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Leaving no one behind: A methodology to identify those furthest behind in Asia and the Pacific¹

Predrag Savić, Jonah Simonds, Ermina Sokou and Yichun Wang

Abstract: With the adoption of the 2030 Agenda for Sustainable Development, the United Nations Member States pledged to reduce inequality in all its forms through Sustainable Development Goal 10, while ensuring that “no one will be left behind.” This paper proposes a methodology that governments and stakeholders can use in their countries to measure inequality of opportunity, using data from nationally representative household surveys. The Dissimilarity Index (D-index) allows a comparison of inequality of opportunity levels among countries. The paper also proposes an innovative approach, the classification and regression tree (CART) analysis, to identify households and individuals furthest behind in access to basic opportunities in the Asia-Pacific region. Regression trees offer a practical way of operationalizing the pledge to leave no one behind (LNOB), accelerating national progress to achieve the Sustainable Development Goals (SDGs).

Key words: Inequality of opportunity, Asia and the Pacific, Leaving No One Behind

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¹ This paper is an update of an earlier version of the Working Paper (No. 2020/01) under the same title. It includes new indicators and improved explanations of the CART analysis methodology.



1. Introduction

Over the past decades, the Asia-Pacific region has made considerable strides in social development, driven by aggregate economic growth. This growth has generated new jobs, increased incomes, and improved overall levels of access to basic services and other opportunities. In several countries, more than 80 per cent of the extreme poor have been lifted out of poverty.

Despite this sustained economic development and substantial reductions in poverty, progress has disproportionately benefited the richest members of society, increasing inequalities between the rich and poor. In Asia and the Pacific, 223 million people are estimated to live below the extreme poverty line of \$1.90 a day and another 800 million people subsist on incomes above \$1.90, but below the moderate poverty level of \$3.20 a day.² An even larger number of people are deprived of basic services and opportunities. More than 3 out of 10 people in the region lack access to health care, and out-of-pocket expenditures for health care are among the highest in the world.³ About a quarter of the region's population lacks access to improved sanitation, while nearly two billion people still rely on unclean fuels for heating and cooking.

While data in the region are scarce, income inequality, as measured by the Gini index, appears to also be increasing in many countries.⁴ This increase has likely been exacerbated by the COVID-19 pandemic. While the consequences of the pandemic are not yet fully understood, informal workers have been the most affected by the crisis. The pandemic has also aggravated inequality in access to other opportunities, including education and health care.

High inequality not only stifles economic progress, but also negatively affects feelings of trust and social cohesion. It thus poses a formidable barrier to sustainable development.⁵ These rising levels of inequality within countries have sparked both public concern and political interest, and have contributed to a stand-alone goal on inequality reduction in the 2030 Agenda for Sustainable Development. Sustainable Development Goal (SDG) 10 to 'reduce inequalities within and among countries' is thus a core policy priority to ensure a sustainable and prosperous future for all.

Large and often increasing inequalities also exist in access to opportunities, such as in educational attainment, ownership of a bank account and access to clean fuels. For example, despite high enrolments, in one third of the countries in the Asia-Pacific region, attendance rates in secondary education for the poorest quintile remained below 30 per cent prior to the COVID-19 pandemic, with

² The Protection We Want: Social Outlook for Asia and the Pacific. 2021. Available at: <https://www.unescap.org/publications/protection-we-want-social-outlook-asia-and-pacific>

³ The Protection We Want: Social Outlook for Asia and the Pacific. 2021. Available at: <https://www.unescap.org/publications/protection-we-want-social-outlook-asia-and-pacific>

⁴ United Nations, Economic and Social Commission for Asia and the Pacific (ESCAP) (2021). SDG Goal 10 Profile, Asia-Pacific Forum for Sustainable Development. Available at: [INSERT LINK]

⁵ United Nations, Economic and Social Commission for Asia and the Pacific (ESCAP) (2017). Sustainable Social Development in Asia and the Pacific: Towards a People-Centred Transformation. Sales No. E.17.II.F.15.



four countries at 10 per cent or below. Meanwhile, attendance rates for children from the upper quintile in these countries was ordinarily as high as 80 per cent. This inequality of opportunity has sparked interest among policymakers and researchers, particularly as it is found to also perpetuate income inequality.

The goal of this working paper is to propose new methodological tools that will help the UN system and policymakers to better respond to these growing inequalities. Sections 2 and 3 of this paper define the concept of inequality of opportunity and explain its relevance to the 2030 Agenda for Sustainable Development. The following sections (4 and 5) describe the data and variables used to undertake the analysis, establishing concrete links with commitments in the 2030 Agenda.

Section 6 describes the new methodological tools in detail. Section 6.1 presents a methodology for measuring and understanding inequality of opportunity: the Dissimilarity Index (D-index). The D-index is a simple formula that determines inequality in accessing key services and opportunities. Governments can use this information to identify which opportunities are particularly unequally distributed. Section 6.2 presents an innovative and intuitive method to identify those furthest behind in each of these services or opportunities, taking into account intersectionality and multiple layers of disadvantage. Through the classification and regression tree (CART) analysis, researchers and policymakers can explore the circumstances shared by those most disadvantaged and the most advantaged groups in each country.

2. What is inequality of opportunity?

Income inequality is a long-standing concern across the developed and developing world, with academics, policymakers and civil society debating on its causes and consequences. Several schools of thought exist with regards to the best course of action for remedying the ills associated with high income inequality.⁶ Equality in access to opportunities, however, is a *sine qua non* for development. There is no dissenting opinion that people should be granted equality of opportunity, or equal access to basic services, to improve their socioeconomic trajectory.

The inequality literature distinguishes between inequality of **outcome** and inequality of **opportunity**. While the former depicts the consequences of unequally distributed income and wealth, inequality of opportunity is concerned with access to key dimensions necessary for decent quality of life. The philosophical foundations of this approach lie in the work of John Rawls⁷ and Amartya Sen⁸. Rawls was among the first modern political philosophers who articulated the importance of balancing personal liberties with distributive justice and fair options for all, arguing that public policy choices should focus on raising the welfare of the poorest people.⁹ Rawls argued that a set of ‘primary goods’ should be made

⁶ A brief but comprehensive literature review can be found in the IMF working paper: *Sharing the Growth Dividend: Analysis of Inequality in Asia*

⁷ Rawls, John. 1971. *A Theory of Justice*. Cambridge, MA: Harvard University Press

⁸ Sen, Amartya, and Geoffrey Hawthorne. 1985. *The Standard of Living* (Tanner Lectures in Human Values). Cambridge: Cambridge University Press.

