0} \) that the household earned from each of the six revenue sources, \( r = \{1, \ldots, 6\} \), and logged value of the initial year costs, \( \text{cost}_{j,c,t=0} \) that the household incurred from each of the two cost sources, \( c = \{1, \ldots, 2\} \). And we also

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8 We omit the household itself when computing the growth rate. We have eight oblasts in total when we treat the capital of Bishkek as an oblast. Bishkek is entirely urban, but the other seven oblasts have both rural and urban areas, leading to 15 oblast–area types in total.

9 We use –ivreg2–, written by Baum et al. (2010) for IV estimation.
control for the interaction of each logged income or cost with a linear time trend, to allow households to be on different trends according to their initial reliance on different sources of revenue, or exposure to different costs. Finally, in case households are also on different secular trends according to their initial year total income, $H_{j,k,t=0}$, we additionally control for logged initial total income and its interaction with a linear time trend.

Our IV strategy thus exploits that part of household income that is due to exogenous changes in the profitability of different forms of earning income, and the costs of different ways of earning income. Our key identifying assumption is that predicted (i.e. projected) total income only affects health-related outcomes through its effects on household income. As for all IV estimates, our estimates reflect average effects for observations that comply with the instrument—that is, we estimate a local average treatment effect (Imbens and Angrist, 1994). Compliers are observations that experience higher total household incomes following increases in the average earnings in sectors on which they are especially reliant and/or that experience higher total household incomes following decreases in the costs of types of production on which they are heavily reliant. In other words, our IV estimates are not driven by the effect of having higher total household income for households and individuals whose total household income is unaffected by changes in the average regional profitability of sectors in which they are heavily engaged.

It is useful to consider the size of typical fluctuations in annual income that sample households experience from one year to the next. In Figure 2, we compute, for each income observation, the absolute value of the percentage change relative to the previous year. For example, if income is 100 in year $t = 0$ and becomes 70 in year $t = 1$, or if it becomes 130 in year $t = 1$, we in either case assign 30 percent as the absolute value of the fluctuation. On average, households experienced an income fluctuation of roughly 36 percent, year-over-year.

Following the logic of Abadie et al. (2017), we cluster standard errors at the household level; fluctuations in household income due to shifts in the profitability of different sectors which we exploit vary at the household level as they depend on both the unique sources of
revenues and costs that characterized what the household chose in its initial period in our sample and the timing (year) of the household’s entry into the sample.

As Table 2 shows, total household income is indeed strongly correlated with predicted income from agriculture. Whether or not we use our full control set, and regardless of which sample we use—young children, older children, youths, older adults, or a household-level sample—the coefficient on predicted income is between 0.62 and 0.73, and our first stage F statistic is always above 360—far from suggesting any problems of weak instruments.

3.3 Attrition

As we lack data on the precise procedure employed for dropping households from the rolling panel each year, we are unable to distinguish households that exit the sample due to planned exit versus more problematic attrition—such as that due to household refusal to participate or inability to locate the household or its members. To assess whether attrition is likely to be non-random as opposed to random (i.e. planned attrition due to the rolling nature of the panel), we used our household-level sample to analyze the extent to which household income, or lagged income, predict the household leaving the sample in the following year.

In Table A3, we find little evidence that household income significantly influences household attrition. While higher income in the current year predicts lower attrition in column 1 (which includes only our basic control set), the coefficient is incredibly small in magnitude: a 36 percent reduction in income (corresponding to the sample mean year-over-year change in income, as shown in Figure 2) leads to a $0.024 \times \ln(1.36) = 0.007$ percentage point increase in the likelihood of attriting from the sample in the following year. Thus, we effectively obtain a precisely estimated zero attrition rate. Additionally, that significance of the coefficient on income disappears when we include our full control set (column 2). Further, we find no evidence that income lagged one year, or lagged two years, has any impact on attrition—either with our limited control set (columns 3 and 5) or our full control set (columns 4 and 6). We conclude that non-random attrition is unlikely to impact our interpretation of the results.
3.4 Outcomes

Our primary outcomes consist of several measures of the nutritional status of young children (ages 1–5), older children and adolescents (ages 5–18), youth (ages 18–35), and older adults (ages 35 and over). These outcomes are measured in the first quarter of the year (i.e. between January and March), during the initial visit with the household in which roster data (including on gender and exact age) were also collected; the median date of data collection is February 15. Fluctuations in income naturally will take time to influence measures of long-term health and nutrition. As such, we are interested in the impacts of lagged income. When we use a single lag of income ($H_{t-1}$), we are considering income over the calendar year that began (ended) approximately 13.5 months (1.5 months) prior to measurement of our health and nutrition outcomes. And when we use a two year lag of income ($H_{t-2}$), we are considering the calendar year that began (ended) approximately 25.5 months (13.5 months) prior. This is depicted visually in Figure 3.

We omit children under 12 months from our main analysis as none of them would have been in utero by the start of the year over which $H_{t-2}$ is measured, and over 40 percent would not yet have been in utero by the start of the year over which we measure $H_{t-1}$. Table A4 illustrates the ages of children (e.g., A months pre-pregnancy, B months in utero, or C months old) at the start and end of each year over which we measure income. Excluded children (ages 0–11 months) are shown in grey shade. For example, the table shows that if we had included children aged 4 months old, they would be between 0.5 months pre-pregnancy (i.e. not yet conceived) and 2.5 months old during the year over which we measure income when we lag income by one year, and they would be 12.5 months pre-pregnancy to 0.5 months pre-pregnancy during the year over which we measure income when we lag income two years. We show that results are robust to including all children.

Nutritional status in young children is generally assessed using height-for-age Z-scores (HAZs), weight-for-age Z-scores (WAZs), and weight-for-height Z-scores (WHZs). In addition to considering height and weight themselves as outcomes, we thus construct each of
these measures, which also utilize information on child gender, exact age (in years, months, and days), and global child growth standards from the World Health Organization (2006). Z-scores measure deviation from the WHO (2006) reference population’s mean; a Z-score of 0 means that the individual has the mean score. Having a HAZ $<-2$ is known as stunting. For older children and adolescents (ages 5–18) as well as adults, we additionally compute the individual’s body mass index (BMI) and consider whether they are overweight (BMI $\geq 25$ kg/m$^2$) or obese (BMI $\geq 30$ kg/m$^2$). We complement these objective measures of health with household head reports about the subjective well-being of members—specifically, we code a dummy for whether each member is in good health.$^{10}$ Subjective impressions of the main respondent are likely to be noisy, so we interpret findings with this caveat in mind.

Table A1 summarizes health and nutrition outcomes for children under ages 5, while Table A2 summarizes them for older children and adults. The data suggest a high rate of stunting among children under age 5, at 31 percent on average during 2005–2016.$^{11}$ The HAZ and WAZ of children under 5 tend to be below average, while WHZ is above average, compared to WHO (2006) standards. Subjective impressions of whether one is in good health appear to decline monotonically in age, from 97.6 percent of our age 1–5 sample to 67.1 percent of our age 35 and over sample. Overweight and obesity are virtually non-existent in children ages 5–18; their average BMI is 17.7. However, 18 percent of youths and 52 percent of those over age 35 are overweight. And while obesity is present among only 2 percent of youths, it is present among 13 percent of older adults. To analyze the mechanisms potentially driving any impacts of fluctuations in household income on health and nutrition outcomes, we consider three additional sets of outcomes: those related to household consumption, dietary diversity, healthcare expenditure, and fertility. These broadly capture whether nutrition and health impacts are due to changing diets and selection into child bearing.$^{12}$

$^{10}$Exact question wording was: “In the opinion of [NAME], what is the state of his/her health?” Response choices included: “very good,” “good,” “satisfactory,” “not bad, not good,” “Poor,” and “very poor.”

$^{11}$This rate of stunting is similar to that found in World Bank (2019b), which shows average rates of stunting among children under age 5 of 36 percent in 1997, 23 percent in 2009, and 13 percent in 2014.

$^{12}$Since the seminal work of Becker (1960), it has been recognized that fertility decisions are affected by household wealth; we assess whether they are also affected by fluctuations in household income.
We employ several measures of household consumption and dietary diversity, all summarized in Table 1. Consumption data come from a two week recall and do not indicate which household members consumed the food. However, they were collected at quarterly intervals during the calendar year (i.e. we have four observations per household in a given year) as opposed to once, helping us achieve greater between-household variation in consumption.\(^{13}\)

We code dummies for the household consuming each of 11 mutually-exclusive categories of food (cereals, eggs, fruits, meat and poultry, pulses/ legumes/ nuts, roots and tubers, fresh vegetables, fish/ seafood, dairy products, oils, and sugar); they take on a one only if the food category was consumed during all four quarters. These comprise our measures of the extensive margin of consumption. We additionally computed the logged average amount consumed, across all four quarters, of each food category—capturing the intensive margin of consumption. Each food category is measured either in liters or in kilos (kg), as appropriate.\(^{14}\)

To better understand the dairy products category, we further sub-divide it into milk products (such as milk, cream, or kefir, all measured in liters) and cheese products (such as cheese, curds, butter, sour cream, or yogurt, all measured in kg) and code both a dummy and the logged amount consumed of each. There is a twelfth, “other” category for which we can code a dummy for consumption but cannot compute the logged amount given it contains a diverse mix of foods varying measured in liters or kilos.\(^{15}\)

Beyond total amounts of food consumed, existing research shows that there is a strong association between child dietary diversity and nutritional status, and that dietary diversity reflects diet quality (Arimond and Ruel, 2004; Moursi et al., 2008; Rah et al., 2010). We thus code two dietary diversity indices. The first is the household dietary diversity score (HDDS); to construct it, we count the total number of our 12 categories of food for which the

\(^{13}\) 24 hour or 7 day recalls are more commonly used in studies of dietary diversity (Arimond and Ruel, 2004). This was an additional motivation to use our four observations per household per year in this way.

\(^{14}\) A number of studies similarly measure consumption in terms of quantity (e.g., liters or kilos) consumed (Ali and Tsou, 1997; Ives, 2002; Suryanarayana and Silva, 2007).

\(^{15}\) While we use this as a food category in computing our dietary diversity index, we do not analyze the dummy or the logged amount of its consumption independently.)
household head reported its consumption during each of the four visits.\textsuperscript{16} Our choice of these 12 categories and our method of combining them into a HDDS follows \textit{Swindale and Bilinsky} (2006).\textsuperscript{17} The second is a “healthy” HDDS, which we code similarly but considering only a subset of four relatively healthy food categories: fruits, pulses/legumes/nuts, vegetables, and fish/seafood. This is similar to an index created by \textit{Imamura et al.} (2015).\textsuperscript{18}

We also measure whether or not women are pregnant as well as two associated measures: whether or not the woman normally practices contraception (this outcome is missing for pregnant women), and whether or not she wants more children. We include in this analysis all women of reproductive age (15-49) who have had their first period and are married or otherwise sexually active. In these regressions, we control for the number of children a woman already has (a continuous variable); on average, sample women already have 2.8 children.

### 3.5 Controls

We present results with and without our full set of controls. In general, results are not sensitive to inclusion of controls and our first stage is always strong. We include in all specifications geographic and time fixed effects, a quadratic in age, and a male dummy. We further include in all specifications controls for the initial period income for the household from each of the six income sources, the initial period costs faced by the household from each of the two cost sources, as well as the initial period value of total household income—all logged—plus a linear time trend interacted with each of these nine variables.

Our full set of controls additionally includes individual-level dummies for relationship with the household head, being married, and having a general secondary degree or higher.\textsuperscript{19} It also includes several household-level controls, summarized in Table 1. These include

\begin{itemize}
  \item \textsuperscript{16}In 2007, data shared with us were already annualized; as a result, we cannot compute either the dummies for consumption of a food or our dietary diversity indices for that year.
  \item \textsuperscript{17}We consider dairy products overall, and not the milk and cheese sub-categories of dairy, when constructing measures of dietary diversity.
  \item \textsuperscript{18}\textit{Imamura et al.} (2015) use whole grains, fruits, and vegetables as healthy food categories, while \textit{Khor} (2014) uses fruit and meat.
  \item \textsuperscript{19}Dummies for being married and for having a general secondary degree or higher have no variation for children under age 5, and are thus omitted from analysis of this age group.
\end{itemize}
a dummy for residing in an urban area, logged land area farmed, the number of unique agricultural goods the household produces annually, dummies for household size, a quadratic in age for the household head, and dummies for the head having a general secondary degree or higher, being married, and being male. All household-level controls are taken from the year in which the household enters the sample.

A few features of our sample are noteworthy. As Table 1, Panel A shows, about 72 percent of households are male-headed, and the average head age is 52. Average annual household income is 132,000 soms/ year (in constant, 2010 soms), and its standard deviation is 102,000 soms. At the June 1, 2010 Kyrgyzstan som – U.S. dollar exchange rate of 45.95 (National Bank of Kyrgyzstan, 2019), this is about 2869 USD. With average household size of 4.3 members, this is about 30,399 soms (662 USD) per capita. While low compared to national income figures ($757 in 2004, rising to $1,042 by 2016—discussed in Section 2), it is in keeping with the fact that we have disproportionately rural sample that depends on agriculture. About 79,000 soms of total income—or about 60 percent—comes from non-agricultural income, with the other 40 percent (agricultural income) coming mostly from harvested crops and income from livestock and meat production. Figure 4 shows trends over 2004–2016 for the top three sources of income. Over 2004–2016, non-farm income increases steadily—most quickly during 2004–2008, then more slowly, with one year of decline during 2014–2015. In contrast, there are considerable fluctuations in income from harvested crops; these are growing through 2009, then declining, and then experiencing another period of growth before declining again during 2013–2016. However, through this period, there is stable income from meat production. Panels B, C, and D of Table 1 summarize additional household-level outcomes. On average, households consumed only 1.9 of the four relatively healthy food categories used to construct our “healthy” HDDS (fruits, pulses/ legumes/ nuts, vegetables, and fish/ seafood) and 8.7 of the 12 food groups used to construct our HDDS.

