Electricity Outages and Health Outcomes of Children: Empirical Evidence from Transition Economy

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Motivation

- Many interlinked systems in the modern world depend on a reliable power supply to function effectively. The health sector is no exception, but the impact of power outages on health is poorly understood. Greater understanding is essential so that adverse health impacts can be prevented and/or mitigated

- The electricity prices in developing countries are relatively low to recover its costs of generation and provision. This results in under-investment in infrastructure, which usually leads to frequent outages or rolling blackouts by the electricity suppliers.
- Outages may have an adverse impact on the household's well being including the health of household members. The paper investigates whether there is a relationship between outages and the health of children. Specifically, it examines the differences in the anthropometric outcomes of children aged 5 and below (given by the z-scores) living in households that experience frequent outages and those which do not.

Literature

Casey et al., 2020 "Power Outages and Community Health: a Narrative Review"-
-In the 23 (48%) reviewed articles, indoor use of charcoal and gasoline-powered generators caused the majority of CO poisoning

Cardiovascular, Respiratory, and Renal Disease

- Dominianni et al. evaluated three major NYC outages (1999, 2003, 2006) and localized warm- and cold-weather outages within NYC In models accounting for temperature, day of week, and seasonal and long-term trends, they confirmed prior findings of increased cardiovascular and respiratory disease hospitalizations during the 2003 outage and found new evidence of elevated risk of renal disease hospitalizations during warm season power outages and cardiovascular disease hospitalizations during cold-season power outages.
- Zhang and colleagues also illustrated the utility of using daily sub-city level power outage data in their study of chronic obstructive pulmonary disease (COPD) hospitalizations statewide.

Gastrointestinal Illness

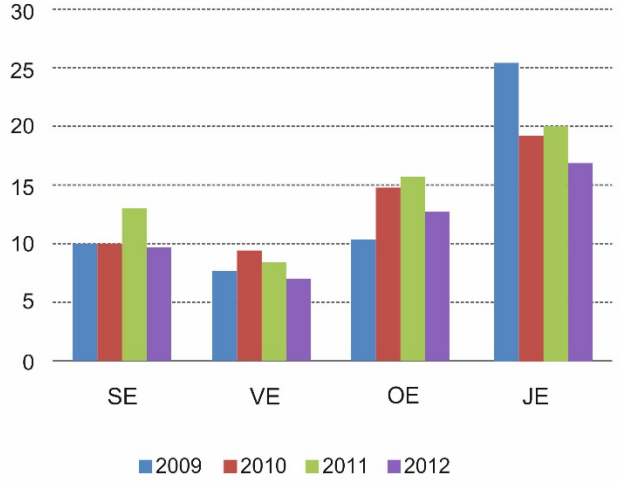
- Marx et al. employed methods from digital epidemiology to evaluate diarrheal illness after the 2003 Northeast Blackout

Temperature-Related Illness

- Power outages reduce individuals' ability to control the indoor environment and may coincide with temperature extremes (both heat waves and winter storms) resulting in illness(Freese, 2006, Greenstein, 2016, Rand DA 2005, Rand DA 2015) and disturbed sleep (Mizuno 2014) related to heat and cold exposure.

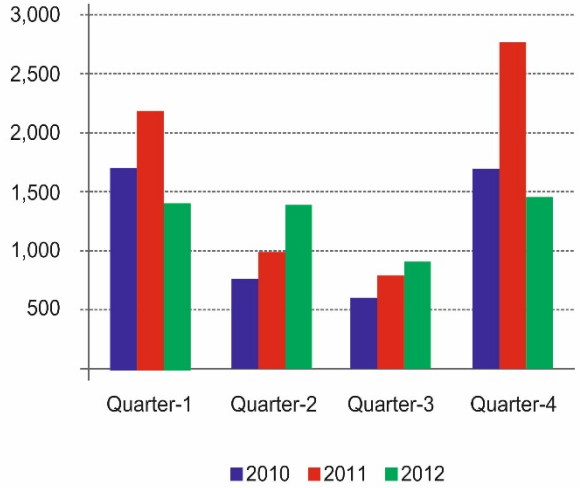
KYRGYZ REPUBLIC

Outages per 1000 Customers by Distribution Company, 2009-2012



Source: The World Bank. 2014. Power Sector Policy Note for the Kyrgyz Republic

Number of Outages on SE Distribution Network, 2010-2012



System Average Interruption Duration Index (SAIDI) in hours

Years	First Quarter	Second Quarter	Third Quarter	Fourth quarter
2017	2.6	7.9	7.7	21.9
2018	4.2	2.6	1.5	3.6
2019	3.6	3.4	1.0	3.5
2020	2.1	3.6	1.9	1.6

