



CAUSES OF DEATH DIVERSITY IN LATIN AMERICA AND CARIBBEAN

Julia Almeida Calazans
Iñaki Permanyer

Exploring Population Heterogeneities
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INTRODUCTION

- Cause of death (CoD) diversity indices measure the extent to which some populations die from more similar or variegated causes than others.
- **Greater heterogeneity could imply lower predictability and more dissimilarity among the causes from which individuals die** → Higher CoD diversity implies greater challenges for health systems, and efforts to reduce total mortality become more complex and possibly less effective (Bergeron-Boucher et al., 2020; Calazans & Permanyer, 2023).
- CoD diversity indicators have recently been recognized as important measures of population health and well-being, providing new perspectives on our understanding of contemporary mortality dynamics (Bergeron-Boucher et al., 2020; Trias-Llimós & Permanyer, 2022; Calazans & Permanyer, 2023).

INTRODUCTION

- Several attempts have been made to document how **diverse** a given CoD profile is. More specifically, these studies define a **CoD diversity index** to investigate if the deaths are highly concentrated in a limited set of causes or are widely dispersed along the CoD classification list (Bergeron et al., 2020; Calazans and Permanyer, 2023).
- Current approaches have never attempted to assess whether the CoD diversity for an entire population is mainly attributable to the CoD diversity **within** the groups conforming to that partition or the diversity in CoD **between** them.

OBJECTIVE

- In this paper, we propose a method to decompose overall CoD diversity as the sum of two clearly interpretable parts: the within- and between-group components.
- To illustrate the usefulness of this novel approach, we will apply it to the context of Latin America and the Caribbean – one of the regions with highest health inequalities around the globe.

MEASURING COD DIVERSITY

CoD diversity is measured using the Simpson Index of diversity.
Formally, it is defined as

$$S = 1 - \sum_{c=1}^k p_c^2$$

where p_c is the share of deaths attributable to cause c in the total deaths.

COD DIVERSITY IN MULTIGROUP SETTINGS

$$S = S_W + S_B = \sum_{g=1}^G \pi_g^2 S_g + \sum_{g=1}^G \sum_{h \neq g} \pi_g \pi_h S_{gh}$$

The first one is a weighted sum of the CoD diversity levels within the groups conforming the population partition, while the second one captures the diversity one can observe when comparing the mortality profiles among the different groups.

COD DIVERSITY IN MULTIGROUP SETTINGS

The CoD diversity index can be written using matrix notation as

$$S = \boldsymbol{\pi}' \times \mathcal{M}_S \times \boldsymbol{\pi}$$

where $\boldsymbol{\pi} = (\pi_1, \dots, \pi_G)$ is the vector of population shares across groups, $\boldsymbol{\pi}'$ denotes its transposed and

$$\mathcal{M}_S = \begin{pmatrix} S_1 & S_{12} & \cdots & S_{1G} \\ S_{21} & S_2 & \ddots & \vdots \\ \vdots & \ddots & \ddots & S_{G-1G} \\ S_{G1} & \cdots & S_{GG-1} & S_G \end{pmatrix}$$

is a symmetric matrix including the within-group diversity terms (S_g) in the diagonal and the between-group diversity terms (S_{gh}) off the diagonal.

CAUSE AND COUNTRY-SPECIFIC CONTRIBUTIONS

It is useful to assess how much of the observed levels of CoD diversity are attributable to

- A cause of death

$$\mathcal{C}_c = p_c(1 - p_c)$$

- A population subgroup

$$\widetilde{\mathcal{C}}_g = \pi_g^2 S_g + \pi_g \sum_{h \neq g} \pi_h S_{gh}$$

- Or a cause *and* population subgroup simultaneously.

$$\widetilde{\mathcal{C}}_{c,g} = [\pi_g^2 (p_{c,g}(1 - p_{c,g}))] + [\pi_g (1 - p_{c,g}) \sum_{h \neq g} \pi_h p_{c,h}]$$