Zero land was imputed to 0.1 square meters of land.
4 Results

4.1 Young child height

Table 3 presents regression results where our outcomes are the height (columns 1–2), HAZ (columns 3–4), and a dummy for stunting (columns 5–6) of young children (aged 1–5). Panels A and B show ordinary least squares (OLS) results when total household income is measured during the calendar year immediately preceding the quarter 1 (Q1) measurement of health and nutrition outcomes \((t - 1)\), and when it is measured two calendar years prior \((t - 2)\), respectively. Panels C and D present the instrumental variables (IV) second stage analogues of panels A and B, respectively. We present specifications with both our basic (odd-numbered columns) and full (even-numbered columns) control sets. Focusing on our preferred, full controls specifications, a reduction in household income predicts significantly lower child height and HAZ regardless of lag structure employed and method of estimation (OLS or IV)—though IV coefficients are modestly larger. While OLS results suggest that reductions in income increase stunting in young children, this finding does not hold in the IV results, where coefficients are smaller in magnitude and statistically insignificant. The negative effects of income on height and HAZ in the specifications in which we measure income in year \(t - 1\) become larger and generally more significant in the specifications measuring income in year \(t - 2\), despite the lower sample size (and thus statistical power) of this further lagged specification; this is consistent with the impacts taking time to materialize.

Our IV specification with the full set of controls reveals that a 36 percent reduction in income (corresponding to the sample mean year-over-year change in income, as shown in Figure 2) leads to a \(0.187 \times \ln(1.36) = 0.057\) standard deviation reduction in HAZs for children aged 1–5 after one year, which grows to a \(0.252 \times \ln(1.36) = 0.077\) standard deviation reduction in HAZs after two years. While we excluded 0–1 year olds as many were not yet conceived when income is lagged by two years, effects are similar if we instead use children aged 0–5, as shown in Table A5. Statistical significance is largely unchanged, and
point estimates are simply slightly smaller—consistent with the very youngest children in the 0–5 year old age group being unexposed (or much less directly exposed) to fluctuations in income because they pre-date their conception. In comparison, Minoiu and Shemyakina (2014) estimate that in utero or early childhood exposure to the 2002–2007 civil conflict in Côte d’Ivoire led HAZs of children in conflict zones to be 0.414 S.D. lower than those of children born during the same period who lived outside conflict regions. This suggests modest long-term health and nutrition reductions owing to reductions in household income.

As Table A6 reveals, these impacts are driven by girls. For neither lag structure, and for neither height nor HAZ, do we find impacts on boys. Compared to the full sample, the same 36 percent reduction in income reduces girls’ HAZ scores a year later by an even higher 0.086 standard deviations, which grows to 0.093 standard deviations after two years. Girls further experience a statistically significant increase in stunting not seen among boys in response to reductions in income; the magnitude is non-trivial, contributing to a $0.113 \times \ln(1.36) = 0.035$ percentage point increase in stunting after one year, and a $0.123 \times \ln(1.36) = 0.038$ percentage point increase after two. Boys may be protected from reductions in households income in ways that girls are not—with long-term impacts on their health and nutrition.

Effects of income on height, HAZ, and stunting are concentrated on children under age 2 (Table A7). Compared to the overall effects, effects on 2–5 year olds are smaller in magnitude and statistically insignificant. However, effects are larger and more statistically significant compared to overall effects when we restrict attention to 1–2 year olds, in columns 2, 5, and 8. Table A8 similarly shows that statistically significant effects of income on height, HAZ, and stunting of 0–1 year olds and 0–2 year olds are in all cases larger than comparable effects on all 0–5 year olds. This is consistent with very early childhood being a critical period.

### 4.2 Young child weight

In addition to impacts on height, Table 4 shows that we also find statistically significant reductions in the weight, weight-for-age (WAZ) Z-scores, and weight-for-height Z-scores (WHZ)
of children aged 1–5 in response to reductions in income. In both OLS and IV specifications, regardless of the control set employed, young children exposed to reductions in income experience lower weight and WAZ. OLS results suggest no impacts on WHZ, but our preferred IV specifications show significant reductions in WHZ that appear to be larger when we lag income by one year than by two years. Considering our preferred, fully controlled specifications, an average-sized reduction in income of 36 percent predicts a $0.234 \times \ln(1.36) = 0.072$ standard deviation reduction in WAZs one year later, and a $0.244 \times \ln(1.36) = 0.075$ standard deviation reduction in WAZs two years later. The impact on WHZ is a more modest but still statistically significant $0.184 \times \ln(1.36) = 0.057$ standard deviation reduction in WHZs one year later, which becomes a smaller and now statistically insignificant $0.156 \times \ln(1.36) = 0.048$ standard deviation reduction in WHZs two years later. Again, results are substantially unchanged when considering 0–5 year olds, with similar statistical significance and coefficients that are slightly smaller in magnitude (Table A8).

In contrast to our findings for young child height, we find no evidence that the weight, WAZ, or WHZ scores of girls and boys are differently affected by reductions in income (Table A9). Nor do we find that the weight, HAZ, and WHZ of 1–2 year olds are generally more heavily affected by reductions in income than are those of 2–5 year olds (Table A10). Negative effects of reductions in income on weight and related measures for young children appear to matter across genders and ages.

4.3 Anthropometric outcomes for older children

We next consider the impacts of income fluctuations on the height, weight, and BMI of children and adolescents (ages 5–18) in Table 5. We do not consider as outcomes dummies for these individuals being overweight or obese as these rates are incredibly low in this population (Table A2). While OLS results suggest impacts of reductions in income on height, weight, and BMI, and OLS coefficients on lagged income are remarkably similar to their IV counterparts, only BMI is significantly affected by lagged income in the IV results. In our
preferred, fully controlled specifications (column 3), a 36 percent reduction in income results in a modest \(0.173 \times \ln(1.36) = 0.053\) point reduction in the BMI when lagging income by one year, and a \(0.190 \times \ln(1.36) = 0.058\) point reduction when lagging income by two years. These are incredibly small but precisely estimated impacts. By comparison, the standard deviation of the BMI for this group is 2.30 points (Table A2). Compared to very young children, older children’s health is scarcely affected by reductions in income.

### 4.4 Anthropometric outcomes for youth and older adults

Table 6 considers anthropometric outcomes for youth (ages 18–35). As for older children, youths also experience declines in BMI a year after a reduction in income—though not when we measure income with a two year lag, suggesting that impacts are not sustained provided that income stabilizes. Measuring income with a one year lag, an average, 36 percent reduction in income reduces youth BMIs by \(0.429 \times \ln(1.36) = 0.13\) points. Once again, this is incredibly small compared to the standard deviation of the BMI for 18–35 year olds: 2.79 (Table A2). We interpret this as effectively a precisely estimated zero effect. More notably, however, youth also experience a decrease in the incidence of overweight after one year that is sustained when we instead measure income with a two year lag. Specifically, a 36 percent reduction in income leads to a 2.1 percentage point reduction in the incidence of overweight after one year \((0.067 \times \ln(1.36))\), which declines to 1.5 percentage points after two years \((0.049 \times \ln(1.36))\). These compare to a mean (standard deviation) of the overweight dummy among youth of about 0.18 (0.39). We find no impacts of fluctuations in income on the incidence of obesity in youths, possibly due to the small mean of this variable in the youth population (only 0.02) (Table A2).

Among those over age 35, we obtain similar results (Table 7), though coefficients are larger in magnitude and statistical significance compared to the youth sample. We also estimate statistically significant impacts on the weights of older adults that are not found in the youth sample. A 36 percent reduction in income leads to a 0.28 unit reduction in older
adults’ BMIs after one year that is roughly sustained after two years \((0.911 \times \ln(1.36))\)—relative to a standard deviation of the older adult BMI of 3.9. Also, older adults subjected to an average-sized decline in income of 36 percent tend to experience a \(0.141 \times \ln(1.36) = 0.043\) percentage point decline in the incidence of overweight after one year that is roughly sustained for a second year. We interpret the null effects of income on adult heights as a useful placebo analysis. It suggests that the results do not reflect some form of systematic measurement error as opposed to real reductions in height following negative economic shocks.

Among young children, girls’ anthropometric outcomes were most susceptible to reductions in income. Among adults, however, we find distinct patterns, shown in Table A13; for youth, it is men whose BMI and incidence of overweight are most sensitive to the level of income; we find no significant impacts on women for either outcome. Among older adults (age 35 and older), in contrast, income affects both men’s and women’s BMIs and incidence of overweight—with impacts generally larger in magnitude for women compared to men.

Overall, the results suggest that economic downturns may be good on some metrics for the health of youth and older adults. To the extent that high BMIs and overweight pose public health concerns, downturns in household income may reduce them. Importantly, though, we identify very modestly-sized impacts. While our results suggest that high BMI and the incidence of overweight are likely to become growing problems as income situations improve in the Kyrgyz Republic, they do not reflect a looming public health epidemic.

### 4.5 Subjective well-being

We next turn to subjective impressions of health—specifically, a dummy for being in good health (Table 8). These findings come with the caveat that they are reports from the main respondent rather than the individual whose health status we measure, but we argue that this should if anything introduce noise that makes it more difficult to identify statistically significant effects. Despite reductions in objective measures of health following reductions in household income, we only find robust evidence of deteriorations in subjective impressions
of health among 5–18 year olds following reductions in income. OLS results suggest positive impacts on all groups, but these are not robust to IV, where we find the coefficients generally lower in magnitude and statistically insignificant. This may reflect that adults’ subjective health is not vulnerable to such shocks, and that respondents almost uniformly reported 1–5 year olds to be in good health (97.6 percent are reported to be in good health). Among 5–18 year olds, effects are very small; a 36 percent reduction in income yields about a 1 percentage point improvement in subjective impressions of health in the specification with a one year lag that is sustained and slightly larger after two years. This provides some evidence that survey respondents—most typically household heads—do not feel that household members’ health suffers drastically following a reduction in household income.

5 Mechanisms

Overall, we have observed that reductions in household income have statistically significant and meaningful effects on not only young children but also on older children as well as adults. These findings hold even after accounting for the endogeneity of income to health outcomes using our instrumental variables strategy. Young children face significant reductions in height, HAZs, and WAZs—critical measures of long-term health and nutrition. They also experience reductions in WHZ, where a low value indicates acute malnutrition. Older children and adolescents experience reductions in weight though not in height. However, youth and older adults benefit from decreases in the incidence of overweight.

To better understand the potential causal mechanisms driving these results, we consider three sets of outcomes: those related to household consumption and dietary diversity, health-care expenditure, and fertility. These help capture whether nutrition and health impacts are due to changing diets, other investments in health, and/or selection into child bearing. As we noted earlier, while the measures we employ have important caveats, the results can at least provide suggestive evidence on the mechanisms at work.
5.1 Consumption and Dietary Diversity

We first explore the food security implications of reductions in household income by considering whether they influence what food groups households consume, the quantities consumed, and dietary diversity. Here, we consider the effects of contemporaneous income and income lagged one year rather than considering longer lags as we expect income to have immediate impacts on consumption—in contrast to its effect on health and nutrition outcomes, which are further down the causal chain. The effects of income on our consumption and dietary diversity variables indeed decline when we go from measuring income in the current period to measuring it with a one year lag (Table 9). The table shows that reductions in household income lead to statistically significantly less dietary diversity (HDDS) (Panel A). A 36 percent reduction in income reduces dietary diversity by 0.097 points ($0.316 \times \ln(1.36)$) in the same year, relative to its standard deviation of 1.26; this is about a 0.08 standard deviation decline. Healthy dietary diversity (HHDDS) declines by 0.042 points ($0.138 \times \ln(1.36)$); relative to its standard deviation of 0.616, this is a 0.07 standard deviation decline.

Examining consumption of specific foods, Panel B provides evidence on the extensive margin (outcomes are dummy variables for consumption) while Panel C shows evidence on the intensive margin (outcomes are logged quantities consumed). From both panels, we see that following a decrease in household income, individuals are less likely to consume fruits, fresh vegetables, roots and tubers, and dairy products—possibly explaining declines in young children’s health. However, consumption of sugar also goes down with declines in income—possibly helping explain declines in BMI and the incidence of overweight among adults. Consumption of meat and poultry is interestingly counter-cyclical—possibly indicating that households are more likely to slaughter and consume their animals in times of economic downturn as a coping strategy. However, effects of income on meat and poultry consumption are found only on the extensive margin (whether meat and poultry are consumed) and not on the intensive margin (logged amount of consumption).
5.2 Healthcare expenditure

In Table 10 we consider another important health input: expenditure on both outpatient and inpatient healthcare. We identify statistically significant and large declines in healthcare expenditures following declines in income. Specifically, a typically-sized, 36 percent reduction in income leads to about a 42 percent reduction in expenditure on outpatient costs a year later ($1.36^{1.134} = 1.42$). And after a two year lag, we find statistically significant and even larger impacts on both types of medical expenditures: in particular, a 70 percent decrease in outpatient expenditures ($1.36^{1.722} = 1.70$) and a 22 percent decline in inpatient expenditures ($1.36^{0.639} = 1.22$). Thus, reductions in investments in healthcare may also explain declines in health—with outpatient care, which may be of a less “urgent” nature compared to inpatient care, being most sensitive to declines in income.

5.3 Fertility

Next, we consider whether reductions in household income influence decisions on fertility in women aged 15–49; these results are reported in Table 11, and importantly reflect self-reports. Column 1 reveals that declines in income predict a greater likelihood of practicing contraception\(^{21}\)—though these results are not statistically significant at conventional levels. As women’s discomfort with talking about contraception with an enumerator may tend to introduce noise, we consult a related outcome measure that is slightly less personal: whether a woman wants to bear additional children (column 3). When we consider a one year lag of income, we find that a typical, 36 percent reduction in income decrease the reported desire to have additional children by $0.09 \times \ln(1.36) = 0.028$ percentage points—a sizeable reduction compared to the variable’s mean of 0.43. This is largely sustained a year later, when it declines only slightly to a $0.078 \times \ln(1.36) = 0.024$ percentage point reduction.

Next, we find a small but precisely estimated decrease in the incidence of pregnancy following a reduction in income. We estimate a $0.023 \times \ln(1.36) = 0.007$ percentage point decrease.

