

# Designing a Microdata File for Public Use

Lara Cleveland, Research Scientist  
7 September 2023

UNESCWA Workshop on Population Projections and Preparing Microdata  
Rabat, Morocco  
4-8 September 2023



UNIVERSITY OF MINNESOTA

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## Desired Characteristics of MICRODATA for Public Use

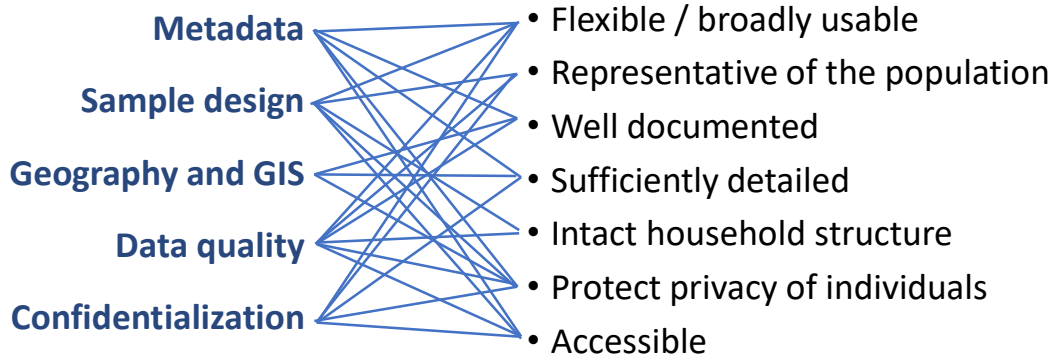
### **Useful – Scientific – Principled**

- Flexible = neutral design
- Representative of the population
- Well documented
- Sufficiently detailed
- Intact household structure
- Protect privacy of individuals
- Accessible

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## Useful – Scientific – Principled



People illustrations by [Storyset](#)



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## Sample characteristics

Keep it simple  
for flexibility

- **High-density** (10% is standard) data file.
- **Household-level** to include all persons from each sampled household
- **Systematic** design (implicitly geographically stratified) every nth record across geographically sorted records
- Inflation factors (or **weights** and design variables for complex samples)
- **Sample design documentation**

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## Metadata

Data are only usable  
or meaningful with  
good metadata

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- **Codebooks**
- **Questionnaires**
- **Enumerator instructions**
- **Census date and methodological notes**
- **Sample design information**

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## Variables and Categories


Full set of census  
topics

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- **Full set of census topics**
- **As many census variables as possible**
- **Single year of age**
- **Geographic codes (subnational units)**
  - Place of residence (or usual residence)
  - Place of previous residence and birthplace (subnational and country)
  - 2nd or lower sub-national administrative level
  - Set lower bound for population per unit (e.g., 20,000)
- **3-digit occupation and industry, if possible**
- Option to omit or collapse sensitive info

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# Metadata



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- Codebooks
  - Short and long variable names
  - Value labels
  - Include labels for different types of missing (unknown vs. not in universe)
  - Variable specification (format-dependent)
    - Location and width
  
- Questionnaires
- Enumerator instructions
- Sample design information

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## Exercises: Data for Research Plans

- 1. WHO Health Workforce Accounts**

This research investigates the location and concentration of health workers, preferably to the second or third subnational geographic level and disaggregated by type of health workers (such as nurses, doctors, midwives, nurse practitioners, medical technicians, etc.).
- 2. Vulnerability of Older Adults**

This study looks at living arrangements of older adults around the world. The research could be useful for understanding vulnerabilities of those living alone, potential familial support systems, and potential caregiving burdens of adult children.
- 3. SDG 8.6.1 – NEET (% young adults not in education, employment, or training)**

We want to measure SDG 8.6.1. The indicator guidelines measure of the percent of young adults (defined as people age 15-24) who are not engaged in education, employment or training to be calculated as

$$\text{NEET} = (\text{total youth} - \text{employed youth} - \text{youth in school}) / (\text{total youth}) * 100$$

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## Exercises: Data for Research Plans

### For each research plan:

- What information (in the form of variables or census questions) is required for this research?
- Does the census have this information?
- Will published census reports have enough information to do this research?

Extra credit: Once you have learned something about the population of interest, what other information in the census could help you determine how to design policy, target resources, or otherwise determine how to improve lives?

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## WHO Health Workforce Accounts

This research investigates the location and concentration of health workers, preferably to the second or third subnational geographic level and disaggregated by type of health workers (such as nurses, doctors, midwives, nurse practitioners, medical technicians, etc.).

### Variables:

- **Occupation**  
with detail (3-digit) about types of health care workers: nurses, doctors, midwives, nurse practitioners, medical technicians, etc.
- **Sub-national geography**  
at least 2<sup>nd</sup> subnational
- 

**In census? Yes**

**Need microdata? Yes**

### Extra Credit:

- **Age, ethnicity, language, access to utilities or amenities, disability, fertility, and others**

**Use International  
Standard Classifications**

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# Emergencies & Understanding Vulnerabilities: WHO on the Health Workforce

## National Health Workforce Accounts (NHWA): Definition

A **system** by which countries **progressively** improve the **availability, quality, and use** of data on health workforce through **monitoring of a set of indicators** to support achievement of Universal Health Coverage, SDGs and other health objectives.