EMPIRICAL APPLICATION

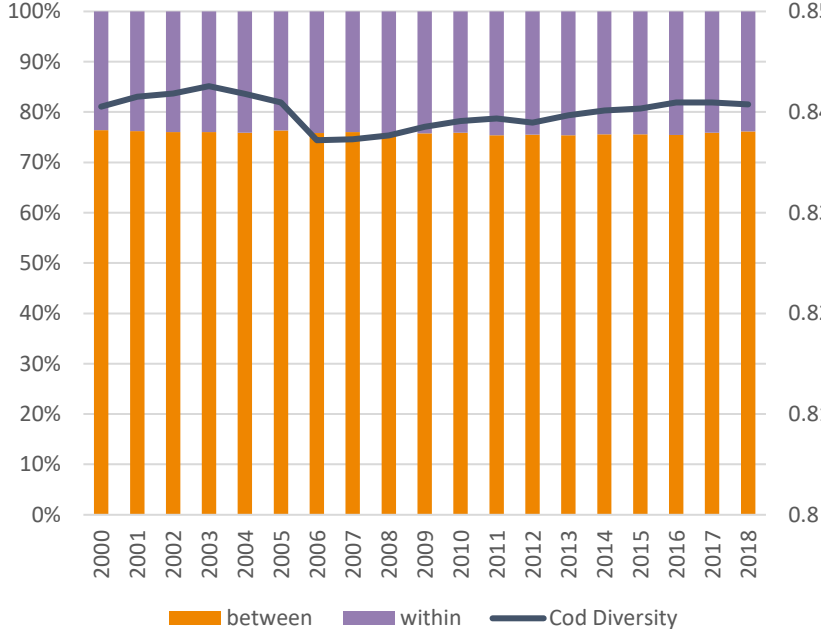
- The probability of dying for each cause was calculated using the age-and-cause-specific number of deaths and the age-specific mortality rates from the World Health Organization (WHO).
- Deaths were classified into 18 major groups of underlying causes of death following the chapters of the 10th Revision of the International Classification of Diseases (ICD-10).
- Antigua and Barbuda, Cuba, Dominica, Dominican Republic, Grenada, Saint Lucia, Saint Vincent and Grenadines, Costa Rica, El Salvador, Mexico, Nicaragua, Panama, Argentina, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru and Uruguay.

Men Women

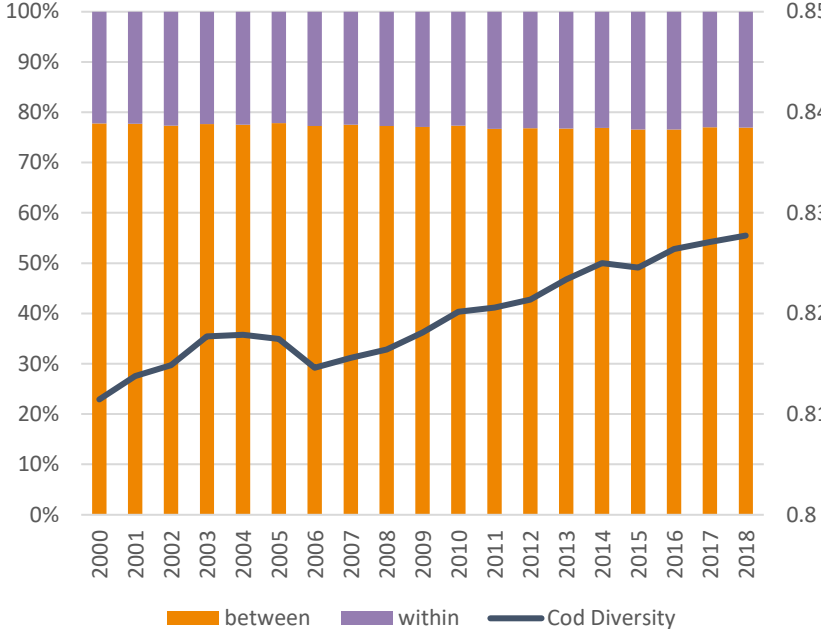


Overall CoD diversity in the LAC region and its components (2000-2018)