\(^{21}\)The contraception variable is missing for women who are already pregnant.
reduction in the probability of being pregnant when using income lagged by one year, which grows to a larger $0.040 \times \ln(1.36) = 0.012$ percentage points when lagging by two years. As the mean (standard deviation) of our pregnancy dummy is only 0.065 (0.247), this is a sizeable decrease. The results suggest that women avoid pregnancy in response to bad economic conditions. With fewer children and without the demands of a pregnancy, parents can conceivably invest more in the children they have. Thus, changes in fertility patterns may help blunt the negative effects of reductions in household income on very young children.

6 Robustness

We carry out a number of robustness checks to assess the validity and sensitivity of those results which were statistically significant for at least one lag structure. These include a check for pre-trends, tightening the requirements to be considered an agriculture-dependent household (thus reducing the sample size), and omitting various observations or trimming variables. In this section, we describe each of these in turn.

6.1 Check for pre-trends

A within-sample check for pre-trends, shown in Table 12, helps us validate our identification strategy. For each individual, we split their observations, ordered in chronological order, into two halves. For the first half, we measure the average level of each outcome variable. For the second half, we measure the average level of income.\footnote{If there are an odd number of years, we always assign one more year to the first period.} We then observe whether income in the later period predicts significantly different health outcomes in the earlier period. If current income predicts past outcomes, conditional on controls, we would worry that health outcomes measured today are correlated with income merely due to these prior trends. We measure income in three ways and check for pre-trends with each: logged predicted income (i.e. the value of our IV), fitted values of logged predicted income (i.e. our stage two
right-hand-side income variable), and logged actual total income. In these cross-sectional regressions, we control for the full set of controls in our 2SLS regressions. We find few statistically significant coefficients—no more than we would expect by random chance. We conclude that our results are not likely due to pre-trends.

6.2 Sample inclusion thresholds

In order to appear in our sample, we require only that households have at least some of their total household income coming from agriculture. Our aim is to capture households that are at least somewhat reliant on the rural sector—and who likely rely on a diverse array of income sources. As this is an arbitrary definition of dependence on agriculture, Table A11 explores the robustness of the results to omitting urban households, and to only considering households earning a substantial share of income from agriculture (specifically, over 10, 20, 30, 40, and 50 percent during their first year in the sample). While sample size and thus statistical power decline with each of these restrictions, we show that the results are remarkably stable in magnitude and statistical significance across all six specifications.

6.3 Sensitivity analysis

Next, Table A12 considers the sensitivity of our results to four separate specifications: a) omitting 2004–2008 data, b) omitting Bishkek and Osh, which contain the two largest cities, c) trimming the top 1 percent of observations of both income and our outcome variables, and d) using the level (instead of log) form of income. All of these analyses, except d), yield smaller datasets and thus less statistical power to detect effects. However, to the extent that our results hold up, they can increase our confidence in the validity of our findings. Omitting

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23 The IV is constructed using as its initial year the first year of the second half period—following the same method as our original instrument. In other words, we pretend data in the first half do not exist. Our stage two right-hand-side variable has also been predicted using the new instrument.

24 The logged values of six types of income and two types of costs are taken from the new initial year of the individual—the first year of the second period. Time-varying variables are averaged across years in the first half of observations.
early years is motivated by the fact that anthropometric data collection improved over time and exhibits measurably less variance by 2009. Dropping Bishkek and Osh is motivated in part by the fact that households in two largest cities, Bishkek and Osh city, are likely atypical compared to households more dependent on agriculture—possibly making only a few soms of income from a very small garden. Further, they may have substantially greater access to services such as healthcare, or other social safety nets, possibly blunting negative effects of downturns in income. Trimming the top 1 percent of observations allows us to assess whether findings are driven by outliers. Finally, using the level of income and of the predicted income instrument helps address potential concerns about our choice of functional form. Overall, our results are highly robust to these various alternative specifications. While point estimates change slightly and there are isolated cases of statistical significance being lost or gained, we generally find that all of our main conclusions are intact.

7 Conclusion

This study provides causal evidence from agriculture-dependent households in Kyrgyzstan that fluctuations in household income can have modest but statistically significant effects on children’s long-term health and nutrition status and the BMIs and incidence of overweight in adults. It also provides evidence of several channels possibly explaining these impacts. Our evidence comes from a study of agriculture-dependent households in a nationally representative, 13 year rolling panel dataset spanning 2004–2016. We address the endogeneity of income to child health, consumption, and other decisions using an instrumental variables approach; specifically, we instrument for household income with predicted income, obtained using the household’s initial period share of income from different sources and aggregate growth rates over time in each source. We find that young children (age 0–5) exposed to negative income shocks experienced reductions in height and height-for-age Z-scores that were largest for girls and children under age two. These groups additionally experienced
increases in stunting. Reduced consumption of healthy foods, reduced dietary diversity, and less expenditure on health may help explain the results. A channel possibly offsetting negative impacts is a decrease in fertility. At the same time, older children and adults saw decreases in BMI and—for adults—decreases in the incidence of overweight.

Our consumption data were household-level and thus mask important intra-household decision-making regarding how to respond to reductions in household income. More analysis is needed that uses better quality health and nutrition data, such as that captured by 24 hour food diaries, to understand changes in consumption patterns within the home following reductions in income. While our analysis of sex- and age-disaggregated data on anthropometric outcomes and subjective health reports are helpful in assessing the impacts of this process of intra-household decision-making on different members, such data would be helpful to better understand the precise changes in consumption taking place within the household. Another channel worth further exploring is how these fluctuations in income influence migration patterns for women and men, as well as the household structure itself. Departure of some members and shifts in the time and labor burdens of other members may themselves have profound impacts on child health, and may also be spurred by income fluctuations.

Our findings provide both good news and bad news for the double burden of malnutrition. While reductions in income, which are ubiquitous in developing country settings and against which households generally under-insure, contribute to under-nutrition in young children, they also reduced over-nutrition in older children and adults. They do so both by decreasing the diversity of diets, leading households to consume less of healthy foods, and reducing overall food consumption. While overall reductions in consumption may be helpful for the problem of over-nutrition in older children and adults, poorer-quality diets combined with lower consumption appear to be contributing to under-nutrition in young children. This suggests the need for public health officials and practitioners in development to respond to fluctuations in household income with tailored solutions that can reduce under-nutrition without simultaneously increasing over-nutrition.
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Figure 1: Distribution of year of household entry

Source: Authors’ calculations based on KIHS 2004–2016.
Source: Authors’ calculations based on KIHS 2004–2016.
Notes: In the final sample for analysis, the maximum year-to-year percentage change is 3267 percent. For easier visualization, we exclude 165 household-year observations (0.55 percent of the full sample) that experienced an income fluctuation of over 300 percent. These large values, however, are retained in the empirical analysis.
Figure 3: Timing of the measurement of health outcomes

\[ \ln(\text{Income}, t - 2) \]
\[ \ln(\text{Income}, t - 1) \]

Q1 Health Measurement
Figure 4: Trends of top three income/cost sources

Source: Authors’ calculations based on KIHS 2004–2016.
Notes: The graph shows the trends in average level of incomes from non-farm sources, from crop production, and from meat production.
Figure 5: Trends of important health outcomes

Source: Authors’ calculations based on KIHS 2004–2016.
Trends of important health outcomes (con’t)

Source: Authors’ calculations based on KIHS 2004–2016.
### Table 1: Summary statistics for household-level variables

| Panel A: Household characteristics | Mean       | SD         | N  |
|-----------------------------------|------------|------------|----|
| Total household income (2010 Som) | 131,839.509 | 101,827.955 | 8,845 |
| Non-agricultural income           | 78,508.603  | 56,164.902  | 8,845 |
| Income from harvested crops       | 39,041.827  | 79,904.717  | 8,845 |
| Income from livestock             | 6,856.478   | 18,383.974  | 8,845 |
| Income from meat production       | 9,420.792   | 16,724.383  | 8,845 |
| Income from food processing       | 2,780.182   | 5,851.877   | 8,845 |
| Income from gathering             | 73.200      | 1,048.245   | 8,845 |
| Cost from crop production         | 2,323.155   | 4,422.305   | 8,845 |
| Cost from livestock production    | 2,518.418   | 5,144.108   | 8,845 |
| Household size                    | 4.337       | 1.924       | 8,845 |
| Land size (m²)                    | 8.203       | 12.784      | 8,845 |
| Qty of unique ag goods household  | 8.169       | 6.347       | 8,845 |
| Age of household head             | 51.696      | 14.000      | 8,845 |
| Dummy – household head is male    | 0.719       | 0.449       | 8,845 |
| Dummy – household head is married | 0.724       | 0.447       | 8,845 |
| Dummy – household head completed general secondary education | 0.857 | 0.350 | 8,845 |
| Dummy – rural                     | 0.575       | 0.494       | 8,845 |

| Panel B: Dietary diversity and health expenditure |
|---------------------------------------------------|
| HDDS                                              | 8.693      | 1.255      | 33,901 |
| Healthy HDDS                                      | 1.925      | 0.616      | 33,901 |
| Out-patient Health expenditure per capita         | 296.030    | 642.141    | 36,849 |
| In-patient Health expenditure per capita          | 133.331    | 569.927    | 36,849 |

| Panel C: Dummy for consumption of food categories |
|---------------------------------------------------|
| Cereals                                           | 0.998      | 0.050      | 33,901 |
| Eggs                                              | 0.265      | 0.441      | 33,901 |
| Fruits                                            | 0.224      | 0.417      | 33,901 |
| Meat & poultry                                    | 0.277      | 0.448      | 33,901 |
| Pulses/legumes/nuts                               | 0.057      | 0.232      | 33,901 |
| Roots & tubers                                    | 0.813      | 0.390      | 33,901 |
| Fresh vegetables                                  | 0.946      | 0.226      | 33,901 |
| Fish & seafood                                    | 0.017      | 0.131      | 33,901 |
| Oils                                              | 0.946      | 0.227      | 33,901 |
| Sugars                                            | 0.945      | 0.228      | 33,901 |
| Dairy products                                    | 0.608      | 0.488      | 33,901 |
| Cheese products                                   | 0.239      | 0.427      | 33,901 |
| Milk products                                     | 0.431      | 0.495      | 33,901 |

| Panel D: Average consumption per adult equivalent per day of food categories |
|--------------------------------------------------------------------------------|
| Cereals                                                   | 1,938.703 | 779.975    | 36,908 |
| Eggs                                                      | 0.920     | 0.940      | 36,828 |
| Fruits                                                    | 495.733   | 407.016    | 36,933 |
| Meat & poultry                                            | 125.415   | 161.373    | 36,920 |
| Pulses/legumes/nuts                                       | 22.960    | 38.098     | 36,795 |
| Roots & tubers                                            | 642.268   | 466.123    | 36,924 |
| Fresh vegetables                                          | 516.268   | 300.405    | 36,935 |
| Fish & seafood                                            | 16.962    | 38.236     | 36,747 |
| Oils                                                      | 201.138   | 80.089     | 36,894 |
| Sugars                                                    | 537.803   | 478.349    | 36,897 |
| Dairy products                                            | 694.223   | 659.457    | 36,790 |
| Cheese products                                           | 47.743    | 63.615     | 36,833 |
| Milk products                                             | 638.978   | 628.419    | 36,788 |

Source: Authors' calculations based on KIHS 2004–2016.
Notes: We include in our sample only those households earning at least some income from agriculture. In this table, only observations that appear in at least one regression in this paper are included (i.e. non-missing for at least one of the outcomes, endogenous income and instrumental variables, and all control variables). Household characteristics are summarized for the first (initial) year that the household is in the sample. All income and expenditure variables are measured in 2010 Som. For details of household-level outcomes and control variables, see Sub-sections 3.4 and 3.5.
Table 2: First stage results

| Universe: | (1) 1-5 years | (2) 5-18 years | (3) 18-35 years | (4) Over 35 years | Individuals | (5) Reduced control set: | (6) Full control set: | (7) Predicted total income, $t−1$ (logged) | (8) $R^2$ | (9) First stage F-stat | (10) N |
|-----------|---------------|---------------|----------------|------------------|-------------|------------------------|-----------------|-----------------------------------------------|---------|----------------------|-------|
|           |               |               |                |                  | (5)         | (6)                    | (7)             | (8)                                           | (9)     | (10)                 | (11)  |
| Control set |               |               |                |                  |             |                        |                 |                                               |         |                      |       |
| Reduced control set: | X             | X             | X              | X                | X           | X                      | X               | 0.733*** (0.036)                               | 0.634   | 408.5                | 10,041|
| Full control set: |               |               |                |                  |             |                        |                 | 0.678*** (0.036)                               | 0.651   | 363.8                | 10,041|
| Predicted total income, $t−1$ (logged) | 0.670*** (0.029) | 0.628*** (0.029) | 0.701*** (0.027) | 0.648*** (0.027) | 0.682*** (0.022) | 0.619*** (0.022) | 0.711*** (0.022) | 0.648*** (0.021) | 0.630 | 520.5                | 38,008|
| $R^2$ | 0.634 | 0.651 | 0.619 | 0.630 | 0.630 | 0.643 | 0.643 | 0.657 | 0.653 | 0.666 |
| First stage F-stat | 408.5 | 363.8 | 520.5 | 477.2 | 651.9 | 569.3 | 942.7 | 809.9 | 1069 | 920.3 |
| N | 10,041 | 10,041 | 38,008 | 38,008 | 25,414 | 25,414 | 49,820 | 49,820 | 27,687 | 27,687 |

*Source:* Authors’ calculations based on KIHS 2004–2016.

