Does the use of biomass for cooking affect early childhood development? A case study of Kiribati

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Introduction

- Importance of non-solid fuel (clean fuel)
- Tracking United Nations SDG goal 7
- Biomass – health and time use effects.
- Child educational outcomes (child development)
- Tracking United Nations SDG goal 4

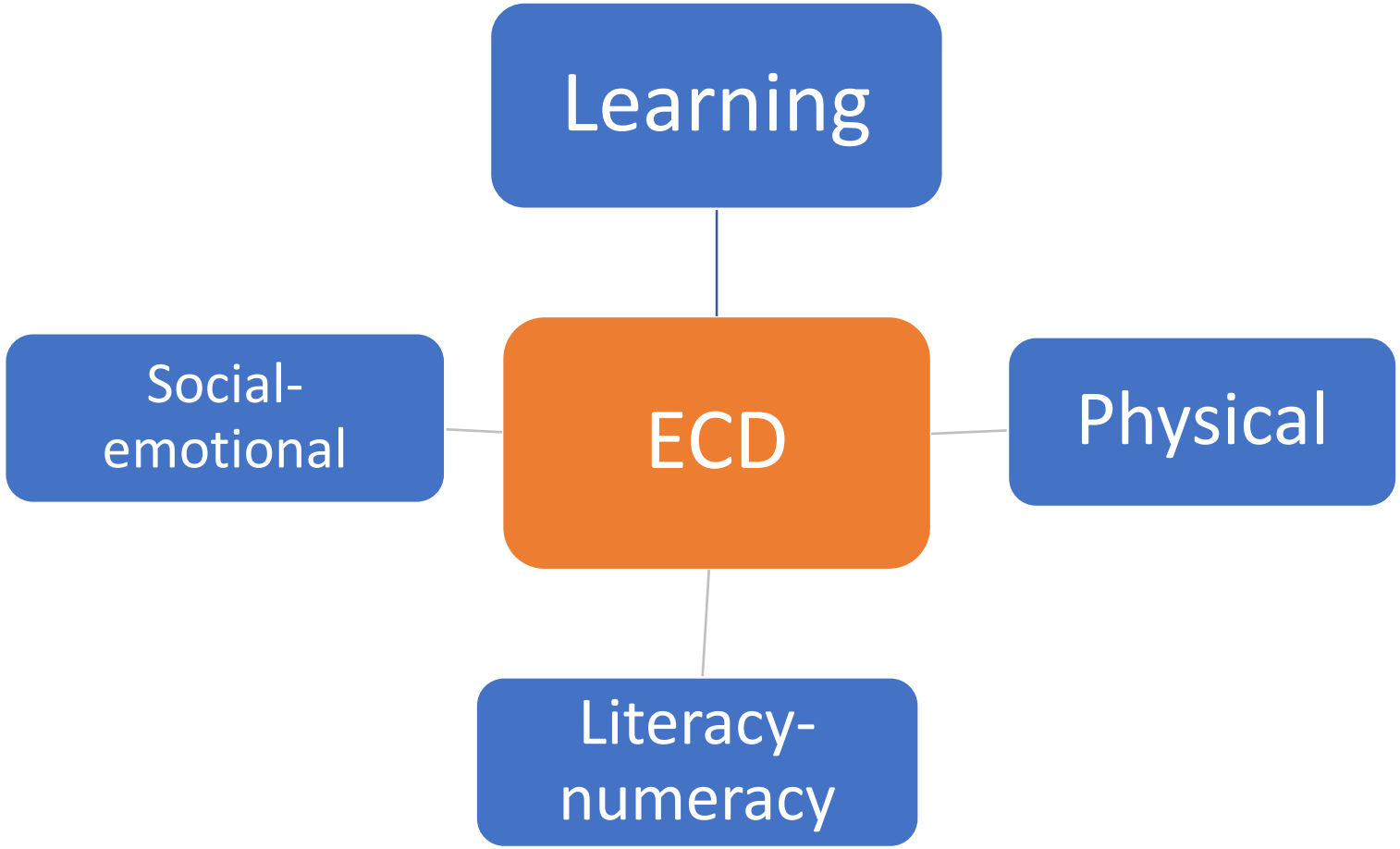
Motivation

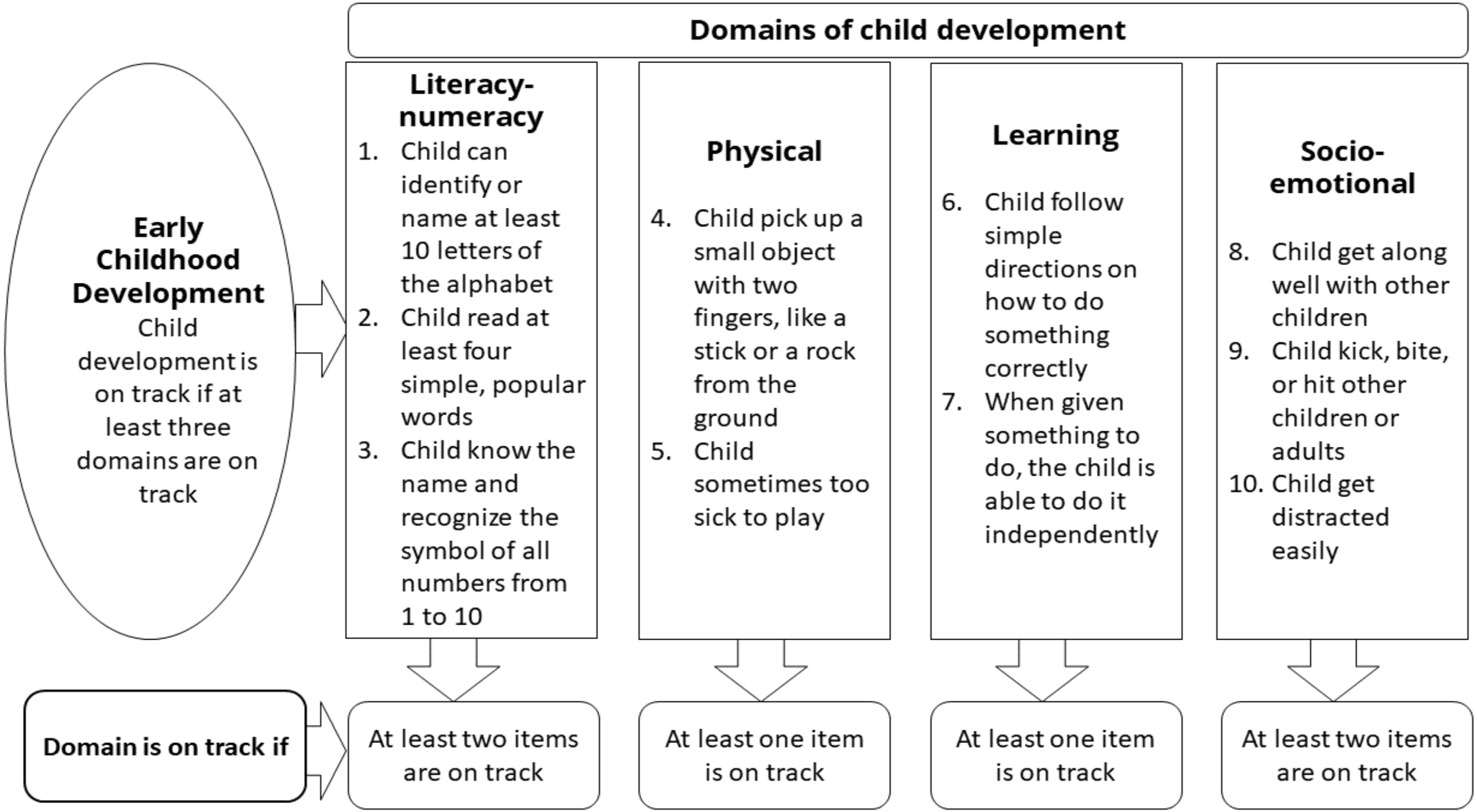
- Early childhood development sets the starting point for future health, learning, and well-being.
- Globally 2.5 billion people still lack clean fuel for cooking (IEA, 2022). Around 3 billion individuals in poor countries still use solid fuels, such as firewood, crop residue, dung cakes, and other biomass fuels (WHO, 2015).
- Kiribati is one of the least developed countries in the Pacific Islands, with a GDP of $197 million (2017 estimate)

Literature

- Literature is clearly taking a position on the negative impact of biomass use for cooking on child respiratory diseases, stunting, pregnancy, and birth weight (Mishra and Retherford, 2007).
- Significant empirical studies are available to show a negative effect of the use of biomass for cooking on the educational and learning outcomes of young children (Williams et al., 2020).
- According to literature, indoor air pollution, and mother time spent collecting firewood and preparing dung cake are channels through which biomass influences child health 5 (Mulenga and Siziya, 2019).