⁹ Ravallion, Martin, 2016. *The Economics of Poverty*. Oxford University Press.



available for everyone, so that she or he would be able to realize their ‘life plan’. Sen, later, argued that inequality could be re-examined from the perspective of human capability, looking at the ‘means’ rather than the ‘ends’ of development. Without equal opportunity, equitable outcomes cannot be secured.

A more complete theoretical framework for understanding and analysing inequality of opportunity has since then been developed. John Roemer refers to inequality of opportunity as the portion of inequality of outcome that can be credited to differences in ‘individual circumstances.’¹⁰

Inequality of opportunity is reflected in the 2030 Agenda’s vision of a “just, equitable, tolerant, open and socially inclusive world in which the needs of the most vulnerable are met.” Target 10.3 of SDG 10 calls for ensuring equal opportunity and reducing inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action. Target 10.3, however, is not the only one in the 2030 Agenda that relates to inequality of opportunity. Several other SDGs call for universal access to key services, such as education, health care, clean water and sanitation, among others, thus reflecting a call for equality of opportunity. The indicators used in this paper draw on targets beyond SDG 10 (Table 2).

Focusing on inequality of opportunity also serves as a reminder that inequality is not a static phenomenon. Inequality of outcome among parents is also transmitted to their children, creating inequality of opportunity for the next generation. A parent’s outcomes in terms of education and health will impact upon their children’s circumstances, sustaining income or wealth inequality across generations.¹¹ Inequality of opportunity thus represents a critical challenge for the goal of sustainable development that improves welfare for all.

3. LNOB in the context of the 2030 Agenda

To eliminate inequality of opportunity, the 2030 Agenda takes an ambitious yet pragmatic approach, stressing that no one should be left behind in any of its Goals - and that the furthest behind should become the focus of policymaking. It states:

“As we embark on this great collective journey, we pledge that no one will be left behind. Recognizing that the dignity of the human person is fundamental, we wish to see the Goals and targets met for all nations and peoples and for all segments of society. And we will endeavour to reach the furthest behind first.” (Paragraph 4)

Member States have also explicitly called on the United Nations and its agencies, funds and programmes to implement the Leave No One Behind (LNOB) pledge. The United Nations system has responded by integrating the LNOB pledge into its core programming. The United Nations System Shared Framework for Action calls for “greater data disaggregation across a wider range of grounds for all SDG indicators; systematic analysis of available (disaggregated) data on marginalized groups; new

¹⁰ Roemer, John E. 1998. *Equality of Opportunity*. Cambridge, MA: Harvard University Press.

¹¹ The World Bank, Berlin Workshop Series, 2006. *Equity and Development*. Available online at: <https://openknowledge.worldbank.org/handle/10986/6964>



tools for analyzing horizontal and vertical inequalities, as well as discrimination, stigma, exclusion, and equity issues; identification of subjects of multiple and intersecting forms of discrimination; joined-up analysis of the drivers, root causes and underlying determinants of inequalities and discrimination.”¹²

Further, the UN Sustainable Development Cooperation Framework (previously the UN Development Assistance Framework) places the pledge to *leave no one behind* at the core of its four principles for unifying programming and advocacy, requiring all UN entities “to prioritize its programmatic interventions to address the situation of those most marginalized, discriminated against and excluded, and to empower them as active agents of development.”¹³ The methodology presented here is of thus of direct use for generating knowledge on this topic, corresponding to Steps 1, 4 and 5 of the five-step methodology developed by the UNSDG Operational Guide for UN Country Teams, assisting Member States in operationalizing the pledge to Leave No One Behind (LNOB) and reach the furthest behind first.¹⁴

4. The data

In practice, leaving no one behind means moving beyond assessing average and aggregate progress, towards ensuring progress for all population groups at a disaggregated level. This requires disaggregating data to identify groups being excluded or discriminated against, as well those experiencing multiple and intersecting forms of discrimination and inequalities.

The methodological tools presented in this paper (D-Index in section 6.1 and the CART analysis in section 6.2) use the Demographic and Health Surveys (DHS) and the Multiple Indicator Cluster Surveys (MICS). DHS and MICS are publicly available for 29 Asian and Pacific countries. The datasets are selected because of a) comparability across countries; b) accessibility of the data; and c) the rich set of questions on health, demographic and basic socioeconomic data that refer both to the household (e.g. water and sanitation, financial inclusion, electricity and clean fuels, as well as ownership of mobile phones/bank cards) and to individuals (e.g. level of education, nutrition status, access to basic healthcare services for children, household head, other household members.) 23 countries have surveys representing two or more different points in time. The full list of 29 countries and survey years (latest) is provided in Table 1.

Despite their many advantages, DHS and MICS also have shortcomings. For example, because some questions are answered at the household level, they do not allow for calculation of sex-disaggregated data at the household level. Furthermore, men are not always asked the same sets of questions as women. Lastly, the surveys do not capture people least likely to be counted and reflected in national

¹² Leaving No One Behind: Equality and Non-Discrimination at the Heart of Sustainable Development, The United Nations System Shared Framework for Action: <https://www.unsystem.org/CEBPublicFiles/CEB%20equality%20framework-A4-web-rev3.pdf>

¹³ United Nations Development Assistance Framework Guidance, https://unsdg.un.org/sites/default/files/2017-UNDAF_Guidance_01-May-2017.pdf

¹⁴ Leaving No One Behind: A UNSDG Operational Guide for UN Country Teams (Interim Draft), <https://unsdg.un.org/resources/leaving-no-one-behind-unsdg-operational-guide-un-country-teams-interim-draft>



statistics, such as the homeless, slum dwellers, irregular migrants, nomadic or displaced populations, stateless persons, criminalized populations (e.g., people who use drugs, sex workers) and people in temporary shelters or institutions.