Documentation and tools available here:  
[www.who.int/hrh/statistics/nhwa/](http://www.who.int/hrh/statistics/nhwa/)

WHO examples shared courtesy of Dr. Mathieu Boniol  
Presentation for IPUMS International Pre-conference Workshop  
ISI World Statistics Congress, Kuala Lumpur  
August 18, 2019



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## WHO example: measuring the health workforce

Group code			Occupational title	Group code			Occupational title
Sub	Minor	Unit		Sub	Minor	Unit	
22			<b>Health professionals</b>	32			<b>Health associate professionals</b>
	221		<b>Medical doctors</b>		321		<b>Medical and pharmaceutical technicians</b>
		2211	Generalist medical practiti			3211	Medical imaging and therapeutic equipment technicians
		2212	Specialist medical practitio			3212	Medical and pathology laboratory technicians
	222		<b>Nursing and midwifery pr</b>			3213	Pharmaceutical technicians and assistants
		2221	Nursing professionals			3214	Medical and dental prosthetic and related technicians
		2222	Midwifery professionals		322		<b>Nursing and midwifery associate professionals</b>
	223		<b>Traditional and compleme</b>			3221	Nursing associate professionals
		2230	Traditional and compleme			3222	Midwifery associate
	224		<b>Paramedical practitioners</b>		323		<b>Traditional and com</b>
		2240	Paramedical practitioners			3230	Traditional and com
	226		<b>Other health professional</b>		325		<b>Other health associ</b>
		2261	Dentists			3251	Dental assistants an
		2262	Pharmacists			3252	Medical records and
		2263	Environmental and occupa			3253	Community health
		2264	Physiotherapists			3254	Dispensing optician
		2265	Dieticians and nutritionists			3255	Physiotherapy techni
		2266	Audiologists and speech th			3256	Medical assistants
		2267	Optometrists and ophthalr			3257	Environmental and
		2269	Health professionals not el			3258	Ambulance workers
						3259	Health associate pr
						532	
						5321	Health care assistants
						5322	Home-based personal care workers
						5329	Personal care workers in health services not elsewhere classified
							<b>Additional health-related unit groups</b>
						1342	Health service managers
						1343	Aged care service managers
						2634	Psychologists
						2635	Social work and counselling professionals
						3344	Medical secretaries

Occupational information  
**ISCO** International Classification  
at 3-digit or 4-digit level  
from IPUMS

**Some info for 35 countries**  
but detail at preferred level  
for only 14 countries

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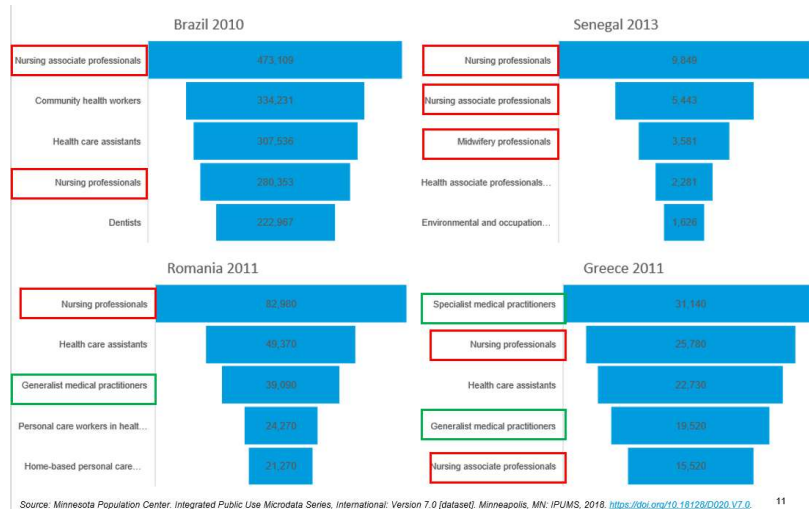
# WHO example: measuring the health workforce

## Top 5 health occupations for selected countries

Medical doctors

Nursing and midwifery personnel

Wide variability in medical professional availability and distribution

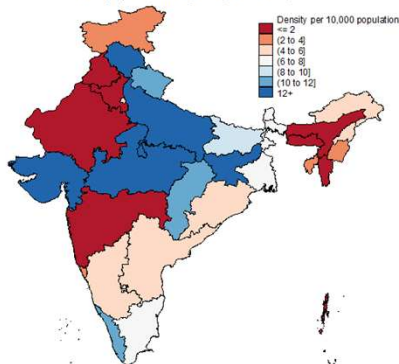


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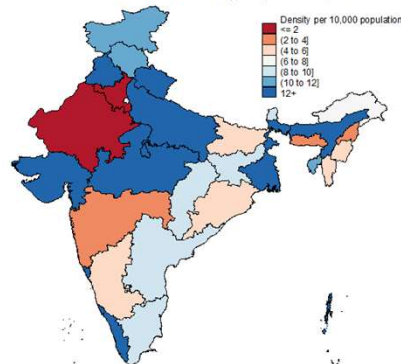
# WHO example: measuring the health workforce