*Notes:* We include in our sample only those households earning at least some income from agriculture. For individuals, we show the first stage for the height outcome. For households, we show the first stage for the household dietary diversity score outcome. The dependent variable is logged total income. Income is measured in 2010 Som. Our instrumental variable is logged predicted total income. Predicted total income is constructed from eight sources of income and cost by multiplying the household’s initial period level with the growth rate of the average level in an oblast-rural/urban combo for each income/cost component, excluding one’s own household. The basic control set includes year, oblast, and urban fixed effects, initial period level of income or cost (logged), the initial period value of household income (logged), and interactions of each of the latter two with a linear time trend. They also include several very basic individual-level controls (present in all regression specifications that include individual-level outcomes): a quadratic in age and a dummy for being male. Our full control set additionally includes several individual level controls: dummies for relationship with the household head, being married, and having a general secondary degree or higher (these latter two controls are omitted when we consider children age 1 to 5). It also includes several household-level controls: the number of unique agricultural goods produced, logged land farmed (with zero land imputed to 0.1 square meters of land), dummies for household size, a quadratic in age for the household head, and dummies for whether the head has a general secondary degree or higher, is married, and is male. All household-level controls are taken from the year in which the household enters the sample. Standard errors are in parentheses and clustered at the household level. *** indicates $p<0.01$; ** indicates $p<0.05$; and * indicates $p<0.10$. 
Table 3: Effects of income fluctuations on height, height-for-age Z-score (HAZ), and dummy for stunting of children age 1-5

| Control set  | (1)        | (2)        | (3)        | (4)        | (5)        | (6)        |
|--------------|------------|------------|------------|------------|------------|------------|
|              | Height (cm) | HAZ        | Dummy – stunting |
| Basic control set: | X         | X         | X          | X          | X          | X          |
| Full control set: | X         | X         | X          | X          | X          | X          |

Panel A: OLS, using income of the calendar year preceding Q1 measurement of the outcome

| Income, $t - 1$ (logged) | 0.514*** | 0.587*** | 0.149*** | 0.168*** | -0.066*** | -0.070*** |
|--------------------------|----------|----------|----------|----------|------------|------------|
| $R^2$                    | 0.820    | 0.821    | 0.029    | 0.036    | 0.028      | 0.032      |
| N                        | 10,041   | 10,041   | 10,041   | 10,041   | 10,041     | 10,041     |

Panel B: OLS, using income two calendar years prior to Q1 measurement of the outcome

| Income, $t - 2$ (logged) | 0.541*** | 0.628*** | 0.145*** | 0.167*** | -0.061*** | -0.062*** |
|--------------------------|----------|----------|----------|----------|------------|------------|
| $R^2$                    | 0.826    | 0.827    | 0.033    | 0.040    | 0.031      | 0.035      |
| N                        | 7,191    | 7,191    | 7,191    | 7,191    | 7,191      | 7,191      |

Panel C: IV, using income of the calendar year preceding Q1 measurement of the outcome

| Income, $t - 1$ (logged) | 0.515 | 0.650*  | 0.151 | 0.187*  | -0.032 | -0.030  |
|--------------------------|-------|---------|-------|---------|--------|---------|
| $R^2$                    | 0.820 | 0.821   | 0.029 | 0.036   | 0.027  | 0.031   |
| First stage F-stat        | 408.5 | 363.8   | 408.5 | 363.8   | 408.5  | 363.8   |
| N                        | 10,041| 10,041  | 10,041| 10,041  | 10,041 | 10,041  |

Panel D: IV, using income two calendar years prior to Q1 measurement of the outcome

| Income, $t - 2$ (logged) | 0.600 | 0.819** | 0.191* | 0.252** | -0.056 | -0.061 |
|--------------------------|-------|---------|--------|---------|--------|---------|
| $R^2$                    | 0.826 | 0.827   | 0.033  | 0.039   | 0.031  | 0.035  |
| First stage F-stat        | 321   | 277.7   | 321    | 277.7   | 321    | 277.7  |
| N                        | 7,191 | 7,191   | 7,191  | 7,191   | 7,191  | 7,191  |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. HAZ is the child’s height-for-age Z-score computed using WHO 2006 standards (World Health Organization, 2006). The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table 4: Effects of income fluctuations on weight, weight-for-age Z-score (WAZ), and weight-for-height Z-score (WHZ) of children age 1-5

| Control set                  | (1)     | (2)     | (3)     | (4)     | (5)     | (6)     |
|-----------------------------|---------|---------|---------|---------|---------|---------|
| Weight (kg)                 |         |         |         |         |         |         |
| Basic control set:          | X       | X       | X       |         |         |         |
| Full control set:           | X       | X       | X       |         |         |         |

Panel A: OLS, using income of the calendar year preceding Q1 measurement of the outcome

| Income, $t - 1$ (logged)    | 0.151*** | 0.156*** | 0.094*** | 0.098*** | 0.016   | 0.006   |
|                            | (0.039)  | (0.039)  | (0.023)  | (0.022)  | (0.029) | (0.029) |
| $R^2$                      | 0.712    | 0.714    | 0.121    | 0.128    | 0.068   | 0.072   |
| N                          | 10,041   | 10,041   | 10,041   | 10,041   | 10,041  | 10,041  |

Panel B: OLS, using income two calendar years prior to Q1 measurement of the outcome

| Income, $t - 2$ (logged)    | 0.168*** | 0.168*** | 0.093*** | 0.094*** | 0.015   | -0.002  |
|                            | (0.045)  | (0.045)  | (0.026)  | (0.026)  | (0.033) | (0.033) |
| $R^2$                      | 0.720    | 0.722    | 0.126    | 0.133    | 0.067   | 0.073   |
| N                          | 7,191    | 7,191    | 7,191    | 7,191    | 7,191   | 7,191   |

Panel C: IV, using income of the calendar year preceding Q1 measurement of the outcome

| Income, $t - 1$ (logged)    | 0.362*** | 0.411*** | 0.207*** | 0.234*** | 0.174** | 0.184*  |
|                            | (0.118)  | (0.129)  | (0.067)  | (0.073)  | (0.086) | (0.095) |
| $R^2$                      | 0.710    | 0.712    | 0.118    | 0.123    | 0.064   | 0.067   |
| First stage F-stat         | 408.5    | 363.8    | 408.5    | 363.8    | 408.5   | 363.8   |
| N                          | 10,041   | 10,041   | 10,041   | 10,041   | 10,041  | 10,041  |

Panel D: IV, using income two calendar years prior to Q1 measurement of the outcome

| Income, $t - 2$ (logged)    | 0.383*** | 0.426*** | 0.219*** | 0.244*** | 0.169*  | 0.156   |
|                            | (0.133)  | (0.145)  | (0.075)  | (0.082)  | (0.101) | (0.110) |
| $R^2$                      | 0.719    | 0.721    | 0.121    | 0.127    | 0.063   | 0.069   |
| First stage F-stat         | 321      | 277.7    | 321      | 277.7    | 321     | 277.7   |
| N                          | 7,191    | 7,191    | 7,191    | 7,191    | 7,191   | 7,191   |

Source: Authors’ calculations based on KIHS 2004–2016.
Notes: We include in our sample only those households earning at least some income from agriculture. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. WAZ and WHZ are the child’s weight-for-age and weight-for-height Z-scores respectively, computed using WHO 2006 standards (World Health Organization, 2006). The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table 5: Effects of income fluctuations on anthropometric outcomes of children age 5-18

|                      | (1)     | (2)     | (3)     | (4)     | (5)     |
|----------------------|---------|---------|---------|---------|---------|
| **Panel A: OLS, using income of the calendar year preceding Q1 measurement of the outcome** |         |         |         |         |         |
| Income, $t-1$ (logged) | 0.339*** | 0.398*** | 0.110*** | 0.002** | 0.000   |
|                      | (0.100)  | (0.081)  | (0.029)  | (0.001) | (0.000) |
| $R^2$                | 0.926    | 0.897    | 0.541    | 0.012   | 0.003   |
| N                    | 38,008   | 38,008   | 38,008   | 38,008  | 38,008  |
| **Panel B: OLS, using income two calendar years prior to Q1 measurement of the outcome** |         |         |         |         |         |
| Income, $t-2$ (logged) | 0.397*** | 0.424*** | 0.111*** | 0.001   | 0.000   |
|                      | (0.109)  | (0.087)  | (0.031)  | (0.001) | (0.000) |
| $R^2$                | 0.932    | 0.902    | 0.554    | 0.011   | 0.002   |
| N                    | 28,165   | 28,165   | 28,165   | 28,165  | 28,165  |
| **Panel C: IV, using income of the calendar year preceding Q1 measurement of the outcome** |         |         |         |         |         |
| Income, $t-1$ (logged) | 0.257    | 0.330    | 0.173*   | -0.001  | -0.000  |
|                      | (0.339)  | (0.258)  | (0.094)  | (0.003) | (0.000) |
| $R^2$                | 0.926    | 0.897    | 0.541    | 0.012   | 0.003   |
| First stage F-stat   | 477.2    | 477.2    | 477.2    | 477.2   | 477.2   |
| N                    | 38,008   | 38,008   | 38,008   | 38,008  | 38,008  |
| **Panel D: IV, using income two calendar years prior to Q1 measurement of the outcome** |         |         |         |         |         |
| Income, $t-2$ (logged) | 0.418    | 0.429    | 0.190*   | -0.002  | -0.000  |
|                      | (0.382)  | (0.283)  | (0.107)  | (0.003) | (0.000) |
| $R^2$                | 0.932    | 0.902    | 0.554    | 0.011   | 0.002   |
| First stage F-stat   | 369.5    | 369.5    | 369.5    | 369.5   | 369.5   |
| N                    | 28,165   | 28,165   | 28,165   | 28,165  | 28,165  |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. Overweight is defined as having a BMI of at least 25. Obesity is defined as having a BMI of at least 30. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table 6: Effects of income fluctuations on anthropometric outcomes of youths age 18-35

|                      | (1)        | (2)        | (3)        | (4)        | (5)        |
|----------------------|------------|------------|------------|------------|------------|
|                      | Height     | Weight     | BMI        | Dummy –   | Dummy –   |
|                      |            |            |            | overweight| obese      |
| Panel A: OLS, using income of the calendar year preceding Q1 measurement of the outcome |            |            |            |            |            |
| Income, \(t - 1\) (logged) | 0.243*     | 0.500***   | 0.116**    | 0.011      | 0.001      |
|                       | (0.148)    | (0.180)    | (0.058)    | (0.008)    | (0.003)    |
| \(R^2\)              | 0.423      | 0.314      | 0.155      | 0.099      | 0.025      |
| N                    | 25,414     | 25,414     | 25,414     | 25,414     | 25,414     |
| Panel B: OLS, using income two calendar years prior to Q1 measurement of the outcome |            |            |            |            |            |
| Income, \(t - 2\) (logged) | 0.158      | 0.501**    | 0.137**    | 0.017**    | 0.003      |
|                       | (0.168)    | (0.206)    | (0.066)    | (0.009)    | (0.003)    |
| \(R^2\)              | 0.427      | 0.318      | 0.163      | 0.107      | 0.028      |
| N                    | 18,612     | 18,612     | 18,612     | 18,612     | 18,612     |
| Panel C: IV, using income of the calendar year preceding Q1 measurement of the outcome |            |            |            |            |            |
| Income, \(t - 1\) (logged) | -0.696     | 0.603      | 0.429**    | 0.067***   | -0.004     |
|                       | (0.482)    | (0.558)    | (0.190)    | (0.025)    | (0.009)    |
| \(R^2\)              | 0.421      | 0.314      | 0.153      | 0.096      | 0.025      |
| First stage F-stat    | 569.3      | 569.3      | 569.3      | 569.3      | 569.3      |
| N                    | 25,414     | 25,414     | 25,414     | 25,414     | 25,414     |
| Panel D: IV, using income two calendar years prior to Q1 measurement of the outcome |            |            |            |            |            |
| Income, \(t - 2\) (logged) | -0.810     | 0.226      | 0.317      | 0.049*     | -0.005     |
|                       | (0.535)    | (0.620)    | (0.212)    | (0.028)    | (0.010)    |
| \(R^2\)              | 0.424      | 0.318      | 0.162      | 0.106      | 0.028      |
| First stage F-stat    | 497.7      | 497.7      | 497.7      | 497.7      | 497.7      |
| N                    | 18,612     | 18,612     | 18,612     | 18,612     | 18,612     |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. Overweight is defined as having a BMI of at least 25. Obesity is defined as having a BMI of at least 30. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table 7: Effects of income fluctuations on anthropometric outcomes of adults age over 35

| Panel A: OLS, using income of the calendar year preceding Q1 measurement of the outcome | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Income, \( t-1 \) (logged) | 0.523*** | 1.587*** | 0.420*** | 0.050*** | 0.015*** |
| | (0.120) | (0.201) | (0.069) | (0.009) | (0.006) |
| \( R^2 \) | 0.403 | 0.145 | 0.071 | 0.050 | 0.041 |
| N | 49,820 | 49,820 | 49,820 | 49,820 | 49,820 |

| Panel B: OLS, using income two calendar years prior to Q1 measurement of the outcome | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Income, \( t-2 \) (logged) | 0.517*** | 1.621*** | 0.432*** | 0.051*** | 0.015** |
| | (0.133) | (0.222) | (0.076) | (0.009) | (0.006) |
| \( R^2 \) | 0.404 | 0.148 | 0.073 | 0.051 | 0.043 |
| N | 37,252 | 37,252 | 37,252 | 37,252 | 37,252 |

| Panel C: IV, using income of the calendar year preceding Q1 measurement of the outcome | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Income, \( t-1 \) (logged) | 0.528 | 2.845*** | 0.911*** | 0.141*** | 0.024 |
| | (0.453) | (0.703) | (0.248) | (0.031) | (0.021) |
| \( R^2 \) | 0.403 | 0.143 | 0.068 | 0.044 | 0.041 |
| First stage F-stat | 809.9 | 809.9 | 809.9 | 809.9 | 809.9 |
| N | 49,820 | 49,820 | 49,820 | 49,820 | 49,820 |

| Panel D: IV, using income two calendar years prior to Q1 measurement of the outcome | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Income, \( t-2 \) (logged) | 0.600 | 2.778*** | 0.872*** | 0.132*** | 0.020 |
| | (0.498) | (0.750) | (0.268) | (0.033) | (0.023) |
| \( R^2 \) | 0.403 | 0.146 | 0.071 | 0.046 | 0.043 |
| First stage F-stat | 677.6 | 677.6 | 677.6 | 677.6 | 677.6 |
| N | 37,252 | 37,252 | 37,252 | 37,252 | 37,252 |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. Overweight is defined as having a BMI of at least 25. Obesity is defined as having a BMI of at least 30. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table 8: Effects of income fluctuations on subjective well-being

| Age   | 1–5  | 5–18 | 18–35 | 35+  |
|-------|------|------|-------|------|
| Dummy – good health | (1) | (2) | (3) | (4) |