Table 1: List of countries and survey years

	Country	Latest Year	Latest Survey	Multiple Surveys
1	Afghanistan	2015	DHS	Yes
2	Armenia	2016	DHS	Yes
3	Azerbaijan	2006	DHS	Yes
4	Bangladesh	2019	DHS	Yes
5	Bhutan	2010	MICS	No
6	Cambodia	2014	DHS	Yes
7	Georgia	2018	MICS	No
8	India	2016	DHS	Yes
9	Indonesia	2017	DHS	Yes
10	Kazakhstan	2015	MICS	Yes
11	Kiribati	2019	MICS	No
12	Kyrgyzstan	2018	MICS	Yes
13	Lao People's Democratic Republic	2018	MICS	Yes
14	Maldives	2017	DHS	No
15	Mongolia	2018	MICS	Yes
16	Myanmar	2016	MICS	Yes
17	Nepal	2016	DHS	Yes
18	Pakistan	2018	DHS	Yes
19	Papua New Guinea	2018	DHS	No
20	Philippines	2017	DHS	Yes
21	Tajikistan	2017	DHS	Yes



22	Thailand	2019	MICS	Yes
23	Timor-Leste	2016	DHS	Yes
24	Tonga	2019	MICS	No
25	Turkmenistan	2019	MICS	Yes
26	Turkey	2013	DHS	Yes
27	Uzbekistan	2006	MICS	Yes
28	Vanuatu	2007	MICS	No
29	Viet Nam	2014	MICS	Yes

5. Basic opportunities

5.1. The indicators

The indicators measuring household and individual opportunities have been identified as areas where inequality jeopardizes a person's life prospects. Each of these opportunities is covered by specific commitments outlined in the 2030 Agenda for Sustainable Development.

The indicators used to uncover inequality of opportunity can be divided into two groups: opportunities and barriers. Opportunities encompass 11 indicators covering secondary and higher education, early childhood education, women's health (professional help during childbirth and use of modern contraceptive methods), basic drinking water, basic sanitation facilities, electricity, clean fuels, bank account ownership, and access to the Internet. For opportunities, higher access is preferential. Barriers, for which lower prevalence is preferential, include 5 indicators covering children's anthropometric measurements (stunting, overweight and wasting) and violence against women (attitudes towards violence against women as well as physical, sexual, or emotional violence experienced by women over the past 12 months). Taken together, these 16 indicators represent a core analysis that can be used to assess inequality of opportunity in the context of the 2030 Agenda for Sustainable Development.

In addition to the core analysis, auxiliary indicators can be constructed either by augmenting core indicators or through analysis of newly available data. For example, in response to the COVID-19 pandemic, an auxiliary indicator was constructed, measuring an individual's ability to protect themselves from infection (Table 3). This auxiliary indicator is an example of how this methodology can be adapted to better understand inequality of opportunity in the context of future or otherwise unforeseen challenges.

As reported by the Interagency Group on SDG Indicators (IAEG-SDGs), the connection between the core indicators and the Sustainable Development Goals (SDGs) was the main criterion for their selection.¹⁵ (Table 2)

Table 2: The links between opportunities and the SDGs

Indicators		Closest SDG indicator reference	
Opportunities	1	Secondary education	4.1.2 Completion rate (primary education, lower secondary education, upper secondary education)
	2	Higher education	4.3.1 Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex
	3	Early childhood education	4.2.2 Participation rate in organized learning (one year before the official primary entry age), by sex
	4	Demand for modern contraceptive met	3.7.1 Proportion of women aged 15-49 years who have their need for family planning satisfied with modern methods
	5	Skilled birth attendance	3.1.2 Proportion of births attended by skilled health personnel
	6	Basic drinking water	1.4.1 Use of drinking water from an improved source that is available with a collection time of not more than 30 minutes for a round trip, including queuing
	7	Basic sanitation services	1.4.1 Use of improved facilities that are not shared with other households
	8	Access to electricity	7.1.1 Proportion of population with access to electricity
	9	Use of clean fuels	7.1.2 Proportion of population with primary reliance on clean fuels and technology
	10	Bank account ownership	8.10.2 Proportion of adults (15 years and older) with an account at a bank or other financial institution or with a mobile money-service provider
	11	Internet use	17.8.1 Proportion of individuals using the internet
Barriers	12	Stunting in children under 5 years of age	2.2.1 Prevalence of stunting (height for age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age

¹⁵ The latest indicators to be used for monitoring the SDGs can be found at: <https://unstats.un.org/sdgs/iaeg-sdgs/>.



	13	Overweight in children under 5 years of age	2.2.2 Prevalence of malnutrition (weight for height $>+2$ or <-2 standard deviation from the median of the WHO Child Growth Standards) among children under 5 years of age, by type (wasting and overweight)
	14	Wasting in children under 5 years of age	2.2.2 Prevalence of malnutrition (weight for height $>+2$ or <-2 standard deviation from the median of the WHO Child Growth Standards) among children under 5 years of age, by type (wasting and overweight)
	15	Sexual, physical or emotional violence against women (DHS)	5.2.1 Proportion of ever-partnered women and girls aged 15 years and older subjected to physical, sexual or psychological violence by a current or former intimate partner in the previous 12 months, by form of violence and by age
	16	Violence against women justified (MICS)	5.2.1 Proportion of ever-partnered women and girls aged 15 years and older subjected to physical, sexual or psychological violence by a current or former intimate partner in the previous 12 months, by form of violence and by age
Auxilliary	17	Protection against COVID-19	This indicator is a composite including: access to information (via mobile phone ownership or access to TV, radio, or the Internet); access to preventative measures (including access to clean water, handwashing, and a private toilet); and social distancing at home (measured by the density of people per sleeping room at home, excluding children under 2 years).

The exact questions from DHS and MICS questionnaires with a brief description can be found in Table 3.



Table 3: Survey questions from DHS/MICS for each indicator and their description

Indicator	Variable name	Survey Question (in DHS/ MICS)	Description	Survey Recode
Secondary education	DHS: HV109 MICS: ED4A, ED4B	What is the highest level of school you attended: primary, secondary, or higher?	Definition adjusted for each country, see Annex	PR
Higher education	DHS: HV109 MICS: ED4A, ED4B	What is the highest level of school you attended: primary, secondary, or higher?	Definition adjusted for each country, see Annex	PR
Early childhood education	MICS: EC5 /UB6	Has (the child) ever attended kindergarten or any alternative ECE programme?	For age 36-59 months old	CH
Demand for modern contraceptive met	DHS: V313 MICS: CP2, CP3A, CP3B, CP3C, CP3D, CP3E, CP3F, CP3G, CP3H, CP3I, CP3J, CP3K	What are you doing/which method are you using to delay or avoid a pregnancy?	Modern contraceptive methods include pills, UID, foam, condom, etc.	IR
Skilled birth attendance	DHS: M3A, M3B, M3C, M3D, M3E, M3F MICS: MN17A, MN17B, MN17C, MN17D, MN17E, MN17I, MN17J, MN17K	Who assisted with the delivery of (name)?	Skilled birth attendants include doctors, nurses, and midwives	IR
Basic drinking water	DHS: HV201 MICS (4&5): WS1	What is the main source of drinking water for members of your household?	Improved sources include: piped water, boreholes or tube wells, protected dug wells, protected springs, and packaged or delivered water. The collection time is no more than 30 minutes for a round trip, including queuing.	HH
Basic sanitation	DHS: HV205, HV225 MICS (4&5): WS8, WS9	What kind of toilet facility do members of your household usually use?	Improved facilities include: flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, composting toilets or pit latrines with slabs. Facilities are not shared with other households.	HH
Access to electricity	DHS: HV206 MICS: HC8A	Does your household have electricity?		HH
Access to clean fuels	DHS: HV226 MICS: HC6	What type of fuel/energy does your household mainly use for cooking?	Clean fuel includes natural fuel (e.g. compressed natural gas or liquified petroleum gas) or a blend (e.g. gasohol) used as a substitute for fossil fuels and which produces less pollution than the alternatives	HH
Bank account ownership	DHS: HV247 MICS: HC15	Does any member of this household have a bank account?		HH/IR
Stunting in children	DHS: HC70 MICS: HAZ	Height in centimeters for children age 0-5	If the height of the child is two standard deviations below the average of children	PR