Density of Nursing and Midwifery personnel\* in India 2004  
Employment survey, sample size 602,833



\* Nurses, Midwives and health visitors

Density of Nursing and Midwifery personnel\* in India 2009  
Census socio economic survey, sample size 560,741



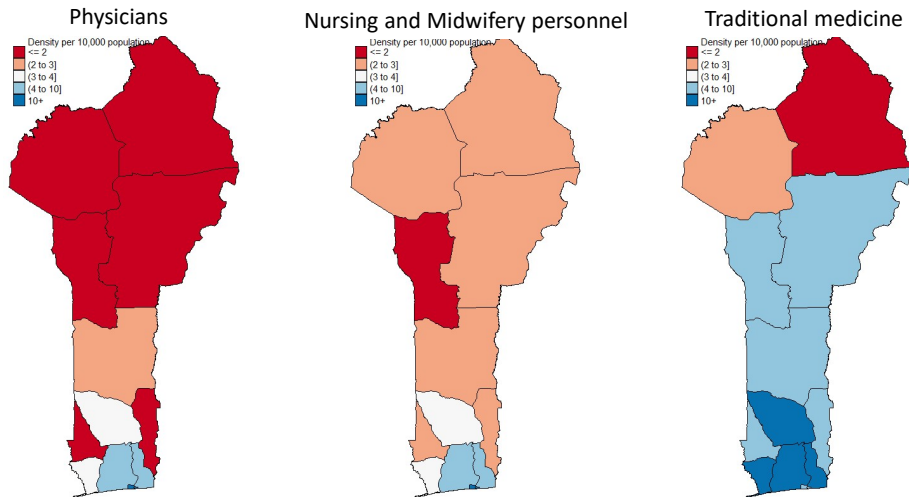
\* Professionals and associates

Source: Minnesota Population Center. Integrated Public Use Microdata Series, International: Version 7.0 [dataset]. Minneapolis, MN: IPUMS, 2018. <https://doi.org/10.18128/0000.V7.0>. Data from the Ministry of Statistics and Programme Implementation, India

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## WHO example: measuring the health workforce



Source: Minnesota Population Center. Integrated Public Use Microdata Series, International: Version 7.0 [dataset], Minneapolis, MN: IPUMS, 2018. <https://doi.org/10.18128/D020.V7.0>. Data from the National Institute for Statistics and Economic Analysis, Benin

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## Vulnerability of Older Adults

This study looks at living arrangements of older adults around the world. The research could be useful for understanding vulnerabilities of those living alone, potential familial support systems, and potential caregiving burdens of adult children.

### Variables:

- **Age**, especially older age groups
- **# people in the household** (or hh sample)
- **Relationship to head of household**

### Extra Credit:

- **Subnational geography, disability, household amenities**

**In census? Yes**

**Need microdata? Yes**

**Census is often the only viable source of data:**

- **study of small groups**
- **household structure**

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# Household Structure of Older Persons

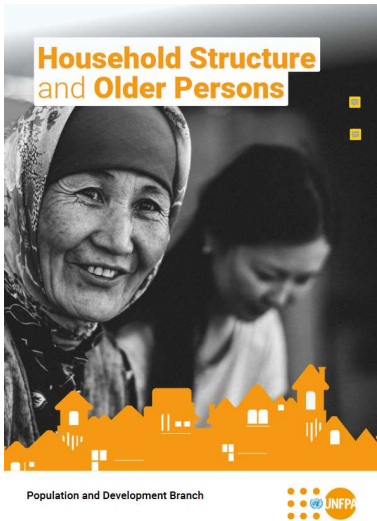
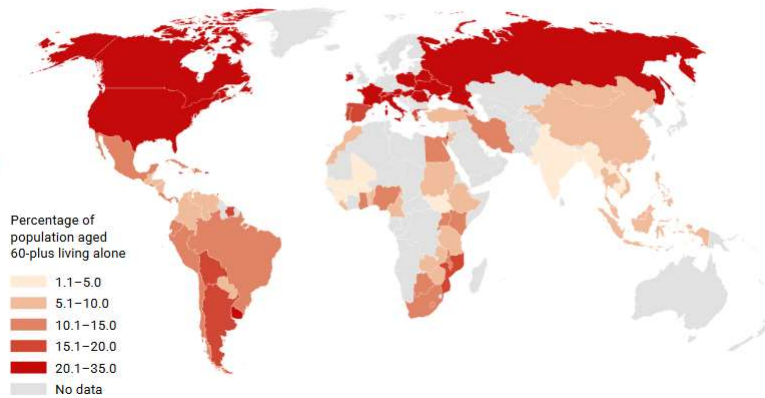