Panel A: OLS, using income of the calendar year preceding Q1 measurement

| Income, $t - 1$ (logged) | 0.010** | 0.014*** | 0.017*** | 0.022*** |
|--------------------------|---------|----------|----------|----------|
|                          | (0.005) | (0.003)  | (0.006)  | (0.007) |
| $R^2$                    | 0.033   | 0.037    | 0.101    | 0.265    |
| N                        | 10,041  | 38,008   | 25,414   | 49,820   |

Panel B: OLS, using income two calendar years prior to Q1 measurement

| Income, $t - 2$ (logged) | 0.006   | 0.010*** | 0.016**  | 0.022*** |
|--------------------------|---------|----------|----------|----------|
|                          | (0.005) | (0.004)  | (0.007)  | (0.008) |
| $R^2$                    | 0.031   | 0.037    | 0.099    | 0.268    |
| N                        | 7,191   | 28,165   | 18,612   | 37,252   |

Panel C: IV, using income of the calendar year preceding Q1 measurement

| Income, $t - 1$ (logged) | 0.012   | 0.020*   | 0.008    | 0.010    |
|--------------------------|---------|----------|----------|----------|
|                          | (0.015) | (0.010)  | (0.019)  | (0.025)  |
| $R^2$                    | 0.033   | 0.037    | 0.101    | 0.265    |
| First stage F-stat        | 363.8   | 477.2    | 569.3    | 809.9    |
| N                        | 10,041  | 38,008   | 25,414   | 49,820   |

Panel D: IV, using income two calendar years prior to Q1 measurement

| Income, $t - 2$ (logged) | 0.020   | 0.036*** | 0.009    | 0.016    |
|--------------------------|---------|----------|----------|----------|
|                          | (0.015) | (0.013)  | (0.021)  | (0.027)  |
| $R^2$                    | 0.029   | 0.033    | 0.099    | 0.268    |
| First stage F-stat        | 277.7   | 369.5    | 497.7    | 677.6    |
| N                        | 7,191   | 28,165   | 18,612   | 37,252   |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. Measures are self-reported subjective well-being. The respondent was given 5 choices to evaluate the “state of his/her health”: very poor, poor, satisfactory, good, and very good. Income (annual) is measured in 2010 Som. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table 9: Effects of income fluctuations on dietary diversity

| Outcome | Lag | ln(Income) | S.E. | R^2 | F-statistic | N  | Outcome | Lag | ln(Income) | S.E. | R^2 | F-statistic | N  |
|---------|-----|------------|------|-----|-------------|----|----------|-----|------------|------|-----|-------------|----|
| HDDS    | 0   | 0.316***   | (0.058) | 0.424 | 986.5 | 33,901 | Panel A: Household dietary diversity score |
|         | 1   | 0.279***   | (0.061) | 0.426 | 920.3 | 27,687 |
| Healthy HDDS | 0 | 0.138*** | (0.029) | 0.356 | 986.5 | 33,901 |
|         | 1   | 0.131***   | (0.031) | 0.356 | 920.3 | 27,687 |
| HDDS    | 0   | 0.067***   | (0.019) | 0.265 | 971.4 | 36,908 | Panel C: Log amount consumed (intensive margin) |
|         | 1   | 0.063      | (0.020) | 0.258 | 875.6 | 30,107 |
| Healthy HDDS | 0 | 0.072      | (0.047) | 0.289 | 784.8 | 30,126 |
|         | 1   | 0.033      | (0.050) | 0.272 | 711.9 | 24,519 |
| HDDS    | 0   | 0.138***   | (0.021) | 0.154 | 986.5 | 33,901 |
|         | 1   | 0.131***   | (0.022) | 0.146 | 920.3 | 27,687 |
| Healthy HDDS | 0 | 0.128*** | (0.019) | 0.150 | 986.5 | 33,901 |
|         | 1   | 0.126***   | (0.021) | 0.158 | 920.3 | 27,687 |
| HDDS    | 0   | 0.001      | (0.002) | 0.006 | 986.5 | 33,901 |
|         | 1   | -0.002     | (0.002) | 0.006 | 920.3 | 27,687 |
| Healthy HDDS | 0 | 0.013      | (0.021) | 0.154 | 986.5 | 33,901 |
|         | 1   | -0.009     | (0.022) | 0.146 | 920.3 | 27,687 |
| HDDS    | 0   | 0.128***   | (0.019) | 0.150 | 986.5 | 33,901 |
|         | 1   | 0.126***   | (0.021) | 0.158 | 920.3 | 27,687 |
| Healthy HDDS | 0 | 0.001      | (0.002) | 0.006 | 986.5 | 33,901 |
|         | 1   | -0.002     | (0.002) | 0.006 | 920.3 | 27,687 |
| HDDS    | 0   | 0.001      | (0.002) | 0.006 | 986.5 | 33,901 |
|         | 1   | -0.002     | (0.002) | 0.006 | 920.3 | 27,687 |
| Healthy HDDS | 0 | 0.013      | (0.021) | 0.154 | 986.5 | 33,901 |
|         | 1   | -0.009     | (0.022) | 0.146 | 920.3 | 27,687 |
| Cereals | 0   | 0.067***   | (0.019) | 0.265 | 971.4 | 36,908 |
|         | 1   | 0.063      | (0.020) | 0.258 | 875.6 | 30,107 |
| Eggs    | 0   | 0.072      | (0.047) | 0.289 | 784.8 | 30,126 |
|         | 1   | 0.033      | (0.050) | 0.272 | 711.9 | 24,519 |
| Fruits  | 0   | 0.041      | (0.015) | 0.158 | 986.5 | 33,901 |
|         | 1   | -0.009     | (0.022) | 0.146 | 920.3 | 27,687 |
| Pulses/legumes/nuts | 0 | 0.013      | (0.013) | 0.092 | 986.5 | 33,901 |
|         | 1   | 0.013      | (0.015) | 0.099 | 920.3 | 27,687 |
| Roots & tubers | 0 | 0.152***   | (0.017) | 0.279 | 986.5 | 33,901 |
|         | 1   | 0.125***   | (0.017) | 0.292 | 920.3 | 27,687 |
| Fresh vegetables | 0 | 0.058***   | (0.011) | 0.027 | 986.5 | 33,901 |
|         | 1   | 0.029***   | (0.012) | 0.033 | 920.3 | 27,687 |
| Fish & seafood | 0 | 0.013**    | (0.005) | 0.050 | 986.5 | 33,901 |
|         | 1   | 0.010**    | (0.006) | 0.052 | 920.3 | 27,687 |
| Oils    | 0   | 0.008      | (0.009) | 0.025 | 986.5 | 33,901 |
|         | 1   | -0.002     | (0.009) | 0.028 | 920.3 | 27,687 |
| Sugar   | 0   | 0.032***   | (0.009) | 0.038 | 986.5 | 33,901 |
|         | 1   | 0.024***   | (0.009) | 0.037 | 920.3 | 27,687 |
| Dairy products | 0 | 0.153***   | (0.025) | 0.100 | 986.5 | 33,901 |
|         | 1   | 0.144***   | (0.020) | 0.095 | 920.3 | 27,687 |
| Cheese products | 0 | 0.210***   | (0.022) | 0.165 | 986.5 | 33,901 |
|         | 1   | 0.209***   | (0.024) | 0.163 | 920.3 | 27,687 |
| Milk products | 0 | 0.131***   | (0.025) | 0.060 | 986.5 | 33,901 |
|         | 1   | 0.120***   | (0.027) | 0.059 | 920.3 | 27,687 |

Source: Authors’ calculations based on KIHS 2004–2016.
Notes: We include in our sample only those households earning at least some income from agriculture. Data in our regressions are annual, but based on quarterly observations. Consumption dummies (Panel B) takes on a value of 1 only if the food category is consumed in all four quarters.Logged consumption (Panel C) is averaged over the four quarters to get annual outcomes. The household dietary diversity score (HDDS) is constructed by counting the number of the 12 total food categories that have been consumed in the last 2 weeks during each of the four quarterly visits. A “healthy” HDDS is constructed similarly by counting the number of categories a household consumes from: fruits, pulses/legumes/nuts, vegetables, and fish/seafood. In Panel B, the category of dairy products is further sub-divided into milk products (such as milk, cream, or kefir, measured in liters) and cheese products (such as cheese, curds, butter, sour cream, or yogurt, measured in kg) for the purposes of understanding the dairy category better, but these two subcategories are not considered when constructing the HDDS. Panel A and B outcomes are missing in 2007 because 2007 data were annual while other years were quarterly. This does not affect the consumption level used in the panel C outcomes, but it does make it impossible to accurately compare 2007 with other years for the outcomes of panels A and B. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable is described in Table 2. We include all control variables described in Table 2 except for individual characteristics. Standard errors are in parentheses and clustered at the household level. *** indicates p < 0.01; ** indicates p < 0.05; and * indicates p < 0.10.
Table 10: Effects of income fluctuations on household health expenditure

|                      | (1)                  | (2)                  |
|----------------------|----------------------|----------------------|
|                      | outpatient cost      | inpatient cost       |
| **Panel A: IV estimates using income from this year** |                      |                      |
| Income, $t$ (logged) | 1.134***             | 0.455                |
|                      | (0.376)              | (0.283)              |
| $R^2$                | 0.139                | 0.067                |
| First stage F-stat   | 970.9                | 970.9                |
| N                    | 36,849               | 36,849               |
| **Panel B: IV estimates using income from last year** |                      |                      |
| Income, $t-1$ (logged)| 1.722***             | 0.639**              |
|                      | (0.405)              | (0.300)              |
| $R^2$                | 0.140                | 0.066                |
| First stage F-stat   | 874.3                | 874.3                |
| N                    | 30,082               | 30,082               |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates $p<0.01$; ** indicates $p<0.05$; and * indicates $p<0.10$. 
Table 11: Effects of income fluctuations on women’s health

|                      | (1)          | (2)          | (3)          |
|----------------------|--------------|--------------|--------------|
|                      | Dummy – practices contraception | Dummy – pregnant | Dummy – wants additional children |
| Income, $t - 1$ (logged) | -0.036 (0.031) | 0.023* (0.013) | 0.090*** (0.025) |
| $R^2$                | 0.151        | 0.117        | 0.483        |
| First stage F-stat   | 623.6        | 660.9        | 672.5        |
| N                    | 16,704       | 17,873       | 20,053       |

Panel A: IV, using income of the calendar year preceding Q1 measurement

Panel B: IV, using income two calendar years prior to Q1 measurement

|                      | (1)          | (2)          | (3)          |
|----------------------|--------------|--------------|--------------|
|                      | Dummy – practices contraception | Dummy – pregnant | Dummy – wants additional children |
| Income, $t - 2$ (logged) | -0.055 (0.035) | 0.040** (0.016) | 0.078*** (0.028) |
| $R^2$                | 0.162        | 0.116        | 0.493        |
| First stage F-stat   | 484.3        | 519.9        | 541.5        |
| N                    | 12,279       | 13,144       | 14,751       |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. The universe for all of these outcomes is restricted to women 15–49 who are either married or otherwise sexually active. The universe for the contraception outcome additionally excludes women who are pregnant. The instrumental variable and the full set of controls are described in Table 2. Additionally, all regressions control for the number of children a woman already had. Standard errors are in parentheses and clustered at the household level. *** indicates $p<0.01$; ** indicates $p<0.05$; and * indicates $p<0.10$. 
Table 12: Within sample check for pre-trends, examining if average income in the latter half of the sample predicts average levels of key outcomes in the first half of the sample