Men



Women



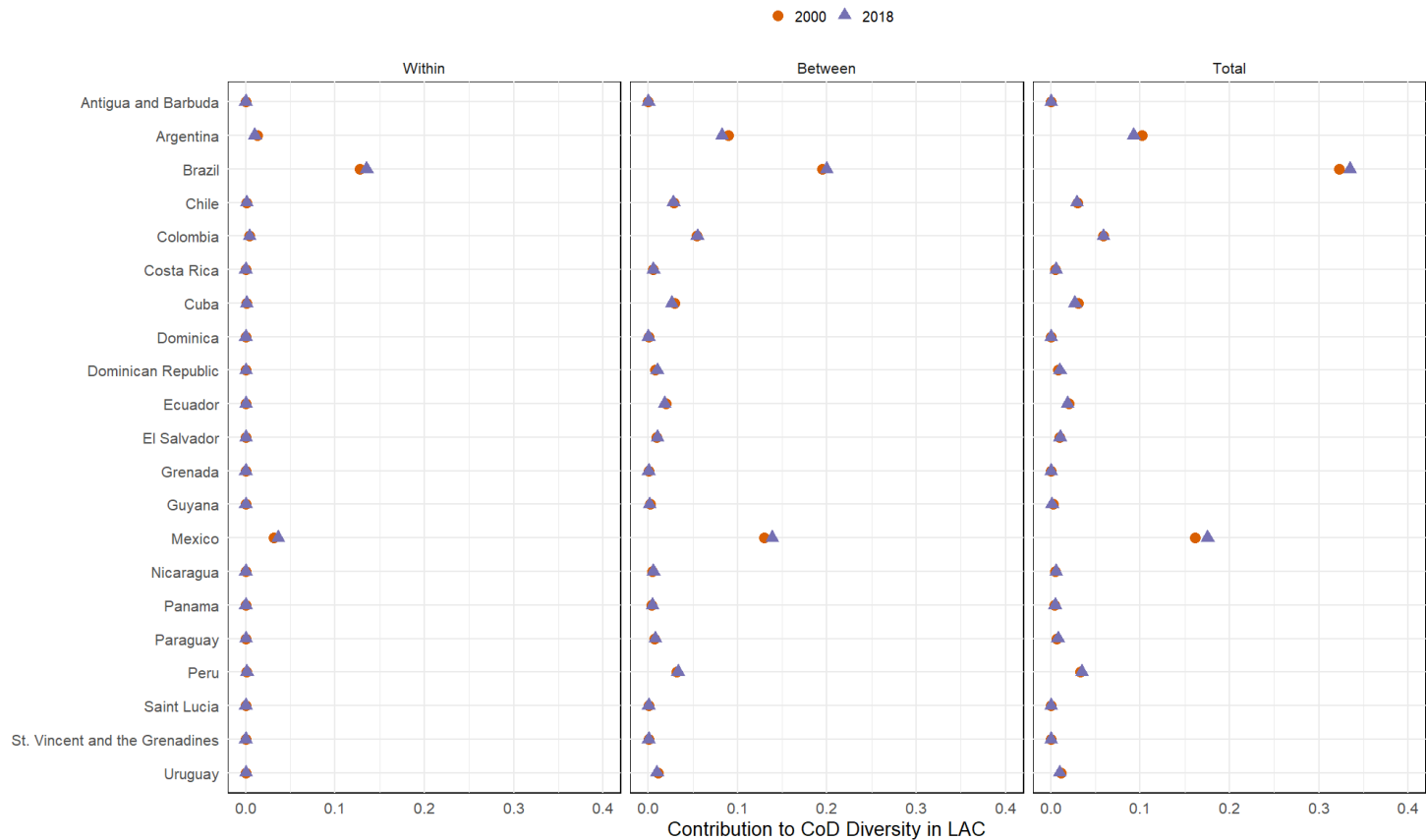
CoD diversity in multigroup settings – Women (2000)