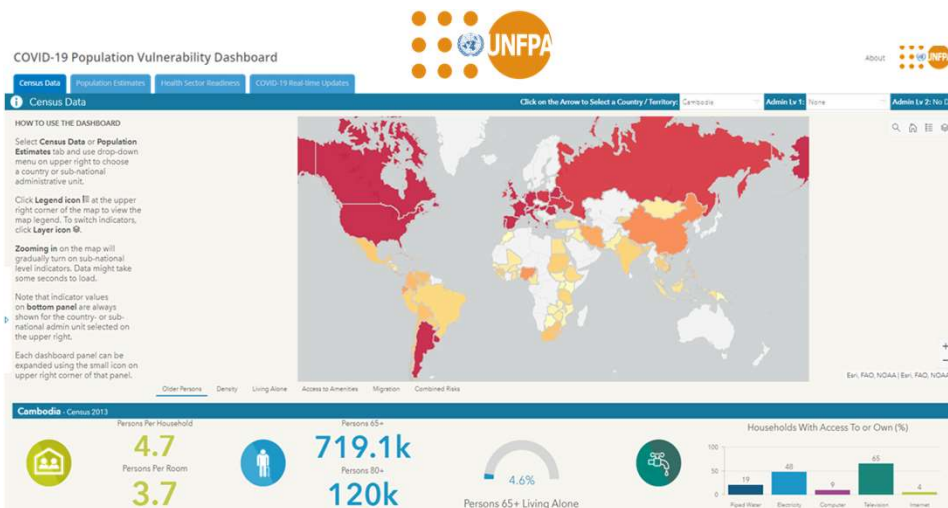
Figure 5. Percentage distribution of older persons living alone in countries with available data, 2000–2017



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# Census Data: Ready for Anything Adapting to Covid Response Needs



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# Scholarly Research on COVID-19

## National age and coresidence patterns shape COVID-19 vulnerability

Albert Esteve<sup>1,2</sup>, Iñaki Permanyer<sup>3</sup>, Diederik Boertien<sup>4</sup>, and James W. Vaupel<sup>5</sup>

<sup>1</sup>Center for Demographic Studies, Centres de Recerca de Catalunya, 08193 Bellaterra, Spain; <sup>2</sup>Geography Department, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain; and <sup>3</sup>Interdisciplinary Centre on Population Dynamics, University of Southern Denmark, 5000 Odense, Denmark

Edited by Douglas S. Massey, Princeton University, Princeton, NJ, and approved June 8, 2020 (received for review May 8, 2020)

Based on harmonized census data from 81 countries, we estimate how age and coresidence patterns shape the vulnerability of countries' populations to outbreaks of coronavirus disease 2019 (COVID-19). We estimate variation in deaths arising due to a simulated random infection of 10% of the population living in private households and subsequent within-household transmission of the virus. The age structures of European and North American countries increase their vulnerability to COVID-related deaths in general. The coresidence patterns of elderly persons in Africa and parts of Asia increase these countries' vulnerability to deaths induced by within-household transmission of COVID-19. Southern European countries, which have aged populations and relatively high levels of intergenerational coresidence, are, all else equal, the most vulnerable to outbreaks of COVID-19. In a second step, we estimate to what extent avoiding primary infections for specific age groups would prevent subsequent deaths due to within-household transmission of the virus. Preventing primary infections among the elderly is the most effective in countries with small households and little intergenerational coresidence, such as France, whereas confining younger age groups can have a greater impact in countries with large and intergenerational households, such as Bangladesh.

demography | households | COVID-19 | aging | global

The coronavirus disease 2019 (COVID-19) pandemic currently confronts nearly all of the world's countries. A growing number of governments are enforcing or recommending home quarantines to contain the spread of the virus. As the virus can be transmitted outside and within households, the effects of such measures will

infections). Lower rates of household transmission would reduce this number of indirect deaths proportionally. The direct effect depends on the age structure of the population; the indirect effect hinges on the size and age structure of households. Combined, they show how, all else equal, national age and coresidence patterns alter the vulnerability of a country to COVID-19 outbreaks.

The expected direct death rates per 100,000 individuals range from 19 in South Sudan to 120 in Italy. Together with Italy, three southern European countries—Greece, Portugal, and Spain—rank among the top six, followed by the rest of Europe and North America. Latin American countries form a homogenous cluster lower than the European and North American cluster. Asian countries spread all over the range, with estimates as high as 81 in South Korea and as low as 23 in Jordan. African countries tend to experience the lowest direct death rates. Where the elderly comprise a large portion of the population, the direct effect is high, whereas direct deaths are much lower where the elderly are vastly outnumbered by younger people.

Mortality due to intrahousehold contagion (right-hand segment of a bar in Fig. 1) does not follow the same order, because coresidence patterns differ widely across countries, even among those countries with similar age structures (4–7). The ratio between indirect and direct effects is a simple indicator of the importance of coresidence patterns, in particular, of the elderly, the most vulnerable group. For European and North American countries, direct and indirect deaths are roughly equal. In Latin America, indirect deaths could approximately double the number of direct deaths. The ratio between potential indirect and direct deaths in Asia ranges from 1.3 (South Korea) to 3.7 (Laos). In

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# Older Adults Living with Children

## Disaggregated by sex

Note utility of having household composition information

### Percentage of men and women aged 65 years or over who co-reside with children aged 20 years or over, countries and areas with available data

Source: United Nations, Department of Economic and Social Affairs, Population Division (2016). Database on the Households and Living Arrangements of Older Persons 2015.