Early Childhood Development




Domains of child development
Early Childhood Development
Child development is on track if at least three domains are on track
Literacy-numeracy
1. Child can identify or name at least 10 letters of the alphabet
2. Child read at least four simple, popular words
3. Child know the name and recognize the symbol of all numbers from 1 to 10
Physical
4. Child pick up a small object with two fingers, like a stick or a rock from the ground
5. Child sometimes too sick to play
Learning
6. Child follow simple directions on how to do something correctly
7. When given something to do, the child is able to do it independently
Socio-emotional
8. Child get along well with other children
9. Child kick, bite, or hit other children or adults
10. Child get distracted easily
Domain is on track if
At least two items are on track
At least one item is on track
At least one item is on track
At least two items are on track

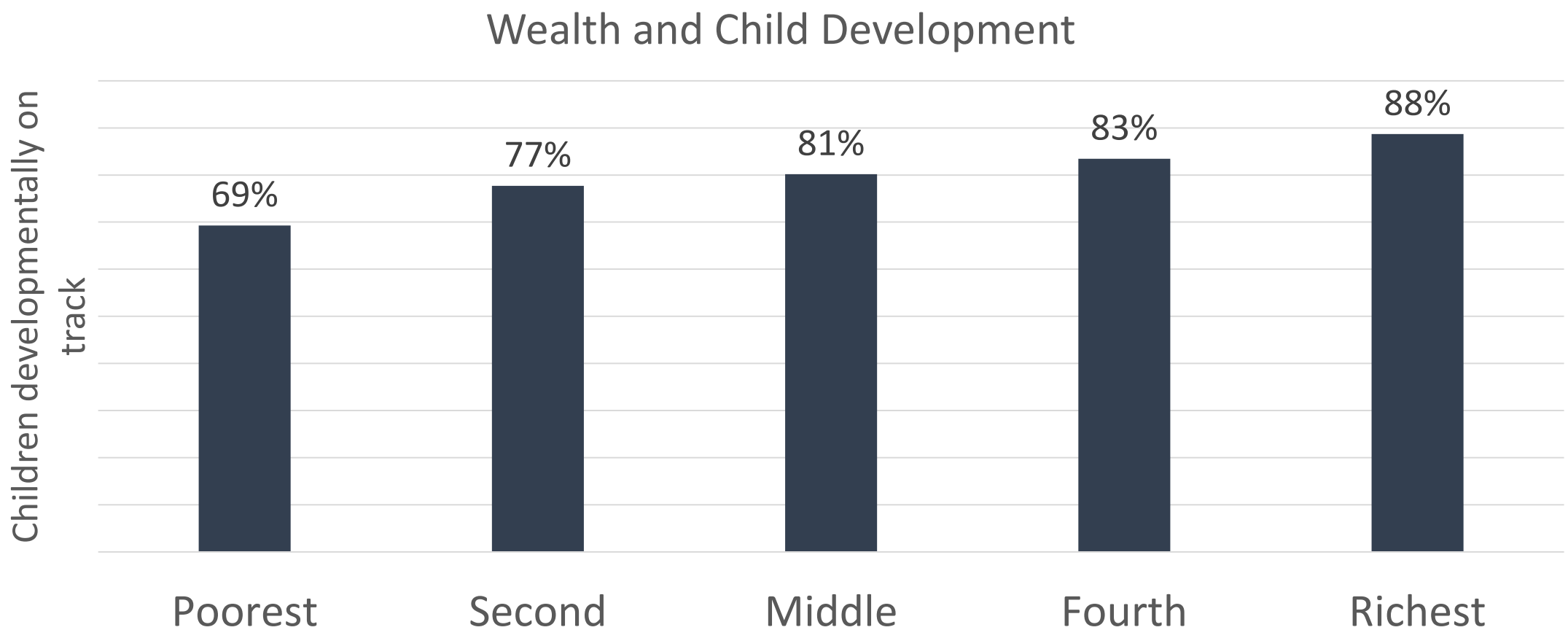
Data

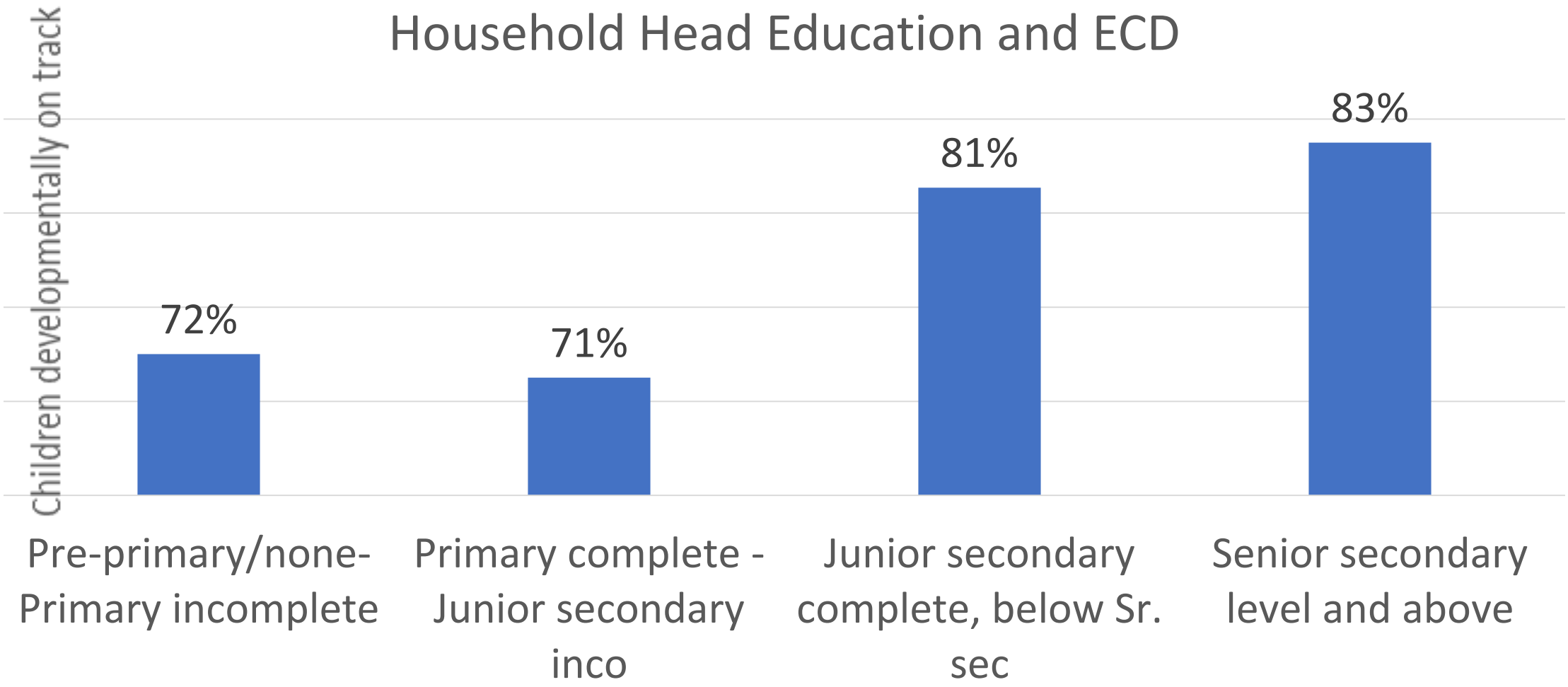
- Multiple Indicator Cluster Survey-6 (2018-19)
- Individual level data
- Sub-sample of children(35-59months)
- Children sampling weights included