Kyrgyz Republic's Energy Sector

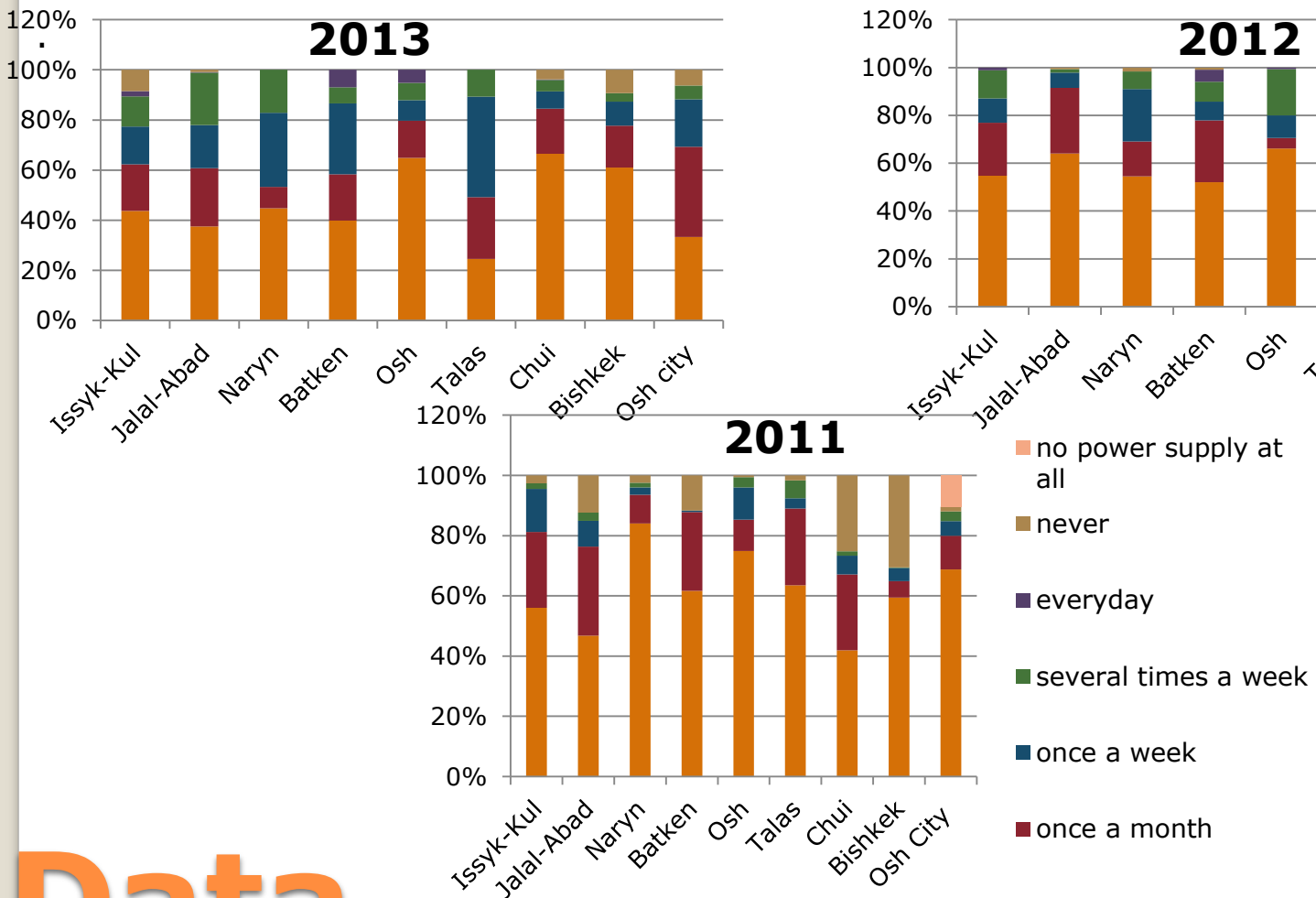
How long did these power outages last on average ?(in hours)