Indicator	Variable name	Survey Question (in DHS/ MICS)	Description	Survey Recode
under 5 years of age			of the same age, he/she is considered stunted	
Overweight in children under 5 years of age	DHS: HC71 MICS: WAZ	Weight in kilograms and height in centimeters for children age 0-5	If the ratio of the weight over height of the child is more than two standard deviations of the average of children of the same age, he/she is considered overweight	PR
Wasting in children under 5 years of age	DHS: HC72 MICS: WHZ	Weight in kilograms and height in centimeters for children age 0-5	If the ratio of the weight over height of the child is below two standard deviations of the average of children of the same age, he/she is considered wasted	PR
Sexual, physical or emotional violence against women	DHS: D104, D106, D107, D108 (sample weight: D005, selected for the module: V044)	Ever experienced emotional, sexual or physical violence by partner.	This indicator is presented in 5 different combinations for the analysis: Physical violence; Sexual violence; Physical or sexual violence; Emotional violence; Physical, sexual or emotional violence.	IR
Violence against women justified	MICS: DV1A, DV1B, DV1C, DV1D, DV1E, DV1F	Sometimes a husband is annoyed or angered by things that his wife does. In your opinion, is a husband justified in hitting or beating his wife in the following situations: [A] If she goes out without telling him? [B] If she neglects the children? [C] If she argues with him? [D] If she refuses to have sex with him? [E] If she prepares burns the food?		WM
Protection against COVID-19	DHS:HV207, HV208, HV221, HV243A, HV201, HV204, HV230A, HV216, HV009, HV230B, HV232, HV232C, HV232D, HV232E, HV205, HV225 MICS: HC13, HC7B, HC9A, HC7A, HC12, HW7A, HW1, HW2, HW3, HW7A, HW7B, WS1, WS4, WS3, WS11, WS15, HH48, HC3	A person has minimum protection against COVID-19 if he/she has a device to access information (radio, phone, internet, TV), lives in a house that is not overcrowded (no more than 2 people per bedroom), has water on site, has improved sanitation, has handwash facility at home.	ESCAP-defined Index defined as follows: the individual has access to the internet, TV, phone, mobile phone or radio; lives in a household with water pipes into the dwelling or yard or other private water source; and with a handwashing facility on premises with soap and water available; there are no more than 2 people per sleeping room in the household; and lives in a household that has a toilet which is not shared with other households.	PR/HL, HR



5.2. The determinant factors (*circumstances*)

Inequality of opportunity in recent literature has been used to denote the extent of inequality of outcome (income or consumption) that can be attributed to circumstances over which individuals have no control, such as race and sex, as opposed to effort. In literature, this analysis is usually conducted through linear regression analysis, where the identified circumstances explain a share of the inequality of outcome. The inequality of opportunity resulting from this regression (the share of inequality that can be explained by these circumstances) is usually understood to be the lower bound of the total (unobserved) inequality of opportunity since available datasets cannot and do not include all possible circumstances that may impact outcomes. This approach to measuring inequality of opportunity is deemed to be ‘indirect’.

Given that the DHS and MICS datasets do not include information on income or consumption (both classified as outcomes), the approach proposed in this paper does not include such linear regressions. Future analysis could use the wealth index of the DHS and MICS as a proxy of an ‘outcome’ and regress it against the set of circumstances used in these reports.

A more ‘direct’ approach, used here, is to identify a set of ‘opportunities’ and to measure the gaps among groups in access to these opportunities. To do so, a set of ‘circumstances’ is selected from available variables in the DHS and MICS datasets to define the groups. These circumstances are usually a set of conditions that the individuals or the households have little control over.

The selection of variables is consistent across all surveys to maintain comparability across countries. These circumstances (determinant factors) also define the composition of the groups, whose access to opportunities is measured. For example, rural women is one of the possible groups created when considering the circumstances residence and sex. However, circumstances should not be interpreted as ‘causes’ of inequality, but rather correlates. Furthermore, there are many other factors that these models cannot consider, given the limited variables available in the datasets.

Ideally, it would have been preferred to include only circumstances over which a household member had almost no control, such as dominant religion in a household where a respondent is born, ethnicity, existence of a disability, or the education of the mother or father of the respondent. The majority of the DHS did not include these questions. MICS do ask questions related to ethnicity, language and religion.¹⁶ The most recent MICS also include questions on prevalence of a functioning disability, following the Washington Group questions. In the cases where these questions were included, the analysis can be repeated using these additional determinant factors. Additional potentially useful factors that could have been of interest for the study are geographical variables, such as province or region of a given country, but that would affect comparability across countries. These geographic variables can be included in custom analyses focusing specifically on one country only.

¹⁶ More recent MICS and DHS datasets started including more questions on disability, migration status, etc.