| Outcome | Mean of income | Mean of outcome | Coef. | Std. Err. | N |
|---------|----------------|----------------|-------|-----------|---|
| Panel A: Using logged predicted income (instrumental variable) | | | | | |
| Children age 1-5: height | 11.971 | 88.242 | -1.060 | (1.079) | 2,533 |
| Children age 1-5: HAZ | 11.971 | -1.441 | -0.303 | (0.294) | 2,533 |
| Children age 1-5: weight | 11.971 | 13.306 | -0.062 | (0.321) | 2,533 |
| Children age 1-5: WAZ | 11.971 | -0.215 | 0.039 | (0.186) | 2,533 |
| Children age 1-5: WHZ | 11.971 | 0.803 | 0.247 | (0.250) | 2,533 |
| Children age 5-18: dummy – good health | 11.909 | 0.965 | 0.011 | (0.024) | 7,739 |
| Children age 5-18: BMI | 11.909 | 17.377 | 0.230 | (0.238) | 7,739 |
| Individuals age 18-35: BMI | 11.958 | 22.854 | -0.275 | (0.629) | 4,863 |
| Individuals age 18-35: dummy – overweight | 11.958 | 0.192 | -0.147* | (0.089) | 4,863 |
| Individuals age 35+: weight | 11.903 | 70.137 | 1.203 | (1.908) | 10,166 |
| Individuals age 35+: BMI | 11.903 | 25.719 | -0.616 | (0.623) | 10,166 |
| Individuals age 35+: dummy – overweight | 11.903 | 0.518 | -0.019 | (0.083) | 10,166 |
| Panel B: Using fitted values of logged predicted total income (stage 2 right-hand-side income variable) | | | | | |
| Children age 1-5: height | 11.973 | 88.242 | -1.439 | (0.993) | 2,533 |
| Children age 1-5: HAZ | 11.973 | -1.441 | -0.416 | (0.283) | 2,533 |
| Children age 1-5: weight | 11.973 | 13.306 | -0.049 | (0.327) | 2,533 |
| Children age 1-5: WAZ | 11.973 | -0.215 | 0.021 | (0.193) | 2,533 |
| Children age 1-5: WHZ | 11.973 | 0.803 | 0.335 | (0.234) | 2,533 |
| Children age 5-18: dummy – good health | 11.915 | 0.965 | 0.016 | (0.030) | 7,739 |
| Children age 5-18: BMI | 11.915 | 17.377 | 0.208 | (0.250) | 7,739 |
| Individuals age 18-35: BMI | 11.960 | 22.854 | 0.124 | (0.617) | 4,863 |
| Individuals age 18-35: dummy – overweight | 11.960 | 0.192 | -0.117 | (0.085) | 4,863 |
| Individuals age 35+: weight | 11.898 | 70.137 | 0.233 | (1.829) | 10,166 |
| Individuals age 35+: BMI | 11.898 | 25.719 | -0.661 | (0.608) | 10,166 |
| Individuals age 35+: dummy – overweight | 11.898 | 0.518 | -0.017 | (0.078) | 10,166 |
| Panel C: Using logged actual total income (endogenous variable used in OLS regressions) | | | | | |
| Children age 1-5: height | 11.973 | 88.242 | 0.254 | (0.390) | 2,533 |
| Children age 1-5: HAZ | 11.973 | -1.441 | 0.054 | (0.108) | 2,533 |
| Children age 1-5: weight | 11.973 | 13.306 | 0.024 | (0.135) | 2,533 |
| Children age 1-5: WAZ | 11.973 | -0.215 | 0.013 | (0.076) | 2,533 |
| Children age 1-5: WHZ | 11.973 | 0.803 | -0.038 | (0.093) | 2,533 |
| Children age 5-18: BMI | 11.913 | 17.377 | 0.047 | (0.106) | 7,739 |
| Children age 5-18: dummy – good health | 11.913 | 0.965 | -0.017* | (0.010) | 7,739 |
| Individuals age 18-35: BMI | 11.959 | 22.854 | -0.176 | (0.217) | 4,863 |
| Individuals age 18-35: dummy – overweight | 11.959 | 0.192 | -0.027 | (0.031) | 4,863 |
| Individuals age 35+: weight | 11.897 | 70.137 | 1.175* | (0.625) | 10,166 |
| Individuals age 35+: BMI | 11.897 | 25.719 | 0.385* | (0.208) | 10,166 |
| Individuals age 35+: dummy – overweight | 11.897 | 0.518 | 0.021 | (0.026) | 10,166 |

Source: Authors’ calculations based on KIHS 2004-2016.
Notes: We divide all years an individual/a household in our sample into two halves of roughly equal length. We calculate average level of health-related variables in the first period. We take the first year of the second half as the initial year and re-construct the instrumental variable and predict the income used as the second stage right-hand-side income variable. We compute the average income using three variants of income measures, income instrument, predicted income (second stage right-hand-side variable), and the endogenous income in Panels A, B, and C. All regressions in pre-trends analysis include the full set of controls in individual-level regressions in Tables 2 except for interactions with time trends. Time variant individual controls are averaged across all years in first period. In addition, we include dummies for “base” and “end” year of the first period for each individual. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Appendix Tables
Table A1: Summary statistics for children 1-5 years old

| Panel A: Health outcomes for children 1-5 years | Mean | SD  | N   |
|-----------------------------------------------|------|-----|-----|
| Height (cm)                                   | 89.523 | 9.792 | 10,041 |
| Height-for-age Z-score                        | -1.452 | 1.201 | 10,041 |
| Dummy – stunting (HAZ ≤ -2)                   | 0.310  | 0.462 | 10,041 |
| Dummy – good or very good health              | 0.976  | 0.154 | 10,041 |
| Weight (kg)                                   | 13.664 | 2.505 | 10,041 |
| Weight-for-age Z-score                        | -0.227 | 0.830 | 10,041 |
| Weight-for-height Z-score                     | 0.812  | 1.073 | 10,041 |

| Panel B: Health outcomes for girls 1-5 years  | Mean    | SD    | N   |
|-----------------------------------------------|---------|-------|-----|
| Height (cm)                                   | 89.138  | 9.752 | 4,857 |
| Height-for-age Z-score                        | -1.371  | 1.169 | 4,857 |
| Dummy – stunting (HAZ ≤ -2)                   | 0.285   | 0.452 | 4,857 |
| Dummy – good or very good health              | 0.977   | 0.150 | 4,857 |
| Weight (kg)                                   | 13.434  | 2.444 | 4,857 |
| Weight-for-age Z-score                        | -0.200  | 0.827 | 4,857 |
| Weight-for-height Z-score                     | 0.782   | 1.065 | 4,857 |

| Panel C: Health outcomes for boys 1-5 years   | Mean    | SD    | N   |
|-----------------------------------------------|---------|-------|-----|
| Height (cm)                                   | 89.883  | 9.817 | 5,184 |
| Height-for-age Z-score                        | -1.528  | 1.226 | 5,184 |
| Dummy – stunting (HAZ ≤ -2)                   | 0.333   | 0.471 | 5,184 |
| Dummy – good or very good health              | 0.974   | 0.158 | 5,184 |
| Weight (kg)                                   | 13.879  | 2.543 | 5,184 |
| Weight-for-age Z-score                        | -0.251  | 0.832 | 5,184 |
| Weight-for-height Z-score                     | 0.840   | 1.079 | 5,184 |

| Panel D: Individual characteristics for children 1-5 years | Mean | SD    | N   |
|-----------------------------------------------------------|------|-------|-----|
| Age                                                       | 3.033 | 1.149 | 10,041 |
| Dummy – male                                              | 0.516 | 0.500 | 10,041 |
| Dummy – child of the head                                  | 0.486 | 0.500 | 10,041 |
| Dummy – grand child of the head                            | 0.492 | 0.500 | 10,041 |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. In this table, only observations that appear in at least one regression in this paper are included (i.e. non-missing for at least one of the outcomes, endogenous income and instrumental variables, and all control variables). We use exact age data (i.e. age in days divided by 365). Age 1–5 includes children age 1.0 to 5.0.
| Panel A: Health outcomes for children 5-18 years                      | Mean   | SD    | N     |
|---------------------------------------------------------------------|--------|-------|-------|
| Height (cm)                                                         | 140.61 | 18.75 | 38,008|
| Weight (kg)                                                         | 36.45  | 12.95 | 38,008|
| Body mass index (kg/m²)                                             | 17.73  | 2.30  | 38,008|
| Dummy – overweight (BMI≥25)                                         | 0.005  | 0.07  | 38,008|
| Dummy – obese (BMI≥30)                                              | 0.000  | 0.02  | 38,008|
| Dummy – good or very good health                                    | 0.97   | 0.18  | 38,008|

| Panel B: Health outcomes for youths 18-35 years                    | Mean   | SD    | N     |
|---------------------------------------------------------------------|--------|-------|-------|
| Height (cm)                                                         | 166.39 | 7.84  | 25,414|
| Weight (kg)                                                         | 63.28  | 9.28  | 25,414|
| Body mass index (kg/m²)                                             | 22.83  | 2.79  | 25,414|
| Dummy – overweight (BMI≥25)                                         | 0.18   | 0.39  | 25,414|
| Dummy – obese (BMI≥30)                                              | 0.02   | 0.14  | 25,414|
| Dummy – good or very good health                                    | 0.91   | 0.28  | 25,414|

| Panel C: Health outcomes for individuals over 35 years             | Mean   | SD    | N     |
|---------------------------------------------------------------------|--------|-------|-------|
| Height (cm)                                                         | 164.98 | 7.88  | 49,820|
| Weight (kg)                                                         | 70.04  | 11.71 | 49,820|
| Body mass index (kg/m²)                                             | 25.72  | 3.89  | 49,820|
| Dummy – overweight (BMI≥25)                                         | 0.52   | 0.50  | 49,820|
| Dummy – obese (BMI≥30)                                              | 0.13   | 0.34  | 49,820|
| Dummy – good or very good health                                    | 0.67   | 0.47  | 49,820|

| Panel D: Women’s health (age 15–49)                                | Mean   | SD    | N     |
|---------------------------------------------------------------------|--------|-------|-------|
| Dummy – practices contraception                                     | 0.71   | 0.45  | 16,704|
| Dummy – pregnant                                                    | 0.06   | 0.24  | 17,873|
| Dummy – wants additional children                                   | 0.43   | 0.49  | 20,053|
| Number of children a woman has                                     | 2.81   | 1.58  | 20,054|

| Panel E: Individual characteristics for individuals over 5 years    | Mean   | SD    | N     |
|---------------------------------------------------------------------|--------|-------|-------|
| Age                                                                 | 32.99  | 20.30 | 113,242|
| Dummy – male                                                        | 0.48   | 0.50  | 113,242|
| Dummy – head                                                        | 0.26   | 0.44  | 113,242|
| Dummy – spouse of the head                                          | 0.18   | 0.38  | 113,242|
| Dummy – married                                                     | 0.47   | 0.49  | 113,242|
| Dummy – completed general secondary education                        | 0.59   | 0.49  | 113,242|

Source: Authors' calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. In this table, only observations that appear in at least one regression in this paper are included (i.e. non-missing for at least one of the outcomes, endogenous income and instrumental variables, and all control variables). We use exact age data (i.e. age in days divided by 365). For example, age 5–18 includes children age 5.0 to 18.0 (but not those past their 18th birthday). Women’s health outcomes are restricted to women 15–49 who are either married or otherwise sexually active.
Table A3: Effects of income fluctuations on attrition

| Control set | (1)   | (2)   | (3)   | (4)   | (5)   | (6)   |
|-------------|-------|-------|-------|-------|-------|-------|
| Basic control set: | X | X | X | | | |
| Full control set: | | X | X | X | | |
| Dummy – leaving the sample in the next year | | | | | | |
| income, $t$ (logged) | -0.024*** | -0.010 | (0.008) | (0.009) | | |
| income, $t-1$ (logged) | | -0.012 | 0.001 | (0.009) | (0.010) | |
| income, $t-2$ (logged) | | | | -0.015 | -0.003 | (0.010) | (0.011) |
| $R^2$ | 0.599 | 0.603 | 0.676 | 0.678 | 0.727 | 0.730 |
| First stage F-stat | 1213 | 1041 | 1014 | 877.8 | 838.6 | 727.9 |
| N | 40,546 | 39,850 | 30,763 | 30,257 | 22,777 | 22,378 |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. Dummy – leaving the sample in the next year is a household-level variable coded 1 in the last year that the household stayed in the sample for analysis. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table A4: Exposure to lags of household income according to child age at time of interview

| (1) Age (months) at time of health measurements (Q1) | (2) Age at start of year \( t - 2 \) (and start of year \( t - 1 \)) | (3) Age at end of year \( t - 2 \) | (4) Age at end of year \( t - 1 \) |
|---------------------------------------------------|------------------------------------------------------|-----------------|-----------------|
| 0.001                                             | 16.5 months pre-pregnancy                            | 4.5 months pre-pregnancy | 7.5 months in utero |
| 1                                                 | 15.5 months pre-pregnancy                           | 3.5 months pre-pregnancy | 8.5 months in utero  |
| 2                                                 | 14.5 months pre-pregnancy                           | 2.5 months pre-pregnancy | 9.5 months in utero  |
| 3                                                 | 13.5 months pre-pregnancy                           | 1.5 months pre-pregnancy | 10.5 months in utero |
| 4                                                 | 12.5 months pre-pregnancy                           | 0.5 months pre-pregnancy | 11.5 months in utero |
| 5                                                 | 11.5 months pre-pregnancy                           | 0.5 months in utero   | 12.5 months in utero |
| 6                                                 | 10.5 months pre-pregnancy                           | 1.5 months in utero   | 13.5 months in utero |
| 7                                                 | 9.5 months pre-pregnancy                            | 2.5 months in utero   | 14.5 months in utero |
| 8                                                 | 8.5 months pre-pregnancy                            | 3.5 months in utero   | 15.5 months in utero |
| 9                                                 | 7.5 months pre-pregnancy                            | 4.5 months in utero   | 16.5 months in utero |
| 10                                                | 6.5 months pre-pregnancy                            | 5.5 months in utero   | 17.5 months in utero |
| 11                                                | 5.5 months pre-pregnancy                            | 6.5 months in utero   | 18.5 months in utero |
| 12                                                | 4.5 months pre-pregnancy                            | 7.5 months in utero   | 19.5 months in utero |
| 13                                                | 3.5 months pre-pregnancy                            | 8.5 months in utero   | 20.5 months in utero |
| 14                                                | 2.5 months pre-pregnancy                            | 9.5 months in utero   | 21.5 months in utero |
| 15                                                | 1.5 months pre-pregnancy                            | 10.5 months in utero  | 22.5 months in utero |
| 16                                                | 0.5 months pre-pregnancy                            | 11.5 months in utero  | 23.5 months in utero |
| 17                                                | 0.5 months in utero                                 | 12.5 months old       | 24.5 months old      |
| 18                                                | 1.5 months in utero                                 | 13.5 months old       | 25.5 months old      |
| 19                                                | 2.5 months in utero                                 | 14.5 months old       | 26.5 months old      |
| 20                                                | 3.5 months in utero                                 | 15.5 months old       | 27.5 months old      |
| 21                                                | 4.5 months in utero                                 | 16.5 months old       | 28.5 months old      |
| 22                                                | 5.5 months in utero                                 | 17.5 months old       | 29.5 months old      |
| 23                                                | 6.5 months in utero                                 | 18.5 months old       | 30.5 months old      |
| 24                                                | 7.5 months in utero                                 | 19.5 months old       | 31.5 months old      |
| 25                                                | 8.5 months in utero                                 | 20.5 months old       | 32.5 months old      |
| 26                                                | 0.5 months old                                     | 21.5 months old       | 33.5 months old      |
| 27                                                | 1.5 months old                                     | 22.5 months old       | 34.5 months old      |
| 28                                                | 2.5 months old                                     | 23.5 months old       | 35.5 months old      |
| 29                                                | 3.5 months old                                     | 24.5 months old       | 36.5 months old      |
| 30                                                | 4.5 months old                                     | 25.5 months old       | 37.5 months old      |
| 31                                                | 5.5 months old                                     | 26.5 months old       | 38.5 months old      |
| 32                                                | 6.5 months old                                     | 27.5 months old       | 39.5 months old      |
| 33                                                | 7.5 months old                                     | 28.5 months old       | 40.5 months old      |
| 34                                                | 8.5 months old                                     | 29.5 months old       | 41.5 months old      |
| 35                                                | 9.5 months old                                     | 30.5 months old       | 42.5 months old      |
| 36                                                | 10.5 months old                                    | 31.5 months old       | 43.5 months old      |
| 37                                                | 11.5 months old                                    | 32.5 months old       | 44.5 months old      |
| 38                                                | 12.5 months old                                    | 33.5 months old       | 45.5 months old      |
| 39                                                | 13.5 months old                                    | 34.5 months old       | 46.5 months old      |
| 40                                                | 14.5 months old                                    | 35.5 months old       | 47.5 months old      |
| 41                                                | 15.5 months old                                    | 36.5 months old       | 48.5 months old      |
| 42                                                | 16.5 months old                                    | 37.5 months old       | 49.5 months old      |
| 43                                                | 17.5 months old                                    | 38.5 months old       | 50.5 months old      |
| 44                                                | 18.5 months old                                    | 39.5 months old       | 51.5 months old      |
| 45                                                | 19.5 months old                                    | 40.5 months old       | 52.5 months old      |
| 46                                                | 20.5 months old                                    | 41.5 months old       | 53.5 months old      |
| 47                                                | 21.5 months old                                    | 42.5 months old       | 54.5 months old      |
| 48                                                | 22.5 months old                                    | 43.5 months old       | 55.5 months old      |
| 49                                                | 23.5 months old                                    | 44.5 months old       | 56.5 months old      |
| 50                                                | 24.5 months old                                    | 45.5 months old       | 57.5 months old      |
| 51                                                | 25.5 months old                                    | 46.5 months old       | 58.5 months old      |
| 52                                                | 26.5 months old                                    | 47.5 months old       | 59.5 months old      |
| 53                                                | 27.5 months old                                    | 48.5 months old       | 60.5 months old      |
| 54                                                | 28.5 months old                                    | 49.5 months old       | 61.5 months old      |
| 55                                                | 29.5 months old                                    | 50.5 months old       | 62.5 months old      |
| 56                                                | 30.5 months old                                    | 51.5 months old       | 63.5 months old      |
| 57                                                | 31.5 months old                                    | 52.5 months old       | 64.5 months old      |
| 58                                                | 32.5 months old                                    | 53.5 months old       | 65.5 months old      |
| 59                                                | 33.5 months old                                    | 54.5 months old       | 66.5 months old      |
| 60                                                | 34.5 months old                                    | 55.5 months old       | 67.5 months old      |