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## SDG 8.6.1 – NEET

(% young adults not in education, employment, or training)

We want to measure SDG 8.6.1. The indicator guidelines measure of the percent of young adults (defined as people age 15-24) who are not engaged in education, employment or training to be calculated as

$$\text{NEET} = (\text{total youth} - \text{employed youth} - \text{youth in school}) / (\text{total youth}) * 100$$

**Variables:**

- Employment (in labor force)
- School attendance
- Age

**In census? Yes**

**Need microdata? Yes**

**Extra Credit:**

- Sex, sub-national geography,

**Disaggregation**

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## Disaggregation for SDGs

The collage features several key reports and documents:

- Gender equity in the health workforce: Analysis of 104 countries** (Health Workforce Working paper 1, March 2019)
- UNFPA Strategy for the 2020 Round of Population & Housing Censuses (2015-2024)**
- A pilot study on disaggregating SDG indicators by migratory status**
- Global strategy on human resources for health: Workforce 2030** (World Health Organization)
- BECAUSE EVERYONE COUNTS** (UN Women)
- TURNING PROMISES INTO ACTION: GENDER EQUALITY IN THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT** (UN Women)
- ILO global estimates on migrant workers: Results and methodology** (Special focus on migrant domestic workers)

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## Disaggregation and Study of Small Populations: SDG Reporting

### Census Microdata

110 of 169 Targets for 11 of the 17 Goals

Multidimensional crosstabulation and investigation

#### Household

- Household composition
- Dwelling ownership
- Household amenities
- Access to utilities
- Group quarters
- Subnational geography

#### Person

- Fertility
- Mortality
- Migration
- Education
- Labor-force participation
- Occupational structure
- Ethnicity
- Disability

 SUSTAINABLE DEVELOPMENT GOALS



IPUMS supports the  
Sustainable Development Goals

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## Disaggregation and Study of Small Populations: SDG Reporting

### Census Microdata

To fulfill recommended disaggregation

- Sex and gender
- Age
- Income quintiles or deciles
- Disability
- Ethnicity and indigenous status
- Economic activity
- Geographic location (at least urban/rural)
- Migrant status