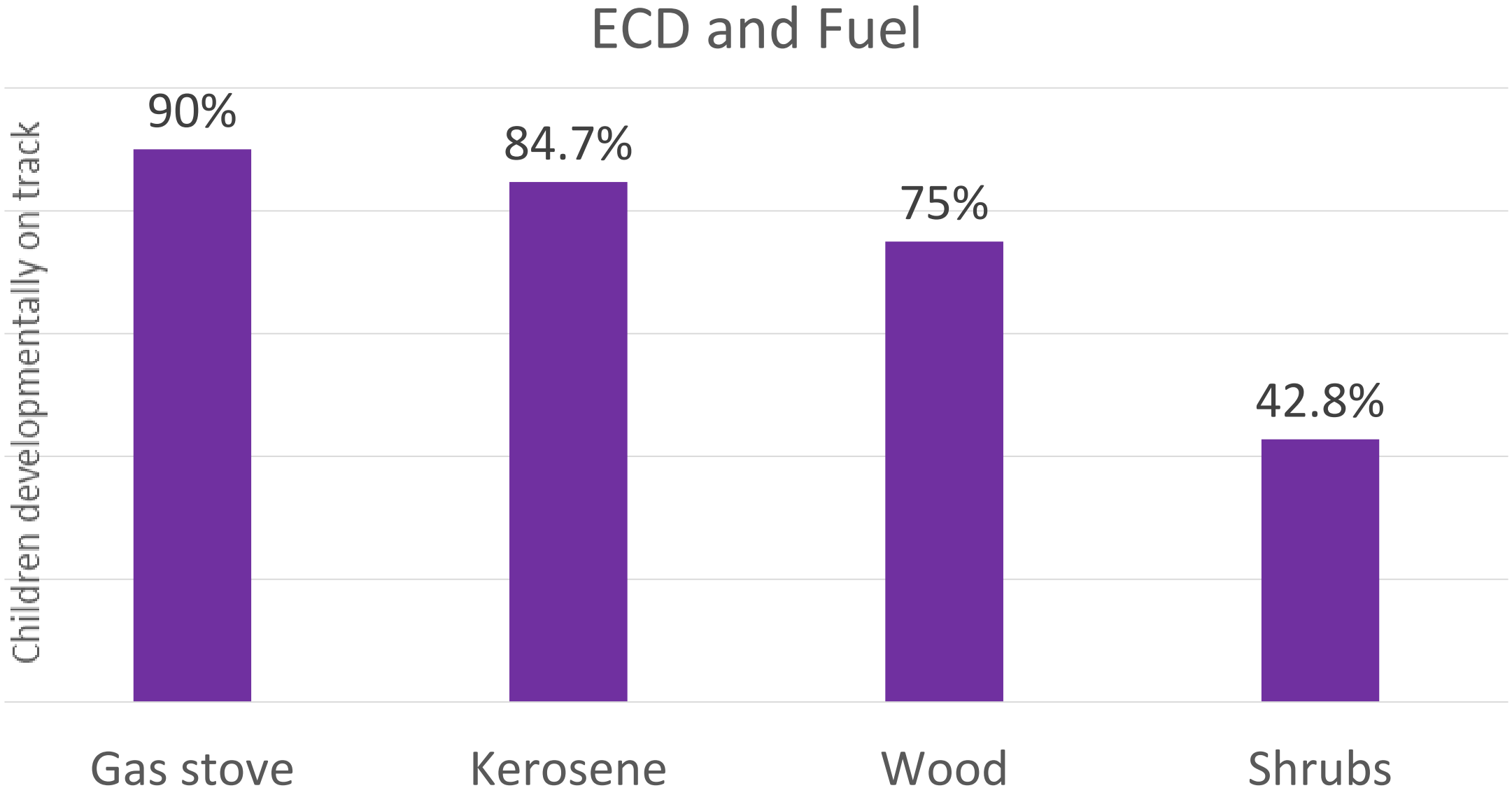
Empirical Methodology

- Propensity Score Matching (PSM)
- Dependent variable – ECD
- Covariates – wealth, head's education-age-gender, districts, urban/rural, number of children age less than 5 in household, roof type, family size and internet access.
- Treatment – biomass use for cooking purpose.