Notes: The anthropometric measurements of KIHS have been always administered in the first quarter, but the exact date varies across households. Here, to simplify presentation, we take the midpoint of the first quarter—that is, February 15th—in order to calculate exposure.
Table A5: Effects of income fluctuations on height, height-for-age Z-score (HAZ), and dummy for stunting of young children (0–5) by age

|                  | (1)          | (2)          | (3)          | (4)          | (5)          | (6)          | (7)          | (8)          | (9)          |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
|                  | Age 0-5      | Age 0-1      | Age 0-2      | Age 0-5      | Age 0-1      | Age 0-2      | Age 0-5      | Age 0-1      | Age 0-2      |
| Height (cm)      |              |              |              |              |              |              |              |              |              |
| HAZ              |              |              |              |              |              |              |              |              |              |
| Dummy – stunting |              |              |              |              |              |              |              |              |              |

**Panel A: IV, using income of the calendar year preceding Q1 measurement of the outcome**

|                  | (1)          | (2)          | (3)          | (4)          | (5)          | (6)          | (7)          | (8)          | (9)          |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Income, $t-1$ (logged) | 0.608**      | 0.870**      | 0.918**      | 0.234**      | 0.391*       | 0.380**      | -0.028       | -0.023       | -0.084**     |
|                  | (0.328)      | (0.443)      | (0.397)      | (0.095)      | (0.203)      | (0.151)      | (0.033)      | (0.035)      | (0.043)      |
| $R^2$            | 0.898        | 0.800        | 0.786        | 0.140        | 0.072        | 0.256        | 0.052        | 0.040        | 0.198        |
| First stage F-stat| 361.3        | 142.5        | 234          | 361.3        | 142.5        | 234          | 361.3        | 142.5        | 234          |
| N                | 12,058       | 2,017        | 4,422        | 12,058       | 2,017        | 4,422        | 12,058       | 2,017        | 4,422        |

**Panel B: IV, using income two calendar years prior to Q1 measurement of the outcome**

|                  | (1)          | (2)          | (3)          | (4)          | (5)          | (6)          | (7)          | (8)          | (9)          |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Income, $t-2$ (logged) | 0.793**      | 1.318***     | 1.282***     | 0.329***     | 0.644***     | 0.539***     | -0.064*      | -0.095***     | -0.135***     |
|                  | (0.355)      | (0.436)      | (0.439)      | (0.102)      | (0.200)      | (0.166)      | (0.036)      | (0.037)      | (0.049)      |
| $R^2$            | 0.903        | 0.809        | 0.791        | 0.157        | 0.068        | 0.263        | 0.060        | 0.033        | 0.198        |
| First stage F-stat| 302.4        | 177.3        | 204.9        | 302.4        | 177.3        | 204.9        | 302.4        | 177.3        | 204.9        |
| N                | 8,709        | 1,518        | 3,228        | 8,709        | 1,518        | 3,228        | 8,709        | 1,518        | 3,228        |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.

Table A6: Effects of income fluctuations on height, height-for-age Z-score (HAZ), and dummy for stunting of young children by gender

|                  | (1)          | (2)          | (3)          | (4)          | (5)          | (6)          | (7)          | (8)          | (9)          |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
|                  | All          | Girls        | Boys         | All          | Girls        | Boys         | All          | Girls        | Boys         |
| Height (cm)      |              |              |              |              |              |              |              |              |              |
| HAZ              |              |              |              |              |              |              |              |              |              |
| Dummy – stunting |              |              |              |              |              |              |              |              |              |

**Panel A: IV, using income of the calendar year preceding Q1 measurement of the outcome**

|                  | (1)          | (2)          | (3)          | (4)          | (5)          | (6)          | (7)          | (8)          | (9)          |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Income, $t-1$ (logged) | 0.650*       | 1.092**      | 0.353        | 0.187*       | 0.280**      | 0.143        | -0.030       | -0.113**     | 0.033        |
|                  | (0.374)      | (0.522)      | (0.537)      | (0.104)      | (0.142)      | (0.139)      | (0.039)      | (0.053)      | (0.053)      |
| $R^2$            | 0.821        | 0.822        | 0.823        | 0.036        | 0.037        | 0.050        | 0.031        | 0.035        | 0.032        |
| First stage F-stat| 363.8        | 196.3        | 249.8        | 363.8        | 196.3        | 249.8        | 363.8        | 196.3        | 249.8        |
| N                | 10,041       | 4,857        | 5,184        | 10,041       | 4,857        | 5,184        | 10,041       | 4,857        | 5,184        |

**Panel B: IV, using income two calendar years prior to Q1 measurement of the outcome**

|                  | (1)          | (2)          | (3)          | (4)          | (5)          | (6)          | (7)          | (8)          | (9)          |
|------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Income, $t-2$ (logged) | 0.819**      | 1.141**      | 0.586        | 0.252**      | 0.304*       | 0.217        | -0.061       | -0.123*      | -0.015       |
|                  | (0.412)      | (0.581)      | (0.537)      | (0.114)      | (0.158)      | (0.152)      | (0.043)      | (0.063)      | (0.057)      |
| $R^2$            | 0.827        | 0.823        | 0.835        | 0.039        | 0.042        | 0.060        | 0.035        | 0.037        | 0.049        |
| First stage F-stat| 277.7        | 162.2        | 192.7        | 277.7        | 162.2        | 192.7        | 277.7        | 162.2        | 192.7        |
| N                | 7,191        | 3,486        | 3,705        | 7,191        | 3,486        | 3,705        | 7,191        | 3,486        | 3,705        |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table A7: Effects of income fluctuations on height, height-for-age Z-score (HAZ), and dummy for stunting of young children (1–5) by age

|                  | Height (cm) | HAZ         | Dummy – stunting |
|------------------|-------------|-------------|------------------|
| **Panel A:** IV, using income of the calendar year preceding Q1 measurement of the outcome |             |             |                  |
| **Income,** $t-1$ (logged) | 0.650* (0.374) | 1.051* (0.558) | 0.451 (0.434)    |
| $R^2$            | 0.821       | 0.255       | 0.677            |
| First stage F-stat | 0.036       | 0.148       | 0.036            |
| N                | 10,041      | 2,405       | 7,636            |
| **Panel B:** IV, using income two calendar years prior to Q1 measurement of the outcome |             |             |                  |
| **Income,** $t-2$ (logged) | 0.819** (0.412) | 1.151* (0.674) | 0.630 (0.476)    |
| $R^2$            | 0.827       | 0.255       | 0.691            |
| First stage F-stat | 0.039       | 0.142       | 0.046            |
| N                | 7,191       | 1,710       | 5,481            |

Source: Authors’ calculations based on KIHS 2004–2016.
Notes: We include in our sample only those households earning at least some income from agriculture. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.

Table A8: Effects of income fluctuations on weight, weight-for-age Z-score (WAZ), and weight-for-height Z-score (WHZ) of young children (0–5) by age

|                  | Weight (cm) | WAZ         | WHZ              |
|------------------|-------------|-------------|------------------|
| **Panel A:** IV, using income of the calendar year preceding Q1 measurement of the outcome |             |             |                  |
| **Income,** $t-1$ (logged) | 0.389*** (0.114) | 0.382*** (0.129) | 0.378*** (0.114) |
| $R^2$            | 0.838       | 0.801       | 0.795            |
| First stage F-stat | 0.103       | 0.077       | 0.076            |
| N                | 12,058      | 2,017       | 4,422            |
| **Panel B:** IV, using income two calendar years prior to Q1 measurement of the outcome |             |             |                  |
| **Income,** $t-2$ (logged) | 0.389*** (0.129) | 0.401*** (0.129) | 0.402*** (0.123) |
| $R^2$            | 0.845       | 0.812       | 0.806            |
| First stage F-stat | 0.103       | 0.072       | 0.064            |
| N                | 8,709       | 1,518       | 3,228            |

Source: Authors’ calculations based on KIHS 2004–2016.
Notes: We include in our sample only those households earning at least some income from agriculture. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table A9: Effects of income fluctuations on weight, weight-for-age Z-score (WAZ), and weight-for-height Z-score (WHZ) by gender

|                  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| **Weight (kg)**  | All | Girls | Boys | All | Girls | Boys | All | Girls | Boys |
| **Panel A: IV, using income of the calendar year preceding Q1 measurement of the outcome** |     |       |      |     |       |      |     |       |      |
| **Income, \(t-1\) (logged)** | 0.411*** | 0.483*** | 0.357** | 0.234*** | 0.278*** | 0.210** | 0.184* | 0.156 | 0.198 |
| **(0.129)** | (0.172) | (0.176) | (0.073) | (0.097) | (0.100) | (0.095) | (0.124) | (0.128) |
| **R²** | 0.712 | 0.712 | 0.714 | 0.123 | 0.184 | 0.100 | 0.067 | 0.096 | 0.064 |
| **First stage F-stat** | 363.8 | 196.3 | 249.8 | 363.8 | 196.3 | 249.8 | 363.8 | 196.3 | 249.8 |
| **N** | 10,041 | 4,857 | 5,184 | 10,041 | 4,857 | 5,184 | 10,041 | 4,857 | 5,184 |
| **Panel B: IV, using income two calendar years prior to Q1 measurement of the outcome** |     |       |      |     |       |      |     |       |      |
| **Income, \(t-2\) (logged)** | 0.426*** | 0.432** | 0.431** | 0.244*** | 0.245** | 0.251** | 0.156 | 0.093 | 0.210 |
| **(0.145)** | (0.185) | (0.203) | (0.082) | (0.103) | (0.115) | (0.110) | (0.144) | (0.151) |
| **R²** | 0.721 | 0.720 | 0.725 | 0.127 | 0.199 | 0.103 | 0.069 | 0.099 | 0.071 |
| **First stage F-stat** | 277.7 | 162.2 | 192.7 | 277.7 | 162.2 | 192.7 | 277.7 | 162.2 | 192.7 |
| **N** | 7,191 | 3,486 | 3,705 | 7,191 | 3,486 | 3,705 | 7,191 | 3,486 | 3,705 |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.

Table A10: Effects of income fluctuations on weight, weight-for-age Z-score (WAZ), and weight-for-height Z-score (WHZ) of young children (1–5) by age

|                  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| **Weight (cm)**  | Age 1-5 | Age 1-2 | Age 2-5 | Age 1-5 | Age 1-2 | Age 2-5 | Age 1-5 | Age 1-2 | Age 2-5 |
| **Panel A: IV, using income of the calendar year preceding Q1 measurement of the outcome** |     |       |      |     |       |      |     |       |      |
| **Income, \(t-1\) (logged)** | 0.411*** | 0.414*** | 0.390*** | 0.234*** | 0.327*** | 0.191** | 0.184* | 0.188 | 0.183* |
| **(0.129)** | (0.152) | (0.150) | (0.073) | (0.123) | (0.078) | (0.095) | (0.149) | (0.109) |
| **R²** | 0.712 | 0.720 | 0.725 | 0.127 | 0.199 | 0.103 | 0.067 | 0.099 | 0.071 |
| **First stage F-stat** | 363.8 | 215.2 | 310.9 | 363.8 | 215.2 | 310.9 | 363.8 | 215.2 | 310.9 |
| **N** | 10,041 | 2,405 | 7,636 | 10,041 | 2,405 | 7,636 | 10,041 | 2,405 | 7,636 |
| **Panel B: IV, using income two calendar years prior to Q1 measurement of the outcome** |     |       |      |     |       |      |     |       |      |
| **Income, \(t-2\) (logged)** | 0.426*** | 0.389** | 0.409** | 0.244*** | 0.326** | 0.264** | 0.156 | 0.160 | 0.157 |
| **(0.145)** | (0.175) | (0.139) | (0.082) | (0.139) | (0.088) | (0.110) | (0.174) | (0.126) |
| **R²** | 0.721 | 0.218 | 0.532 | 0.123 | 0.123 | 0.102 | 0.067 | 0.048 | 0.064 |
| **First stage F-stat** | 277.7 | 130.2 | 268.6 | 277.7 | 130.2 | 268.6 | 277.7 | 130.2 | 268.6 |
| **N** | 7,191 | 1,710 | 5,481 | 7,191 | 1,710 | 5,481 | 7,191 | 1,710 | 5,481 |

Source: Authors’ calculations based on KIHS 2004–2016.