Table 4: Circumstances used to determine groups, per indicator

Opportunities / Barriers			Circumstances used to determine groups furthest behind/ ahead					
No.	Indicators	Reference group survey in	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
1	Secondary (upper) education completion	Household member age 20-35	Wealth	Residence	n/a	Woman/ Man	n/a	n/a
2	Higher education attendance (ever)	Household member age 25-35	Wealth	Residence	n/a	Woman/ Man	n/a	n/a
3	Early childhood education attendance (now)	Child aged 2-5 or 3-5	Wealth	Residence	Mother's education	Boy/ Girl	n/a	n/a
3	Demand for modern contraception met	Women between 15-49 currently in union	Wealth	Residence	Responder's education	n/a	Number of children <5	Age: 15-24, 25-34, 35-49
4	Skilled birth attendance	Women between 15-49 ever given birth in the last 5 years	Wealth	Residence	Responder's education	n/a	Number of children <5	Age: 15-24, 25-34, 35-49
5	Basic drinking water	All households	Wealth	Residence	Highest education in household	n/a	n/a	n/a
6	Basic sanitation services	All households	Wealth	Residence	Highest education in household	n/a	n/a	n/a
7	Access to electricity	All households	Wealth	Residence	Highest education in household	n/a	n/a	n/a
8	Access to clean fuels	All households	Wealth	Residence	Highest education in household	n/a	n/a	n/a
9	Bank account ownership	All households/ Household member	Wealth	Residence	Highest education in household	n/a	n/a	n/a
10	Internet use	All households/ Household member	Wealth	Residence	Highest education in household	n/a	n/a	n/a
11	Stunting in children under 5 years of age	Child aged 0-5 who has been measured	Wealth	Residence	Mother's education	Boy/ Girl	Number of children	n/a



Opportunities / Barriers			Circumstances used to determine groups furthest behind/ ahead					
No.	Indicators	Reference group survey in	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
							<5 years of age	
12	Overweight in children under 5 years of age	Child aged 0-5 who has been measured	Wealth	Residence	Mother's education	Boy/ Girl	Number of children <5 years of age	n/a
13	Wasting in children under 5 years of age	Child aged 0-5 who has been measured	Wealth	Residence	Mother's education	Boy/ Girl	Number of children <5 years of age	n/a
14	Sexual, physical or emotional violence against women	Ever married woman	Wealth	Residence	Respondee's education	Only Woman	Number of children >5 years of age	Age group: 15-24, 25-34, 35-49
15	Violence against women justified	Ever married woman	Wealth	Residence	Respondee's education	Only Woman	Number of children >5 years of age	Age group: 15-24, 25-34, 35-49
16	Protection against COVID-19	All individuals	Wealth	Residence	Respondee's education	Male/ Female	n/a	Age group: 15-24, 25-60, 60+

6. A set of practical tools

6.1. Dissimilarity Index (D-Index)

In order to assess how countries are faring in terms of inequality of opportunity, the analysis uses the Dissimilarity Index, or the D-index, a measure of how unequally access to an opportunity is distributed among population groups.

The Dissimilarity Index (D-Index) measures how different groups - such as women, poorer households, or ethnic minorities - fare in terms of access to a certain opportunity. Like the Gini coefficient, the D-Index ranges from 0 to 1, where 0 indicates no inequality, and 1 that the entire access to a service is reserved to a specific group of people with shared circumstances (e.g. men from urban areas). For

example, two countries that have identical average access rates may have a different D-Index if the distribution of the opportunity in one country excludes certain groups (such as females, poorer groups, or ethnic minorities).

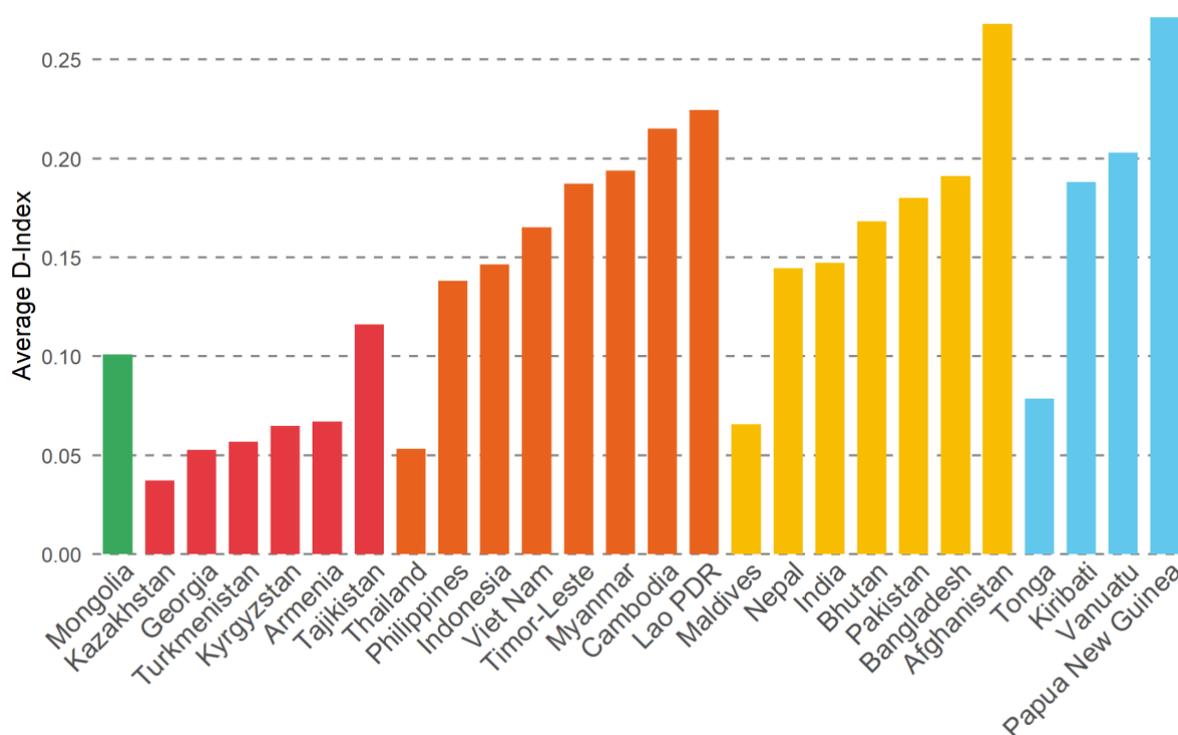
To obtain the D-Index, inequalities in access among all possible groups generated by circumstances variables are calculated using the formula below:

$$D = \frac{1}{2\bar{p}} \sum_{i=1}^n \beta_i |p_i - \bar{p}|$$

where β_i is the weighted sampling proportion of the group i , (sum of β_i equals 1), \bar{p} is the average access rate in the country and p_i is the level of access of population group i , and takes values from 0 to 1. There are n groups, which are defined using the interactions of the circumstances selected for the analysis.