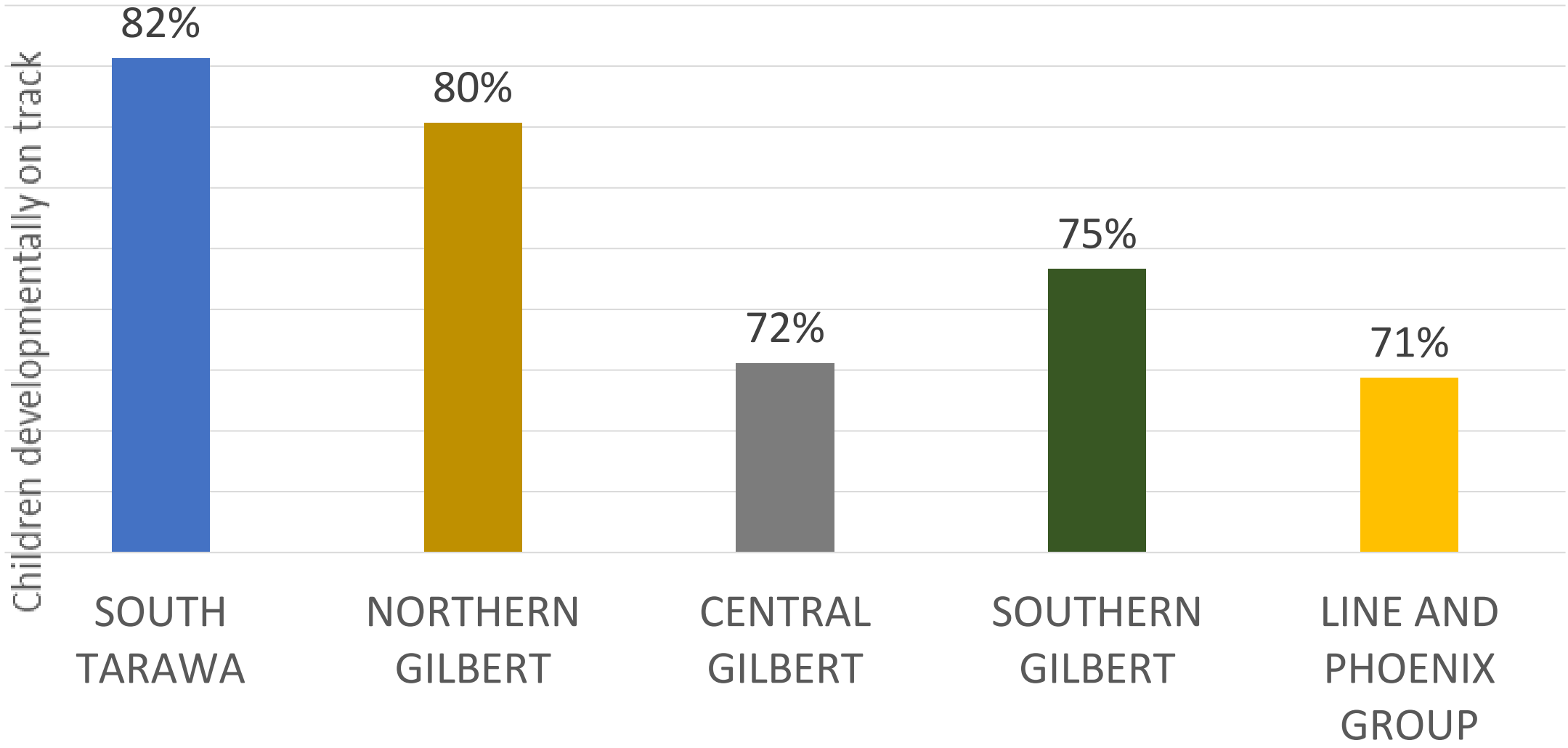
Results


Wealth and Child Development
Children developmentally on track
69%
77%
81%
83%
88%
Poorest
Second
Middle
Fourth
Richest


Household Head Education and ECD
Children developmentally on track
72%
71%
81%
83%
Pre-primary/none-Primary incomplete
Primary complete - Junior secondary inco
Junior secondary complete, below Sr. sec
Senior secondary level and above


ECD and Fuel
Children developmentally on track
90%
84.7%
75%
42.8%
Gas stove
Kerosene
Wood
Shrubs

Regions and ECD



Determinants of biomass

Covariates	Odd Ratio	St.Err.	z-value
Family size	1.09***	0.045	-4.74
Wealth index quantiles – poor as base category			
Second	0.49**	0.039	-6.73
Middle	0.91***	0.17	-4.45