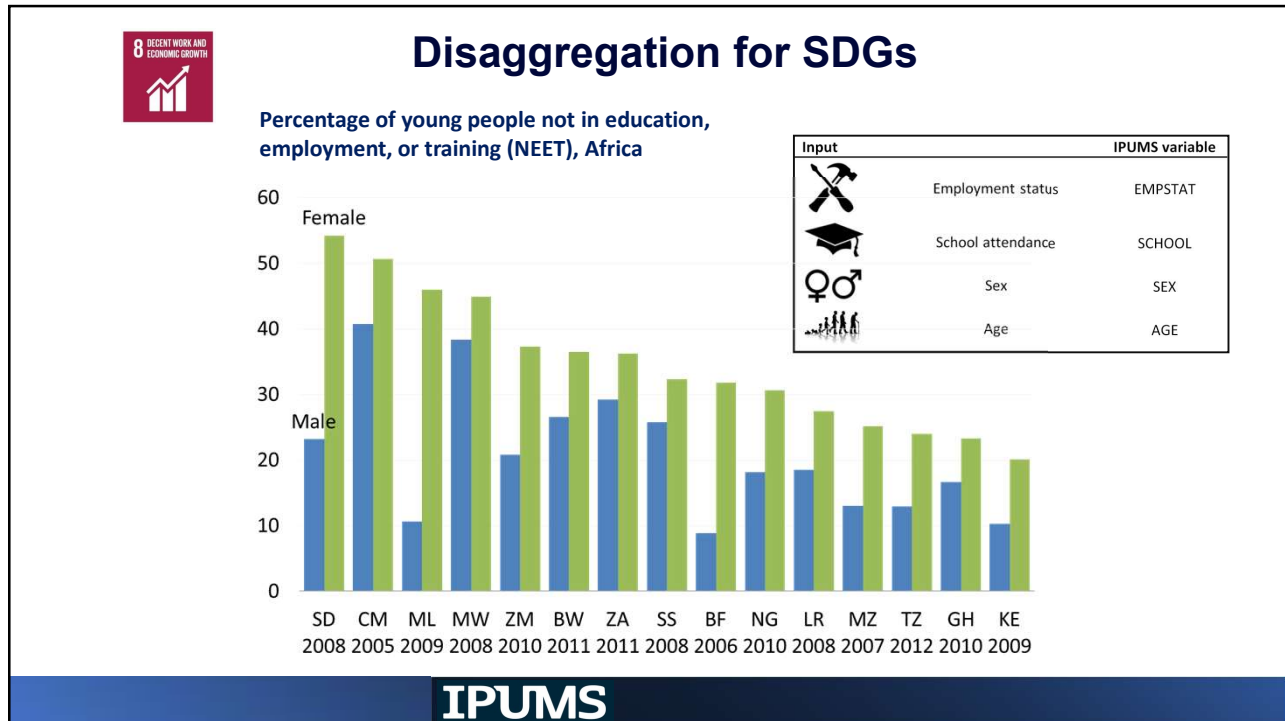
 SUSTAINABLE DEVELOPMENT GOALS



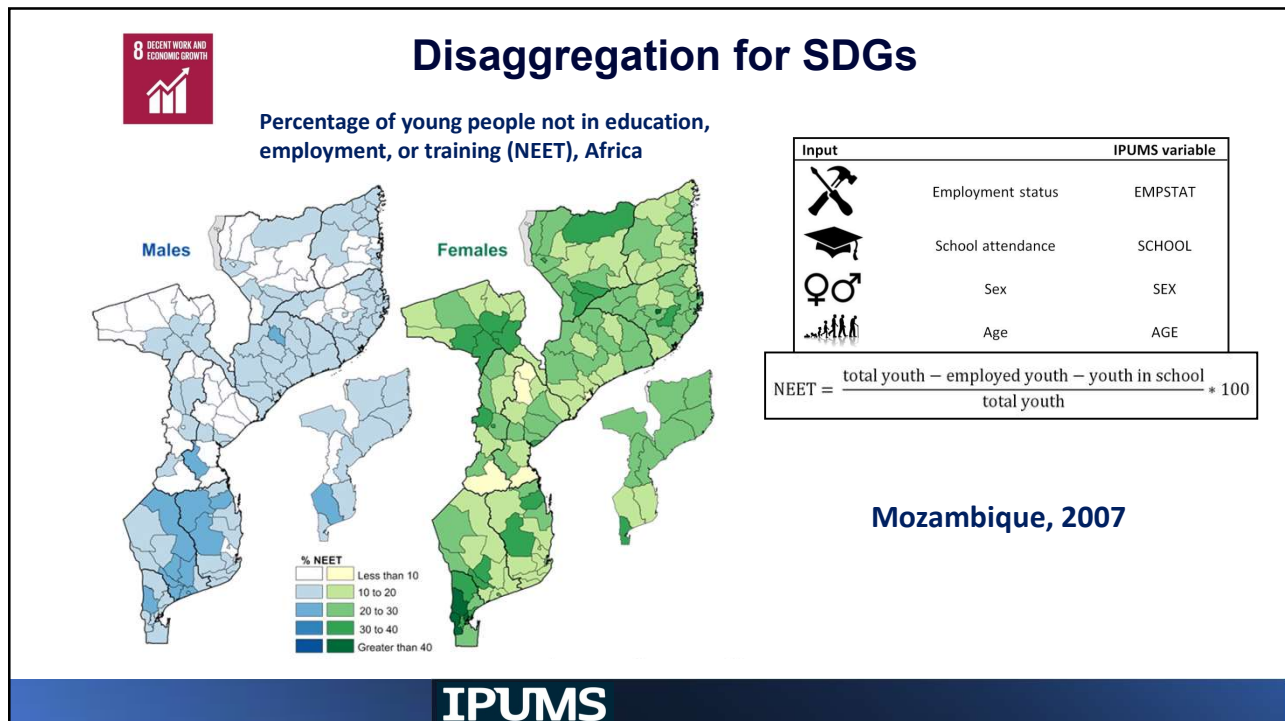
IPUMS supports the  
Sustainable Development Goals

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## Census to Extend the Power of Other Data Sources: Small Area Estimation (Survey + Census)

**Surveys**

- Rich topical coverage and detail
- Small sample sizes = limited disaggregation power

**Small area Estimation**

- Match survey to census on key characteristics
- Extend inference to smaller geographic areas

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## Census to Extend the Power of Other Data Sources: Small Area Estimation (Survey + Census)

**Goal 1: End poverty in all its forms everywhere**

**Target 1.1:** By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day.

**Indicator 1.1.1:** Proportion of the population living below the international poverty line by sex, age, employment status and geographic location (urban/rural)

**Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all**

**Target 8.5:** By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value

**Indicator 8.5.2:** Unemployment rate, by sex, age and persons with disabilities

**Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable**

**Target 11.2:** By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

**Indicator 11.2.1:** Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities

Survey size limits direct estimation  
(e.g., Colombia from UN SAE Toolkit)

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# Small Area Estimation The UN Statistics SAE Toolkit

UN Statistics Wiki Spaces Blogs
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Log in

SAE4SDG

SPACE SHORTCUTS

- SAE4SDG

PAGE TREE

- Why is SAE important for SDG data
- Producing SAE
- Communicating SAE methods and r
- From SAE experiment to production
- SAE practices
- Software packages
- SAE key readings
- Training materials
- SAE projects
- FAQ
- References
- Acknowledgement

Pages

## SAE4SDG

Created by UNSD Clarence Lio, last modified by Haoyi Chen on Apr 08, 2022

<https://unstats.un.org/wiki/display/SAE4SDG/>

**Welcome to the Toolkit on Using Small Area Estimation for SDGs!**

In committing to the realization of the 2030 Agenda for Sustainable Development, Member States recognized that the dignity of the individuals is fundamental and that the Agenda's Goals and targets should be met for all nations and people and for all segments of society. Ensuring that these commitments are translated into effective action requires a precise understanding of the target populations and progress made in addressing their particular priorities.