Notes: We include in our sample only those households earning at least some income from agriculture. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table A11: Robustness of effects of income fluctuations on health outcomes, by different minimum sample inclusion thresholds for agricultural income as a share of total income

| Outcome                          | Lag | Restrict universe to households with more than ... of total income from agriculture |
|---------------------------------|-----|-----------------------------------------------------------------------------------|
|                                 |     | 10% | 20% | 30% | 40% | 50% |

| Children age 0-5: height        |     | (1) |     |     |     |     |
| Children age 0-5: height        |     | (2) |     |     |     |     |
| Children age 0-5: HAZ           | 1   |     |     |     |     |     |
| Children age 0-5: HAZ           | 2   |     |     |     |     |     |
| Children age 0-5: weight        | 1   |     |     |     |     |     |
| Children age 0-5: weight        | 2   |     |     |     |     |     |
| Children age 0-5: WAZ           | 1   |     |     |     |     |     |
| Children age 0-5: WAZ           | 2   |     |     |     |     |     |
| Children age 0-5: WHZ           | 1   |     |     |     |     |     |
| Children age 0-5: WHZ           | 2   |     |     |     |     |     |
| Children age 5-18: BMI          | 1   |     |     |     |     |     |
| Children age 5-18: BMI          | 2   |     |     |     |     |     |
| Children age 5-18: dummy–good health | 1 |     |     |     |     |     |
| Children age 5-18: dummy–good health | 2 |     |     |     |     |     |
| Youth age 18-35: BMI            | 1   |     |     |     |     |     |
| Youth age 18-35: BMI            | 2   |     |     |     |     |     |
| Youth age 18-35: dummy–overweight | 1 |     |     |     |     |     |
| Youth age 18-35: dummy–overweight | 2 |     |     |     |     |     |

Source: Authors' calculations based on KIHS 2004–2016.

Notes: Agricultural income as a share of total income is calculated in the year that the household enters the sample. Income is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table A12: Robustness of effects of income fluctuations on health outcomes to different sample restriction criteria and functional form

| Outcome | Lag | 2004-2008 | Bishkek and Osh | Top 1% income and outcome | Functional form |
|---------|-----|-----------|----------------|--------------------------|----------------|
|         |     | Original specification | (1) | (2) | (3) | (4) | (5) |
| Children age 0-5: height | 1 | 0.650* | -0.374 | 0.434 | -0.467 | 0.727* | -0.374 | 0.457 | -0.378 | 0.470* | 0.267 |
| Children age 0-5: height | 2 | 0.819** | -0.412 | 0.993* | -0.527 | 0.770* | -0.427 | 0.721* | -0.413 | 0.684* | 0.355 |
| Children age 0-5: HAZ | 1 | 0.187* | -0.104 | 0.133 | -0.13 | 0.201* | -0.104 | 0.186* | -0.101 | 0.123* | 0.074 |
| Children age 0-5: HAZ | 2 | 0.252** | -0.114 | 0.311** | -0.136 | 0.193 | -0.118 | 0.310** | -0.119 | 0.290** | 0.100 |
| Children age 0-5: weight | 1 | 0.411*** | -0.129 | 0.437*** | -0.171 | 0.411*** | -0.131 | 0.316** | -0.125 | 0.345*** | 0.103 |
| Children age 0-5: weight | 2 | 0.426*** | -0.145 | 0.517*** | -0.191 | 0.369*** | -0.151 | 0.383*** | -0.141 | 0.407*** | 0.134 |
| Children age 0-5: WAZ | 1 | 0.243*** | -0.073 | 0.251*** | -0.097 | 0.235*** | -0.074 | 0.235*** | -0.073 | 0.194*** | 0.057 |
| Children age 0-5: WAZ | 2 | 0.244*** | -0.082 | 0.302*** | -0.107 | 0.216*** | -0.085 | 0.273*** | -0.081 | 0.225*** | 0.074 |
| Children age 0-5: WHZ | 1 | 0.184* | -0.095 | 0.350** | -0.126 | 0.149** | -0.096 | 0.188** | -0.093 | 0.175** | 0.079 |
| Children age 0-5: WHZ | 2 | 0.156 | -0.11 | 0.196 | -0.149 | 0.13 | -0.114 | 0.180* | -0.106 | 0.167 | 0.104 |
| Children age 5-18: BMI | 1 | 0.173* | -0.094 | 0.239* | -0.125 | 0.171* | -0.097 | 0.146* | -0.089 | 0.297** | 0.083 |
| Children age 5-18: BMI | 2 | 0.190* | -0.107 | 0.219 | -0.137 | 0.203* | -0.111 | 0.161 | -0.101 | 0.201* | 0.105 |
| Children age 5-18: dummy–good health | 1 | 0.020* | -0.01 | 0.035** | -0.014 | 0.019* | -0.011 | 0.021* | -0.011 | 0.007 | 0.011 |
| Children age 5-18: dummy–good health | 2 | 0.036*** | -0.013 | 0.031* | -0.017 | 0.039*** | -0.014 | 0.038*** | -0.014 | 0.023 | 0.015 |
| Youth age 18-35: BMI | 1 | 0.429** | -0.19 | 0.490** | -0.251 | 0.471** | -0.196 | 0.430** | -0.179 | 0.347** | 0.162 |
| Youth age 18-35: BMI | 2 | 0.317 | -0.212 | 0.387 | -0.277 | 0.357 | -0.223 | 0.340* | -0.2 | 0.362 | 0.191 |
| Youth age 18-35: dummy–overweight | 1 | 0.067*** | -0.025 | 0.009** | -0.034 | 0.081*** | -0.026 | 0.066** | -0.020 | 0.062** | 0.024 |
| Youth age 18-35: dummy–overweight | 2 | 0.049* | -0.028 | 0.063* | -0.036 | 0.064** | -0.029 | 0.048 | -0.029 | 0.052* | 0.029 |
| Individuals age 35+: weight | 1 | 2.845*** | -0.703 | 2.934*** | -0.856 | 2.541*** | -0.712 | 2.842*** | -0.694 | 2.230*** | 0.559 |
| Individuals age 35+: weight | 2 | 2.778*** | -0.75 | 3.104*** | -0.946 | 2.492*** | -0.763 | 2.892*** | -0.745 | 2.547*** | 0.658 |
| Individuals age 35+: BMI | 1 | 0.911*** | -0.248 | 0.946*** | -0.303 | 0.817*** | -0.252 | 0.787*** | -0.244 | 0.584*** | 0.189 |
| Individuals age 35+: BMI | 2 | 0.872*** | -0.268 | 0.924*** | -0.336 | 0.776*** | -0.273 | 0.725*** | -0.260 | 0.638*** | 0.221 |
| Individuals age 35+: dummy–overweight | 1 | 0.141*** | -0.031 | 0.139*** | -0.038 | 0.120*** | -0.031 | 0.140*** | -0.032 | 0.113*** | 0.026 |
| Individuals age 35+: dummy–overweight | 2 | 0.132*** | -0.033 | 0.145*** | -0.042 | 0.109*** | -0.034 | 0.135*** | -0.035 | 0.123*** | 0.031 |

Source: Authors’ calculations based on KIHS 2004-2016.
Notes: Agricultural income as a share of total income is calculated in the year that the household enters the sample. Income is measured in 2010 Som. In most regressions, we use the logged form of income and its instrument in the regressions. Note that in (5) we use the level form of the income variables in 100,000 2010 Som for better presentation of the coefficients. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
Table A13: Effects of income shocks on height and weight of adults by age and gender

|                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |                  |
|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|                  | All Women        | Men              | All Women        | Men              | All Women        | Men              | All Women        | Men              | All Women        | Men              |
|                  | Height           | Weight           | BMI              | Dummy – overweight | Dummy – obese |
| (1) (2) (3) (4)  | (5) (6) (7) (8)  | (9) (10) (11) (12) | (13) (14) (15) |
| Income, t − 1 (logged) | -0.696          | 0.025            | -1.059           | 0.603            | 0.721            | 0.662            | 0.429**          | 0.286            | 0.535**          | 0.067***         |
|                  | (0.482)          | (0.590)          | (0.646)          | (0.538)          | (0.719)          | (0.770)          | (0.190)          | (0.264)          | (0.250)          | (0.025)          |
| R²               | 0.421            | 0.100            | 0.054            | 0.314            | 0.128            | 0.194            | 0.153            | 0.141            | 0.185            | 0.096            |
| First stage F-stat | 569.3            | 510.3            | 415.1            | 569.3            | 510.3            | 415.1            | 569.3            | 510.3            | 415.1            | 0.25             |
| N                | 25,414           | 12,805           | 12,609           | 25,414           | 12,805           | 12,609           | 25,414           | 12,805           | 12,609           | 25,414           |

Panel B: IV estimates, using income two calendar years prior to Q1 measurement of the outcome: 18-35 years

|                  | All Women        | Men              | All Women        | Men              | All Women        | Men              | All Women        | Men              | All Women        | Men              |
|                  | Height           | Weight           | BMI              | Dummy – overweight | Dummy – obese |
| (1) (2) (3) (4)  | (5) (6) (7) (8)  | (9) (10) (11) (12) | (13) (14) (15) |
| Income, t − 2 (logged) | -0.810          | -0.207           | -0.949           | 0.226            | 0.009            | 0.665            | 0.317            | 0.077            | 0.507*           | 0.049*           |
|                  | (0.535)          | (0.668)          | (0.691)          | (0.620)          | (0.805)          | (0.829)          | (0.212)          | (0.301)          | (0.269)          | (0.028)          |
| R²               | 0.424            | 0.105            | 0.061            | 0.318            | 0.130            | 0.209            | 0.162            | 0.148            | 0.199            | 0.106            |
| First stage F-stat | 497.7            | 391.3            | 381.5            | 497.7            | 391.3            | 381.5            | 497.7            | 391.3            | 381.5            | 0.28             |
| N                | 18,612           | 9,348            | 9,264            | 18,612           | 9,348            | 9,264            | 18,612           | 9,348            | 9,264            | 18,612           |

Panel C: IV estimates, using income of the calendar year preceding Q1 measurement of the outcome: 35+ years

|                  | All Women        | Men              | All Women        | Men              | All Women        | Men              | All Women        | Men              | All Women        | Men              |
|                  | Height           | Weight           | BMI              | Dummy – overweight | Dummy – obese |
| (1) (2) (3) (4)  | (5) (6) (7) (8)  | (9) (10) (11) (12) | (13) (14) (15) |
| Income, t − 1 (logged) | 0.528            | 0.359            | 0.794            | 2.845***          | 2.802***         | 2.927***         | 0.911***         | 0.963***         | 0.856***         | 0.141***         |
|                  | (0.453)          | (0.373)          | (0.566)          | (0.703)          | (0.936)          | (0.901)          | (0.248)          | (0.345)          | (0.291)          | (0.031)          |
| R²               | 0.403            | 0.143            | 0.080            | 0.143            | 0.097            | 0.100            | 0.068            | 0.083            | 0.070            | 0.044            |
| First stage F-stat | 809.9            | 717.1            | 699.3            | 809.9            | 717.1            | 699.3            | 809.9            | 717.1            | 699.3            | 0.041            |
| N                | 49,820           | 27,440           | 22,380           | 49,820           | 27,440           | 22,380           | 49,820           | 27,440           | 22,380           | 49,820           |

Panel D: IV estimates, using income two calendar years prior to Q1 measurement of the outcome: 35+ years

|                  | All Women        | Men              | All Women        | Men              | All Women        | Men              | All Women        | Men              | All Women        | Men              |
|                  | Height           | Weight           | BMI              | Dummy – overweight | Dummy – obese |
| (1) (2) (3) (4)  | (5) (6) (7) (8)  | (9) (10) (11) (12) | (13) (14) (15) |
| Income, t − 2 (logged) | 0.600            | 0.356            | 0.937            | 2.778***          | 3.013***         | 2.450***         | 0.872***         | 1.029***         | 0.647**          | 0.132**          |
|                  | (0.498)          | (0.627)          | (0.621)          | (0.750)          | (1.004)          | (0.970)          | (0.268)          | (0.374)          | (0.316)          | (0.033)          |
| R²               | 0.403            | 0.142            | 0.080            | 0.146            | 0.099            | 0.105            | 0.071            | 0.085            | 0.073            | 0.046            |
| First stage F-stat | 677.6            | 605.2            | 574.6            | 677.6            | 605.2            | 574.6            | 677.6            | 605.2            | 574.6            | 0.043            |
| N                | 37,252           | 20,573           | 16,679           | 37,252           | 20,573           | 16,679           | 37,252           | 20,573           | 16,679           | 37,252           |

Source: Authors’ calculations based on KIHS 2004–2016.
Notes: We include in our sample only those households earning at least some income from agriculture. Income (annual) is measured in 2010 Som. We use the logged form of income and its instrument in the regressions. The instrumental variable and the full set of controls are described in Table 2. Standard errors are in parentheses and clustered at the household level. *** indicates p<0.01; ** indicates p<0.05; and * indicates p<0.10.
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IFPRI HEADQUARTERS
1201 Eye Street, NW
Washington, DC 20005 USA
Tel.: +1-202-862-5600
Fax: +1-202-862-5606
Email: ifpri@cgiar.org