In the case of an opportunity where three circumstances were considered: wealth (2 groups), residence (2 groups) and education (4 groups), covering the entire sample population, this calculation produces 16 groups (2x2x4). The interactions between these groups form each population group i and are used to calculate the D-index. This index is therefore a weighted average of the absolute difference of most and least advantaged population groups from the average access rate in the country (\bar{p}).

Figure 1: Average D-indices in Asia-Pacific countries, grouped by subregion



Source: ESCAP calculations using data for all available indicators from the latest DHS and MICS surveys for countries in Asia-Pacific.



Note: ESCAP subregions are: East and North-East Asia (ENEA), North and Central Asia (NCA), South-East Asia (SEA), and South and South-West Asia (SSWA), and Pacific.

Averaging the D-indices for individuals and households by country highlights which countries have relatively higher inequality across all opportunities (Figure 1). The highest D-indices are found in the Pacific, followed closely by countries in South-East Asia and South and South-West Asia. Afghanistan and Papua New Guinea appear as particularly unequal across the board of opportunities, with average D-indices above 0.25. At the other end of the scale, Maldives, Thailand, and Tonga, together with several North and Central Asian countries seem to have achieved a relatively equal distribution of opportunities across various population groups for most opportunities. The subregion of North and Central-Asia stands out as the most equal in terms of access to opportunities, thanks to a tradition of a large state that ensures universal provision of basic services. In the middle of the distribution are some of the region’s most rapidly developing countries, including India, Indonesia, Philippines and Viet Nam.

6.2. The classification and regression tree (CART) methodology

Knowing that inequality of opportunity is broadly associated with specific circumstances opens the door to deeper exploration of the data, to see exactly which groups are the most marginalized and which groups have benefitted most from development. Identifying these groups could help policymakers better focus policy and programmes to tackle inequality of opportunity.

The primary goal of using classification and regression tree (CART) analysis is therefore to identify the groups with the lowest and highest access to the opportunities, using the selected indicators. The indicators used are the response variables, while the factors that characterize these groups are the explanatory variables, also referred to as “circumstances”.¹⁷ A tree is an analytical structure that represents groups of the sample population that have significantly different response values, or different levels of access to a certain opportunity or prevalence of a certain barrier.

To identify the groups with the greatest difference in access to an opportunity, a regression tree is constructed for each country using R, an open-source statistical software. The root node of the tree refers to the entire population sample. The tree method algorithm starts by searching for the first split (or “partition”) of the tree. It does so by looking at each circumstance and separating the sample in two groups, so that it best satisfies a certain “splitting criterion.” This splitting criterion can be defined in a few ways, while the one used here is the Analysis of Variance, or “ANOVA.” The formula that represents the core of the algorithm is the following:

$$SS_T = (SS_L + SS_R)$$

¹⁷ Within the field of machine learning, response and explanatory variables are more commonly referred to as target and input attributes, respectively.



Where $SS_T = \sum (y_i - \underline{y})^2$ is the sum of squares for the parent node, and SS_L and SS_R are the sums of squares for the left and right child nodes, respectively.¹⁸ The sum of squares is calculated by first finding the distance between \underline{y} , the sample mean, and the i th data point y_i . This is also referred to as the deviation. If deviations for all data points y_1, y_2, \dots, y_i are squared and then summed, as in $\sum (y_i - \underline{y})^2$, this yields the sum of squares for these data. This is equivalent to choosing the split to maximize the between-groups sum of squares in a simple analysis of variance.

The CART algorithm applies this ANOVA test to each possible split, or partition, of the sample population given by the circumstances identified in Table 4. After comparing all of the available partitions, the algorithm is able to identify the single partition that would decrease variance the most for the combined sum of squares of the child nodes compared to the parent node. This is how CART uses ANOVA to identify the best possible split for each node down the tree.

In the example of access to professional help during childbirth, SS_T would describe the variance in the sum of squares for the average access to professional help during childbirth. The possible partitions of this sample, resulting in SS_L and SS_R , would include the responder's wealth, residence, education, age, and number of children under 5 (see Table 4). Within the parameters of CART, all partitions are binary; among circumstances with multiple split thresholds, such as age, each possible combination of age groupings is considered (for example, 15-24 and 35+ could be a single cohort assigned to one of the child nodes, with 25-34 assigned to the other). This means the resultant child nodes associated with SS_L and SS_R are mutually exclusive and complementary, and every woman who has recently given birth belongs to one and only one of the child nodes for each partition of the tree generation.

The actual algorithm that generates the child nodes for each partition works step-by-step, starting from the entire sample (where T given by SS_T is the root node). Each time the sample is partitioned, new child nodes are generated and the ANOVA is calculated and compared to the ANOVA before the new partition. This stepwise process of building nodes and branches of a tree is also known as “recursive partitioning.” Each partition (and hence the new pair of child nodes) is kept when the decrease of variance exceeds a preset threshold also known as a “complexity parameter.” When the best available partition fails to satisfy the complexity parameter, or a set of other preset conditions can't be satisfied, the algorithm ceases to make additional partitions. The nodes that could not be further partitioned are henceforth referred to as “terminal nodes.”

In addition to finding groups that have significant differences in their access to an opportunity, the CART algorithm, as applied to identify the furthest behind, requires that each group should have enough group members. To avoid a too small sub-sample size, the analysis ceases to make additional partitions if the resultant child nodes would fail to contain either 9 per cent of the total sample population or an absolute value of 49 survey respondents. The analysis is also limited to 6 levels of nodes (encompassing

¹⁸ Therneau, Terry, and Elizabeth Atkinson. 2019. “An Introduction to Recursive Partitioning Using the RPART Routines.” Mayo Foundation. Available at: <https://cran.rproject.org/web/packages/rpart/vignettes/longintro.pdf>

5 partitions), as additional partitions past that point have diminishing returns for the purpose of identifying population groups experiencing inequality of opportunity.