	Average	Min	Max
Bishkek	3.1	1	8
Chui and Talas	4.4	1	10
Issyk - Kul	3	1	6
Naryn	2.4	1	5
South	3	1	6

Enterprise Survey (2013) World Bank

The paper used household level panel data from Kyrgyzstan, our sample includes 1326 households and 3742 observations in all major Kyrgyz regions. The data collection process was administered by IZA's International Data Service Center (IDSC).

Figure 1: Electricity disruption in all regions of Kyrgyz



Data

Variable	Obs.	Mean	Std.Dev.	Min	Max
Income per cap	3,743	766.509	508.7896	67.29975	4092.073
Food expenditure per cap	3,743	407.4529	184.9761	83.68781	1523.262
el_disruption	3,743	0.19	0.39	0	1
WAZ	3,743	0.344929	1.104451	-3.61	4.79
HAZ	3,743	-0.29031	1.784489	-3.97	4.83
age	3,743	2.889126	1.485633	0	5
hh_size	3,743	6.881111	2.45004	2	15
Dependent household members	3,743	3.28934	1.466319	1	9
Heating stove	3,742	0.822288	0.382322	0	1
Cooking in tandir	3,742	0.461518	0.498584	0	1
Rural	3,739	0.698315	0.459051	0	1
remit	3,743	0.134651	0.341396	0	1

Descriptive Statistics

Coarsened Exact Matching

- The cem matching technique belongs to the newly developed class of Monotonic Imbalance Bounding'' (MIB) class of matching methods developed by Iacus et al., (2012) from which cem is derived.
- The cem estimator has several advantages over other matching techniques. It requires fewer assumptions and possesses more attractive statistical properties (King & Nielsen, 2019).
- As the measure of imbalance of the covariates between the groups, I use the overall imbalance indicator introduced by Iacus et al., (2008). It is based on the comprehensive imbalance measure L1, the difference between the multidimensional histogram of all pretreatment covariates in the treated group and that in the control group given by:
- $L_1(f,g) = \frac{1}{2}\sum_{l_1 \ldots l_k} | f_{l_1 \ldots l_k} - g_{l_1 \ldots l_k} |$
- Where $f_{l_1 \ldots l_k}$ and $g_{l_1 \ldots l_k}$ are the k-dimensional relative frequencies for the treated and control groups respectively calculated from the cross-tabulation of the discretized (coarsened) covariates.

Methodology

the study analyze the effect of electricity outages on health outcomes of children aged from 0 to 5 using the following fixed effects econometric model for each of the anthropometric outcomes of interest:

- $WAZ_{it} = \beta_1\, outages_{it} + \beta_2\, X_{it} + a'_{1i} + a'_{2t} + e_{it}$
- $\mathrm{HAZ_{it}} = \delta_1\, outages_{it} + \delta_2\, X_{it} + \gamma_1{'}_{\mathrm{i}} + \gamma_2{'}_{\mathrm{t}} + \mathrm{u_{it}}$
- Where i and t stand for household and time subscripts.
- $outages_{it}$ - is a binary indicator for the frequency of outages occurring more than once a month.
- a'_{1i} & $\gamma_1{'}_{\mathrm{i}}$ -household fixed effects
- X_{it} - (natural logarithm of) per capita household food expenditure, (natural logarithm of) per capita income, number of dependent household members ,age of the child under consideration.
- a'_{2t} & $\gamma_2{'}_{\mathrm{t}}$ - the year fixed effects