Fourth	0.63***	0.06	-8.06
Highest	0.34***	0.03	-8.56
Education of household head none or primary incomplete as base category			
-Primary completed	0.162	.375	0.47
-Junior secondary	0.847*	.587	1.93
-Senior secondary and above	0.341**	.799	2.49
Female head	0.95	0.26	-0.18
Age of head	1.00	0.009	0.17
RURAL dummy	3.118***	1.221	2.91
Division/district base= South Tarawana			
-Northern Gilbert	.368**	.157	2.54
-Central Gilbert	.561	.288	-1.13
-Southern Gilbert	.312**	.145	-2.51
-Line and Phoenix group	.127	.102	-1.58
Roof tin/cement dummy	0.09**	0.69	2.22
ICT-dummy for access to internet	0.36	0.10	-3.37
Constant	04	038	-3.43

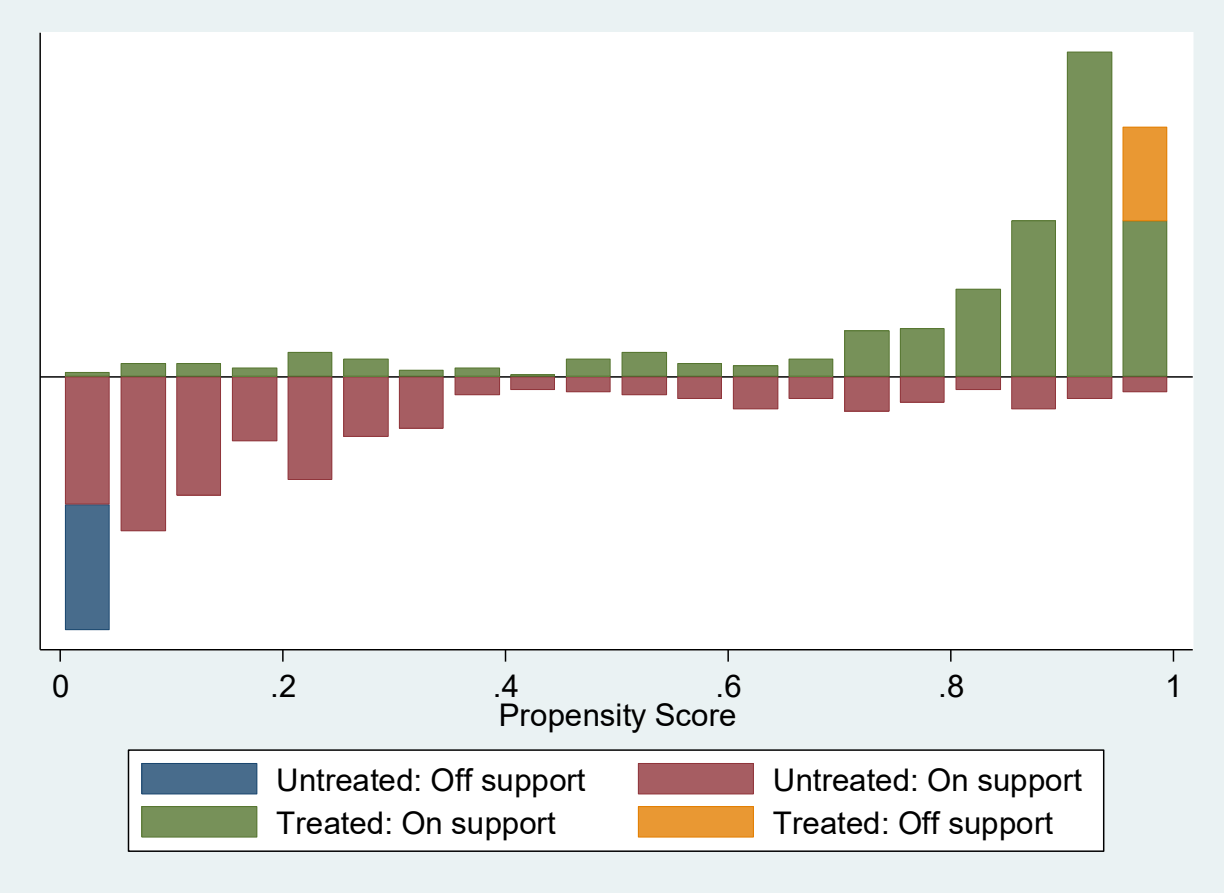
Average treatment effect of the treated of using biomass on ECD using PSM