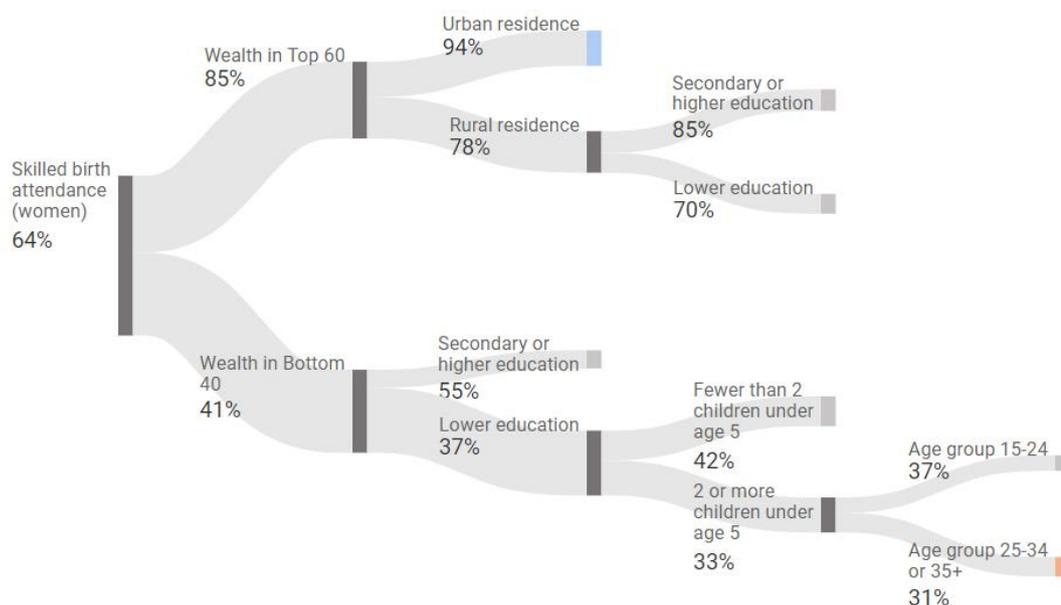
An example: To illustrate how the classification tree identifies the most disadvantaged or advantaged groups, the example of access to professional help during childbirth in Lao People’s Democratic Republic is used.

Indicator (‘target attribute’): Access to professional help during childbirth in Lao People’s Democratic Republic

Circumstances (‘input attributes’): The circumstances being considered are the following:

1. Household wealth (Bottom 40 - Top 60),
2. Residence (Rural – Urban)
3. Education (Lower – Secondary - Higher)
4. Sex (Male – Female)
5. Number of children aged less than 5
6. Age: 15-24, 25-34, 35-49
7. Marital Status (Single – Currently/Formerly married or in a union)

Figure 2: Classification tree highlighting differences in women’s access to professional help in childbirth in Lao People’s Democratic Republic, 2017 (women 15-49 years of age)



Source: ESCAP calculations, using data from the latest DHS and MICS surveys for countries in Asia-Pacific.



The classification tree starts at the average access rate of 64 per cent. This means that among all women surveyed in Lao PDR in 2017 who had recently given birth, 64 per cent had access to a doctor, nurse, or midwife during childbirth. The algorithm determines that the first split into branches should be wealth, specifically where in the wealth distribution a woman belongs: the top 60 per cent or the bottom 40 per cent. Women belonging to the top 60 per cent group have 85 per cent access rate to professional help in childbirth, compared with only 41 per cent for those in the bottom 40 group.

In the same example, the algorithm determines a second split for the less advantaged (bottom 40 group) around the level of education the woman has received. For the relatively small group of women in the bottom 40 per cent of wealth who also have secondary or higher education, 55 per cent had access to skilled birth attendance, while for those with lower education, the rate of skilled birth attendance falls to 37 per cent. Among this less educated group, another split is made based on the number of children under 5 years – those with only one child have higher access to skilled birth attendance (42 per cent) than those with 2 or more children (33 per cent). A final split is made – by age – for the group of women with 2 or more children. Women aged 15-24 have an access rate of 37 per cent, compared to 31 per cent for women aged 25 or older. This group – women aged 25 or older, with 2 or more children, lower education, and in the bottom 40 per cent of wealth – is the group of women that are furthest behind in access to professional help at childbirth in Lao PDR in 2017.

The group with the highest access to professional help in childbirth is women living in urban areas who also are part of the top 60 of the wealth distribution. They have an access rate of 94 per cent and represent around 22 per cent of Laotian women who have given birth in the past five years. Conversely, only three in ten women in the bottom 40 group with lower education, two or more children under 5 years of age, and aged 25 and older have access to professional help during childbirth. The total gap between the groups with the highest and the lowest access is a staggering 63 percentage points.

The uniqueness of the classification and regression tree (CART) approach is that it becomes very clear where policies should, or should not, be focused to reach those furthest behind and close existing gaps in equality of opportunity

7. Gaps and limitations

The methodologies presented in this short paper have several advantages, but also some limitations:

Firstly, the available datasets (DHS and MICS) limit the scope of the analysis to only those indicators for which data are collected. In reality, there are many variables shaping access to different opportunities. For example, the quality and reliability of a water connection is an important factor that might affect the access to basic drinking water. Similarly, distance from a healthcare provider is an important circumstance that might shape a women's access to skilled birth attendance. These variables are not measured in most DHS and MICS surveys, so results have to be understood with this caveat.

Consistent with similar studies on inequalities among groups, this analysis also does not consider inequality within groups. Even with homogeneous groups (e.g. women from poorer households and with lower education), additional unobserved circumstances affect outcomes. This analysis only



calculates the observable average access to an opportunity for each group, and thus draw conclusions on gaps and inequality based in these averages.

For assessing completion of secondary and higher education, the sample has been restricted to those 20-35 (for secondary education) and 25-35 (for higher education). The reason is to avoid: (1) skewing the results because of an older population with significantly lower education levels; and (2) including individuals that, because of their young age, could not have completed their education.

An important limitation is the lack of information on income of individuals or households, as it is not collected by DHS and MICS. Instead, the analysis uses the wealth index, a composite index reflecting a household's cumulative living standard, developed by the DHS and MICS researchers. The wealth index combines a range of household circumstances including: a) ownership of household assets, such as TVs, radios and bicycles; b) materials used for housing; and c) type of water and sanitation facilities. The wealth index is calculated using the Principal Component Analysis and thus allows a relative ranking of households based on their assets.¹⁹ The wealth index is not comparable across countries, as it may consist of different assets in each country. As a result, any cross-country comparison of household access based on “wealth” should be understood with that caveat.

Finally, the results are limited by available indicators. The classification and regression tree (CART) analysis only presents circumstances in the tree branches if they are found to satisfy the splitting criterion. Ultimately, these circumstances define the composition of the groups, but should not be interpreted as “causes” of a lower access. There are also many other factors that could potentially impact the analysis, but because of the limitation of the datasets, have not been included.