The imbalance statistics of the full sample

Multivariate L1 distance: 0.974	Univariate imbalance:						
N=3743	L1	mean	min	25%	50%	75%	max
Per capita Income	0.0892	49.213	22.433	28.151	23.23	105.12	-1218.4
Per capita Food Exp	0.11274	-19.183	23.552	-1.8041	-22.788	-5.2514	-35.668
Household size	0.08899	0.46243	0	0	1	1	0
Heating with Stove	0.08617	0.08617	0	0	0	0	0
Cooking with tandyr	0.00845	-0.00845	0	0	0	0	0
Rural households	0.07931	0.07931	0	1	0	0	0
Receiving remittance	0.02532	0.02532	0	0	0	0	0
Issyk_kul region	0.02427	0.02427	0	0	0	0	0
Jalal_abad region	0.02325	0.02325	0	0	0	0	0
Naryn region	0.01545	0.01545	0	0	0	0	0
Batken region	0.00666	-0.00666	0	0	0	0	0
Osh region	0.03425	0.03425	0	0	0	0	0
Osh city	0.03134	0.03134	0	0	0	0	0
Talas region	0.02908	0.02908	0	0	0	0	0
Chui region	0.07042	-0.07042	0	0	0	0	0
Bishkek city	0.08056	-0.08056	0	0	0	0	0

Number of strata	1810	
Number of matched strata	177	
Observations	Treatment=0	Treatment=1
All	3013	730
Matched	489	306
Unmatched	2524	424

Multivariate L1 distance: 0.806	Univariate imbalance:						
	L1	mean	min	25%	50%	75%	max
Per capita Income	0.09114	2.1306	20.19	0.69675	34.055	-19.64	0
Per capita Food Exp	0.12805	0.41018	18.808	6.2274	-10.839	13.627	0
Household size	0.01089	0.00871	0	0	0	0	1
Heating with Stove	3.50E-18	0	0	0	0	0	0
Cooking with tandyr	1.10E-16	-2.20E-16	0	0	0	0	0
Rural households	1.70E-16	2.20E-16	0	0	0	0	0
Receiving remittance	1.10E-16	6.90E-18	0	0	0	0	0
Issyk_kul region	2.90E-16	-2.80E-17	0	0	0	0	0
Jalal_abad region	6.90E-17	2.80E-17	0	0	0	0	0
Naryn region	5.60E-17	0	0	0	0	0	0
Batken region	1.30E-16	-4.20E-17	0	0	0	0	0
Osh region	4.20E-16	5.60E-17	0	0	0	0	0
Osh city	1.70E-16	6.90E-18	0	0	0	0	0
Talas region	5.90E-17	-6.90E-18	0	0	0	0	0
Chui region	2.30E-16	-1.40E-17	0	0	0	0	0
Bishkek city	1.20E-16	-1.40E-17	0	0	0	0	0

Fixed effects regressions	(1) Height for age Z-score matched	(2) Weight for age Z-score matched	(3) Height for age Z-score full sample	(4) Weight for age Z-score Full sample
el_disruption	-0.334**	-0.157*	-0.041	0.046
	(0.155)	(0.086)	(0.071)	(0.046)
ln_Income	-0.065	-0.387	-0.011	-0.028
	(0.331)	(0.269)	(0.093)	(0.059)
ln_FoodExp	0.131	-0.001	-0.026	-0.007
	(0.175)	(0.116)	(0.062)	(0.041)
Age	-1.428***	-0.821***	-2.254***	-1.201***
	(0.436)	(0.221)	(0.180)	(0.092)
n_of_dependent household members	-0.044	-0.095	0.144***	0.062*
	(0.140)	(0.071)	(0.054)	(0.032)
year2013	1.792*	0.997**	2.858***	1.556***
	(0.978)	(0.496)	(0.385)	(0.199)
year2012	1.369***	0.654**	1.780***	1.009***
	(0.527)	(0.275)	(0.204)	(0.111)
N	795	795	3743	3743
adj. R^2	0.398	0.404	0.457	0.378
F	32.598	17.869	218.577	142.522
p	0.000	0.000	0.000	0.000

Standard errors are clustered at the household level.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Conclusion

- This study documents that, on average, the height for age z-scores of children living in the households which experience frequent outages are 0.334 standard deviations behind, and weight for age z-scores are 0.157 standard deviations behind the children living in the identical household but which do not experience the frequent outages.

- Thank you !