To properly measure this, statistics need to be presented for different population groups and geographical areas. The Sustainable Development Goal (SDG) indicator framework has included an overarching principle of data disaggregation: SDG indicators should be disaggregated, where relevant, by income, sex, age, race, ethnicity, migratory status, disability and geographic location, or other characteristics, in accordance with the Fundamental Principles of Official Statistics.

As sound statistical methods are vital to overcome this challenge, Small Area Estimation (SAE) constitutes an important topic in the way forward. It covers a variety of methods used to produce survey based estimates for geographical areas or domains of study in which the sample sizes are too small, or even absent, to provide valid estimates. In order to obtain reliable estimates, additional datasets are generally brought to bear upon the process through a modelling procedure.

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# Small Area Estimation The UN Statistics SAE Toolkit

Many resources available

- Methodology
- Training materials
- References
- Practical exercises
- Case studies

Initial specification depending on input factors

Indicator	Mean or total?		Small domains?		Unit-level data?	
	Yes	No	Yes	No	Yes	No
Disaggregation	D		D		A2	
	A1		A1		U2	
Data availability	U1		A1		U2	
	U1		A1		U2	
SAE methods	U1		A1		U2	
	U1		A1		U2	

**D:** Direct estimation approaches.

**A1:** The basic area-level model and its extensions for means and totals including, e.g., the spatial-correlation and robust models.

**A2:** Area-level models for other indicators such as ratios. These can either use transformations or a non-linear model specification.

**U1:** The basic unit-level model and its extensions for means and totals, including robust models.

**U2:** Extended unit-level models such as the ELL and the EBP approaches.

Practical exercise

The practical exercise in these guidelines will perform the analysis of three indicators for the SDGs 1, 7 and 8 with different input factors and estimation approaches. In this part, the analysis and potential adaptations are described. The examples are chosen such that the application can be transferred to a wide range of SDG indicators.

**1.1.1/1.2.1 Proportion of the population living below the international/national poverty line** R Code

- > User needs
- > Data availability
- > Specification

**Analysis & Adaptation**

To estimate the regional distribution of the proportion of the population living below a poverty line, the specification based on the input factors leads to the EBP. To implement the analysis, a software package needs to be chosen. For this example, the R packages *emfi* and *maptools* are used. Please note that the proportion of the population living below a poverty line is defined as the head count ratio (HCR) in the package *emfi*. Thus, the proportion will be named as HCR in the following.

**Goal 1. End poverty in all its forms everywhere**

Case studies

Poverty mapping is one of most common applications in small area estimation. Many examples are available for national poverty line (indicators 1.1.1 and 1.2.1).

**World Bank applications**

The World Bank proposed a poverty mapping process that was conducted in several countries. Based on estimates such as the Foster-Greer-Thorbecke poverty estimates and the Gini coefficient were derived. The report *More than a pretty picture - Using poverty maps to design better policies and interventions* in **Bolivia, Bulgaria, Cambodia, Yunnan Province (China), Ecuador, Indonesia, Mexico, Morocco, Sri Lanka** and also lessons learned. Hence this can be a good starting point for a new poverty mapping study.

In 2005, the World Bank provided technical assistance to the **Philippine** national statistical system to develop and city-level poverty statistics. The Philippine Statistics Authority conducts the Family Income and Expenditure Survey in the country, every three years. The small area estimation technique used in the Philippines is

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<https://unstats.un.org/wiki/display/SAE4SDG/>

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# Census to Extend the Power of Other Data Sources: Environmental Pollutants

Vol. 125, No. 9 | Research

## Changes in Transportation-Related Air Pollution Exposures by Race-Ethnicity and Socioeconomic Status: Outdoor Nitrogen Dioxide in the United States in 2000 and 2010

Lara P. Clark, Dylan B. Millet, and Julian D. Marshall

Published: 14 September 2017 | DOI: 10.1289/EHP959 | Cited by: 8

### Estimated Changes in NO<sub>2</sub> Environmental Injustice Metrics

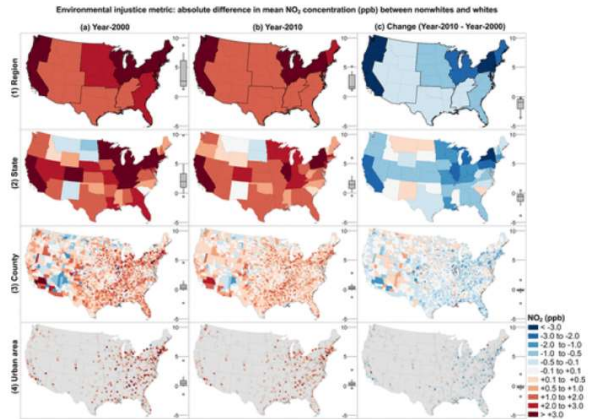
Nationally, on an absolute basis, environmental injustice declined from 2000 to 2010. The nonwhite-white NO<sub>2</sub> disparity decreased from 5.0 ppb in 2000 to 2.9 ppb in 2010 (-42%; Table 2). However, nationally, on a relative basis, environmental injustice persisted. Nonwhites remained more exposed to outdoor NO<sub>2</sub> air pollution than whites on average in 2010, and there was little change in the relative NO<sub>2</sub> difference between nonwhites and whites between 2000 and 2010. The nonwhite-white NO<sub>2</sub> difference was 33% in 2000 (nonwhites were 40% more exposed than whites) and 31% in 2010 (nonwhites were 37% more exposed than whites).