¹⁹ Wealth Index Construction, <https://www.dhsprogram.com/topics/wealth-index/Wealth-Index-Construction.cfm>

Annex: Education variable per country

Survey	Type	Country	Year	Higher Education	Completed secondary education	Details
MICS	Household member	Afghanistan	2010	Higher	Secondary	Secondary (grade>=12)
DHS	Individual	Afghanistan	2015		Completed secondary	Completed grade 12 at the secondary level
DHS	Individual	Armenia	2010		Completed secondary	Completed grade 12 at the secondary level or completed grade 10 or grade 11 at the secondary level and has a secondary school diploma/attestat
DHS	Individual	Armenia	2015-2016		Completed secondary	Completed grade 12 or completed more than 9 years of schooling and has a secondary school attesta
MICS	Household member	Bangladesh	2019	Higher	Secondary/Higher secondary	Secondary/Higher Secondary (grade >=12)
MICS	Household member	Bhutan	2010	College/University	Higher secondary	Higher secondary (grade>=12)
DHS	Individual	Cambodia	2010		Completed secondary	Completed grade 12 at the secondary level
DHS	Individual	Cambodia	2014		Completed secondary	Completed grade 12 at the secondary level
MICS	Household member	Georgia	2018	Higher	Upper secondary, Vocational education on the base of upper secondary education	Grade 12
DHS	Individual	India	2015-2016			
DHS	Individual	Indonesia	2012		Completed secondary	Completed 6th grade at the secondary level
DHS	Individual	Indonesia	2017		Completed secondary	Completed 6th grade at the secondary level
MICS	Household member	Kazakhstan	2010	Higher	Secondary, Secondary specialised	Secondary (grade>=6) Secondary specialised (grade >=3)
eMICS	Household member	Kazakhstan	2015	Higher	Upper secondary, Technical and Professional	Upper secondary (10-11) (grade >=10)
MICS	Household member	Kiribati	2019	Higher	Senior secondary, Vocational	Senior secondary (grade>=7)
DHS	Individual	Kyrgyzstan	2012		Completed secondary	Completed grade 11 at the secondary level or completed grade 10 at the secondary level and has a general education school diploma ("attestat" in the old Soviet educational system terminology)
MICS	Household member	Kyrgyzstan	2014	Higher	Completed secondary, Professional primary, Professional middle	
MICS	Household member	Kyrgyzstan	2018	Higher	Completed secondary, Professional Secondary/Middle	Completed secondary (grade>=10), Professional secondary/middle (grade>=3)

Survey	Type	Country	Year	Higher Education	Completed secondary education	Details
MICS	Household member	Lao PDR	2011	Tertiary education	Upper secondary, Post secondary non tertiary	Upper secondary (grade >=33), Post secondary non tertiary (grade >=43)
MICS	Household member	Lao PDR	2017	Tertiary education	Upper secondary, Post secondary non tertiary	Upper secondary (grade >=33), Post secondary non tertiary (grade >=43)
DHS	Individual	Maldives	2016-2017		Completed lower secondary, some higher secondary, completed higher secondary	Completed lower secondary: Completed 10th grade at the secondary level Completed higher secondary: Completed 12th grade at the higher secondary level
MICS	Household member	Mongolia	2013	College/University	General education school, Vocational training, University/College	Grade 12
MICS	Household member	Mongolia	2018	University, Institute, College	Secondary school, Vocational training centers, Technicum	Grade 12
DHS	Individual	Myanmar	2015-2016		Completed secondary	Completed grade 11 at the secondary level
DHS	Individual	Nepal	2011		Completed secondary	Completed grade 10 at the secondary level
MICS	Household member	Nepal	2019	Higher	Upper secondary	Upper secondary (grade 11-12) (grade >=12)
DHS	Individual	Nepal	2016		Completed secondary	Completed grade 10 at the secondary level
DHS	Individual	Pakistan	2012-2013		Secondary	Secondary refers to completing classes 9-10 Higher refers to completing class 11 and above
DHS	Individual	Pakistan	2017-2018		Secondary	Secondary refers to completing classes 9-10 Higher refers to completing class 11 and above
DHS	Individual	Papua New Guinea	2016-2018		Completed secondary	Completed grade 12 at secondary level
DHS	Individual	Philippines	2013		Completed high school	Completed high school: completed 4th year at the secondary level College or higher: Includes all post-secondary
DHS	Individual	Philippines	2017		Completed secondary	Completed grade 10 of high school under the old educational system or completed grade 12 under the current K-12 educational system
DHS	Individual	Tajikistan	2012		Completed secondary	Completed Grade 11 at the secondary level or completed Grade 10 at the secondary level and has a general education school diploma ("attestat" as in older Soviet educational system terminology)
DHS	Individual	Tajikistan	2017		Completed secondary	Completed Grade 11 at the secondary level or completed Grade 10 at the secondary level and has a general education school diploma ("attestat" as in older Soviet educational system terminology)

Survey	Type	Country	Year	Higher Education	Completed secondary education	Details
MICS	Household member	Thailand	2012	Upper Secondary	Upper secondary, Technical vocational	Upper secondary (grade \geq 6), Technical vocational (grade \geq 3)
MICS	Household member	Thailand	2015	Diploma, Bachelor, Master, Doctoral degree	Secondary, Associate/Commercial college	Secondary (grade \geq 6)
MICS	Household member	Thailand	2019	Certificate, Diploma, Bachelor, Master, Doctoral degree	Upper secondary	Upper secondary (grade \geq 6), Certificate (VCE / TCE), Diploma (HVC / CTV / HTC)
DHS	Individual	Timor-Leste	2009-2010		Completed secondary	Completed grade 12 at the secondary level
DHS	Individual	Timor-Leste	2016		Completed secondary	Completed grade 12 at the secondary level
MICS	Household member	Tonga	2019	Tertiary/University	Upper secondary, Technical and Vocational	Upper secondary (grade \geq 7), Technical and Vocational (grade \geq 2)
DHS	Individual	Turkey	2013		Secondary	Secondary: completed 3 or 4 years at the secondary school depending on the years of schooling (prior to year 2012 or later) High school and higher: completed at least 3 years at the high school
MICS	Household member	Turkmenistan	2015	Higher	Secondary, Primary vocational, Secondary vocational	Secondary (grade 10)
MICS	Household member	Turkmenistan	2019	Higher	Secondary, Primary Vocational, Secondary vocational	Secondary (grade 10)
MICS	Household member	Viet Nam	2010	College/University and above	Upper secondary, Professional school	Upper secondary (grade \geq 12)
MICS	Household member	Viet Nam	2013	College/University and above	Upper secondary, Professional school	Upper secondary (grade \geq 12)

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