Deaths distribution		ATG	ARG	BRA	CHL	COL	CRI	CUB	DMA	DOM	ECU	SLV	GRD	GUY	MEX	NIC	PAN	PRY	PER	LCA	VCT	URY	
0.0002	ATG	0.717																					
0.1273	ARG	0.767	0.792																				[0.712-0.743[
0.3981	BRA	0.787	0.805	0.805																			[0.743-0.774[
0.0362	CHL	0.783	0.802	0.817	0.808																		[0.774-0.805[
0.0747	COL	0.738	0.775	0.792	0.787	0.749																	[0.805-0.836[
0.0065	CRI	0.758	0.786	0.806	0.795	0.764	0.774																[0.836-0.867]
0.0389	CUB	0.731	0.765	0.786	0.778	0.739	0.752	0.721															
0.0003	DMA	0.766	0.802	0.810	0.810	0.778	0.794	0.778	0.783														
0.0102	DOM	0.772	0.796	0.798	0.810	0.780	0.796	0.774	0.800	0.787													
0.0247	ECU	0.799	0.818	0.818	0.827	0.806	0.818	0.803	0.818	0.811	0.827												
0.0116	SLV	0.812	0.825	0.825	0.835	0.816	0.826	0.812	0.831	0.819	0.835	0.840											
0.0005	GRD	0.762	0.797	0.813	0.806	0.775	0.789	0.772	0.791	0.804	0.821	0.833	0.787										
0.0026	GUY	0.784	0.817	0.828	0.830	0.797	0.811	0.792	0.816	0.818	0.837	0.846	0.812	0.821									
0.1954	MEX	0.788	0.820	0.830	0.828	0.799	0.812	0.797	0.807	0.823	0.837	0.848	0.808	0.830	0.822								
0.0058	NIC	0.749	0.787	0.801	0.799	0.763	0.780	0.758	0.784	0.788	0.811	0.822	0.785	0.805	0.806	0.773							
0.0050	PAN	0.761	0.791	0.800	0.803	0.772	0.787	0.766	0.791	0.790	0.812	0.821	0.792	0.812	0.813	0.781	0.786						
0.0083	PRY	0.816	0.825	0.813	0.836	0.819	0.833	0.819	0.826	0.808	0.823	0.830	0.834	0.846	0.847	0.821	0.816	0.807					
0.0389	PER	0.836	0.839	0.845	0.842	0.835	0.838	0.830	0.849	0.844	0.853	0.856	0.846	0.864	0.861	0.844	0.842	0.852	0.857				
0.0004	LCA	0.759	0.798	0.810	0.808	0.774	0.792	0.774	0.786	0.799	0.817	0.831	0.786	0.809	0.807	0.781	0.788	0.825	0.849	0.778			
0.0003	VCT	0.745	0.789	0.802	0.801	0.763	0.782	0.761	0.780	0.790	0.812	0.825	0.779	0.802	0.802	0.771	0.780	0.822	0.846	0.774	0.765		
0.0142	URY	0.764	0.791	0.804	0.800	0.773	0.785	0.763	0.799	0.793	0.816	0.824	0.798	0.817	0.821	0.784	0.789	0.822	0.842	0.795	0.786	0.783	

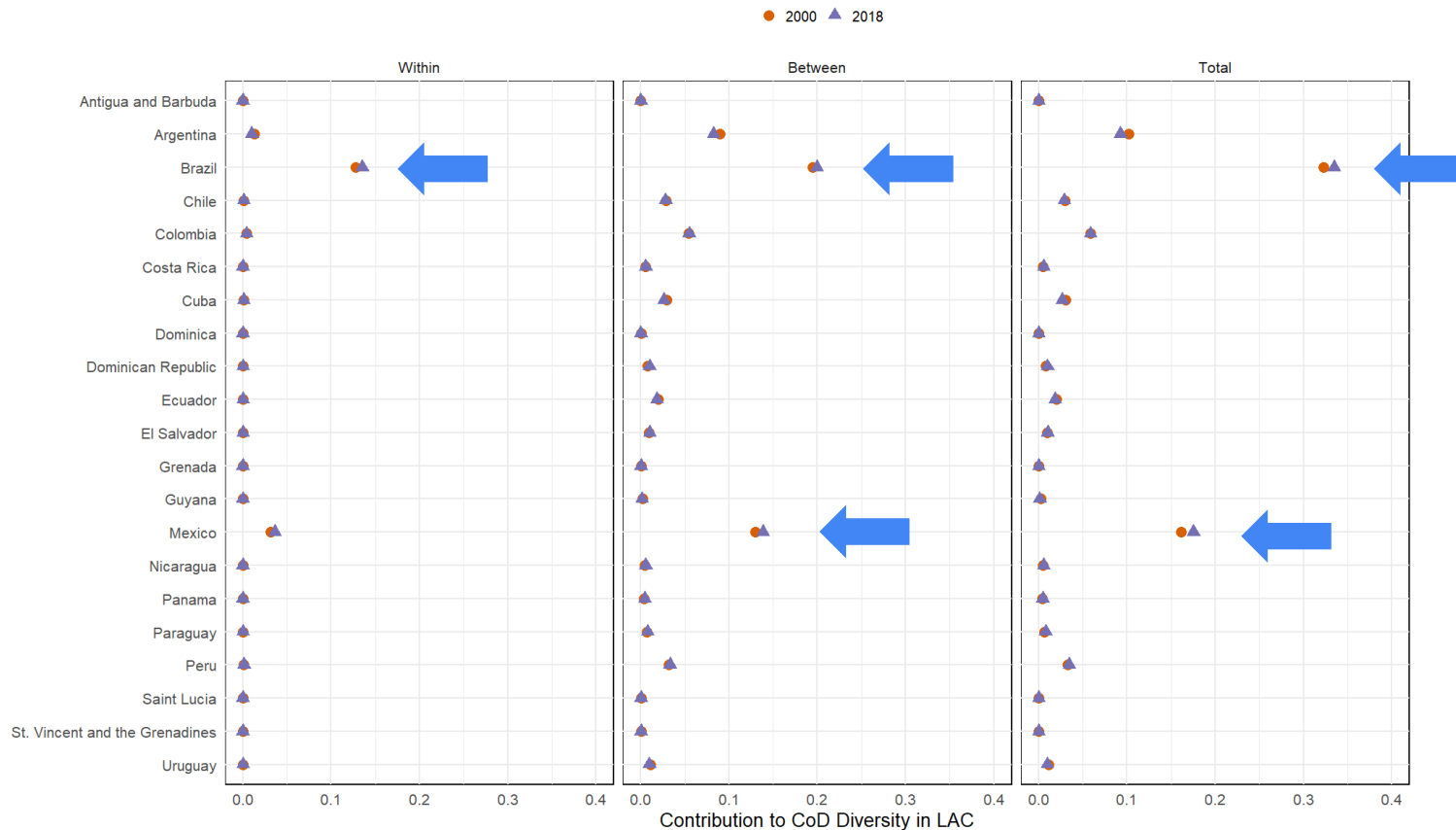
CoD diversity in multigroup settings – Women (2018)