**Table 2** Estimated population-weighted mean NO<sub>2</sub> concentrations (ppb) for nonwhites and whites: year 2000, year 2010, and change over time (year 2010-year 2000).

Race-ethnicity	2000	2010	Change: 2010-2000
Nonwhites <sup>a</sup>	17.6	10.7	-6.9 (-39%)
Whites <sup>b</sup>	12.6	7.8	-4.7 (-38%)
Difference: nonwhites-whites	5.0 (33%)	2.9 (31%)	-2.1 (-42%)

<sup>a</sup>Nonwhites includes all race-ethnicity minority groups (i.e., people who reported any race-ethnicity other than white alone, non-Hispanic).

<sup>b</sup>Whites includes people who reported white alone, non-Hispanic race-ethnicity.



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# IPUMS Award Winners: Census + Climate, Economic Surveys, & More

PLOS ONE

OPEN ACCESS | PEER-REVIEWED  
RESEARCH ARTICLE

## An introduction to DUIA: The database on urban inequality and amenities

Frederico Roman Ramos, Justus Ullmermark

Published: June 25, 2021 | DOI: 10.1371/journal.pone.0253824



Global Environmental Change  
Volume 65, November 2020, 102183



## Climate-Induced migration and unemployment in middle-income Africa

Valerie Mueller<sup>1,2,3,4,5,6</sup>, Clark Gray<sup>5,6</sup>, Douglas Hopping<sup>4,6</sup>

Show more

Population Studies  
A Journal of Demography  
ISSN: 0032-4728 (Print) 1477-4747 (Online) Journal homepage: <https://www.tandfonline.com/loi/tpst20>

## Until work do us part: Labour migration and occupational stratification in non-cohabiting marriage

Giulia Ferrari & Ross Macmillan

To cite this article: Giulia Ferrari & Ross Macmillan (2019), Until work do us part: Labour migration and occupational stratification in non-cohabiting marriage, Population Studies  
To link to this article: <https://doi.org/10.1080/00324728.2019.1583359>

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# Questions



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## Census Microdata: A Research Goldmine



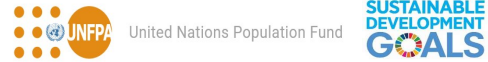
The collage features several key elements:
 

- Sustainable Development Goals:** A central graphic with 17 colorful icons.
- World Population Ageing 2020:** A report cover from the United Nations.
- Household Structure and Older Persons:** A report cover featuring an elderly woman's portrait.
- Older Americans Key Indicators of Well-Being 2020:** A report cover with a colorful leaf pattern.
- COVID-19 Population Vulnerability Dashboard:** A screenshot of a web dashboard showing a world map and various data indicators for Argentina, such as 3.3 persons per room and 4M persons aged 65+.
- Journal Covers:** Includes 'Environmental Change' and 'The Economic Journal'.

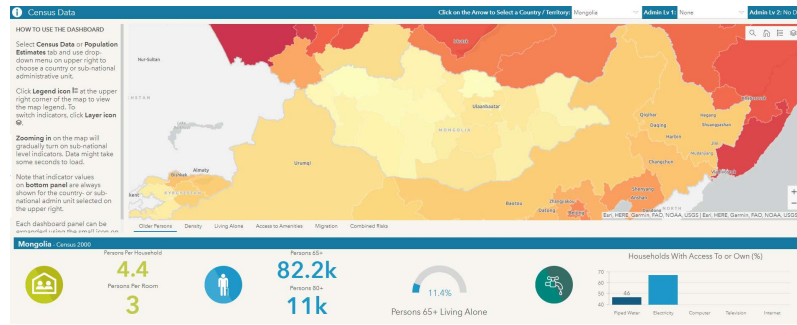
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# Responding to Emergencies & Understanding Vulnerabilities

## Census-based indicators for SDG reporting:



- Fertility
- Sex ratio
- Age composition
- Nuptiality
- Household living arrangements
- Migrant status
- Education level
- Labor force participation
- Disability status



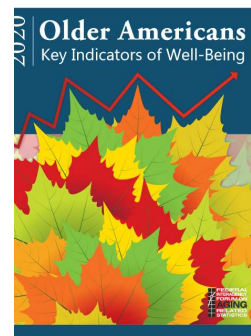
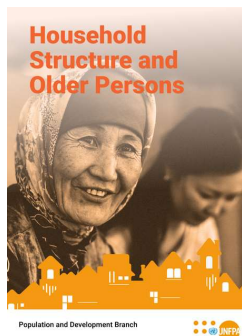
*IPUMS provided more than 8 million data cells (without geographic disaggregation)  
 Included cell suppression where appropriate  
 Provided statistical confidence intervals.*



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# Disaggregation and Study of Small Populations:

## Research on Aging



Publications by the United Nations, U. S. Census Bureau, and U.S. Federal Agencies on Global Aging Trends

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