Matching technique	Outcome	ATT	S.E	T	Treated	Controls
Radius	ECDI	-0.1399***	0.06	-5.50	521	326
Kernel	ECDI	-0.136***	0.65	2.13	521	326
Nearest Neighbor	ECDI	-0.0927***	0.056	2.01	521	326
Radius	Literacy numeracy	-0.08***	0.025	-4.58	521	326
Radius	Physical	-0.013***	0.004	-3.66	521	326
Radius	Socio-emotional	-0.12***	0.021	-2.62	521	326
Radius	Learning	-0.04***	0.012	-2.46	521	326
NN(5)	Literacy numeracy	-0.09***	0.033	-2.99	521	326
NN(5)	Physical	-0.02***	0.007	-3.03	521	326
NN(5)	Socio-emotional	-0.036***	0.028	-2.25	521	326
NN(5)	Learning	-0.106***	0.05	-1.98	521	326

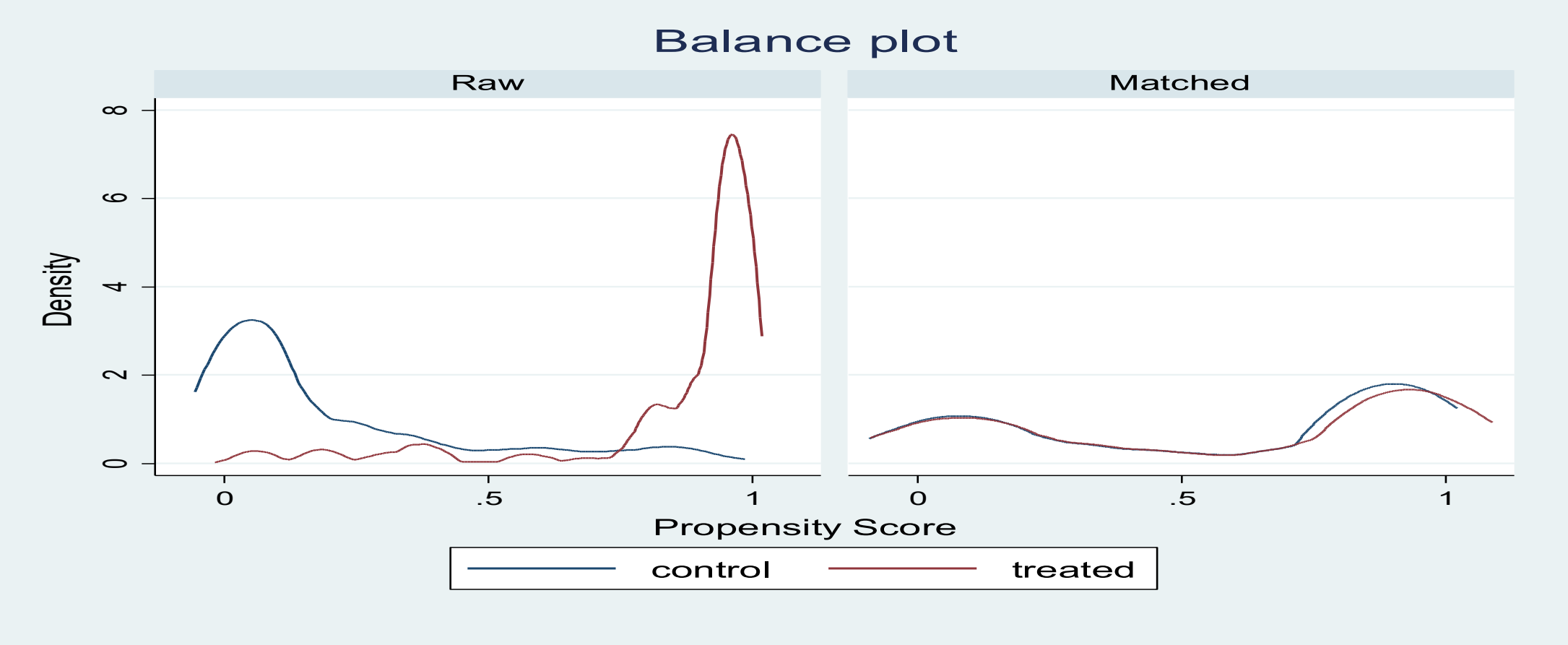
Balancing test before and after matching

Matching	Outcome	Mean bias before	Mean bias after matching	Bias reduction %	R-Square before matching	R-square after matching	Covariant's joint significance before matching	Covariants' joint significance after matching
Kernel	ECDI	91.1	6.7	85	0.53	0.012	0.000	0.297
Radius	ECDI	91	8.1	10	0.53	0.47	0.000	0.210
NN (1)	ECDI	91.1	8.2	93	0.538	0.025	0.000	0.209
NN (5)	ECDI	91.1	12.3	68	0.538	0.022	0.000	0.223
NN (10)	ECDI	91.1	7.0	92	0.538	0.008	0.000	0.593
NN(5)	Soci-emo.	91.1	12.36	85	0.53	0.012	0.000	0.423
NN(5)	Lit-num.	91.1	12.3	68	0.538	0.022	0.000	0.383
NN(5)	Phy.	91.1	12.3	68	0.530	0.022	0.000	0.623
NN(5)	learn	91.1	12.7	68	0.530	0.022	0.000	0.543

Common support



Comparison of propensity score before and after matching



Robustness analysis

Average treatment effect of the treated of using three stones stove on ECD using PSM

Matching technique	Outcome	ATT	S.E	T	Treated	Controls
Radius	ECD	-0.1067***	0.02	-3.56	500	347
Kernel	ECD	-0.106***	0.065	4.27	500	347
Nearest Neighbor	ECD	-0.0927	0.076	1.37	500	347

Average treatment effect of the treated of stratified for child age

Child age	Matching technique	Outcome	ATT	S.E	T	Treated	Controls
3 years	Radius	ECD	-0.097***	0.04	-2.99	252	168
	Kernel	ECD	-0.106***	0.055	-1.84	252	168
	Nearest Neighbor	ECD	-0.0912	0.043	2.10	252	168
4 years	Radius	ECD	-0.11	0.090	-1.96	248	179
	Kernel	ECD	-0.11	0.028	-2.64	248	179
	Nearest Neighbor	ECD	-0.11	0.028	-3.91	248	179

Average treatment effect of the treated of stratified for Mother education

Mothers education	Outcome	ATT	S.E	T	Treated	Controls
None- Primary incomplete						
Primary complete	ECD	-0.106***	0.065	-5.78	100	41
Junior secondary complete	ECD	-0.0727	0.036	1.98	124	67
Secondary	ECD	-0.095	0.035	-2.66	145	169
Senior Secondary						

Sensitivity to hidden bias MH bounds test

Gamma	Q_mh+	Q_mh-	p_mh+	p_mh-
1	2.82245	2.82245	0.002383	0.002383
1.05	3.07078	2.57924	0.001067	0.004951
1.1	3.30641	2.34606	0.000473	0.009487
1.15	3.53241	2.12388	0.000206	0.01684
1.2	3.74961	1.91167	0.000089	0.027959
1.25	3.95875	1.70857	0.000038	0.043765
1.3	4.16047	1.5138	0.000016	0.065039
1.35	4.35532	1.32668	6.60E-06	0.092308
1.4	4.54381	1.14661	2.80E-06	0.125771

Conclusion and policy recommendations

- Biomass adoption has a significant effect on early child development
- PSM model shows that the likelihood of child development being on track reduces significantly in case the child belongs to a household that consumes biomass fuel for cooking
- Identifying families without clean energy for cooking is crucial to achieving SDGs related to clean energy and child development.
- Provision of small gas tubes at affordable prices/subsidized should be accessible to poor households in rural areas
- We believe that even though these results were obtained using observational data, the selection bias was reduced, if not eliminated, by using the PSM method .

Thank you