Deaths distribution		ATG	ARG	BRA	CHL	COL	CRI	CUB	DMA	DOM	ECU	SLV	GRD	GUY	MEX	NIC	PAN	PRY	PER	LCA	VCT	URY	
0.0002	ATG	0.734																					
0.1123	ARG	0.802	0.817																				[0.712-0.743[
0.4024	BRA	0.803	0.830	0.836																			[0.743-0.774[
0.0350	CHL	0.807	0.829	0.836	0.830																		[0.774-0.805[
0.0733	COL	0.763	0.801	0.810	0.807	0.771																	[0.805-0.836[
0.0070	CRI	0.788	0.822	0.827	0.822	0.794	0.810																[0.836-0.867]
0.0333	CUB	0.770	0.808	0.815	0.810	0.776	0.797	0.772															
0.0002	DMA	0.761	0.815	0.818	0.817	0.780	0.801	0.786	0.779														
0.0124	DOM	0.771	0.815	0.820	0.825	0.788	0.812	0.793	0.792	0.793													
0.0224	ECU	0.798	0.830	0.835	0.835	0.808	0.824	0.814	0.814	0.818	0.830												
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0.0003	GRD	0.783	0.832	0.832	0.834	0.804	0.820	0.809	0.803	0.812	0.828	0.836	0.815										
0.0015	GUY	0.747	0.810	0.811	0.815	0.773	0.796	0.778	0.772	0.779	0.807	0.808	0.794	0.756									
0.2122	MEX	0.782	0.833	0.833	0.837	0.805	0.821	0.813	0.804	0.812	0.828	0.834	0.817	0.792	0.811								
0.0071	NIC	0.764	0.818	0.819	0.822	0.785	0.806	0.792	0.786	0.794	0.815	0.815	0.805	0.774	0.802	0.786							
0.0058	PAN	0.770	0.817	0.820	0.821	0.787	0.807	0.792	0.790	0.797	0.817	0.817	0.810	0.780	0.810	0.792	0.795						
0.0094	PRY	0.793	0.832	0.835	0.838	0.810	0.827	0.815	0.813	0.815	0.830	0.826	0.825	0.803	0.825	0.811	0.815	0.826					
0.0407	PER	0.840	0.839	0.852	0.849	0.831	0.844	0.840	0.846	0.850	0.853	0.867	0.854	0.847	0.855	0.850	0.849	0.859	0.840				
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0.0003	VCT	0.725	0.801	0.799	0.804	0.758	0.783	0.763	0.753	0.764	0.794	0.791	0.779	0.738	0.778	0.757	0.762	0.788	0.846	0.756	0.712		
0.0116	URY	0.826	0.844	0.851	0.845	0.828	0.840	0.825	0.836	0.839	0.847	0.844	0.850	0.834	0.855	0.840	0.837	0.848	0.867	0.841	0.822	0.849	

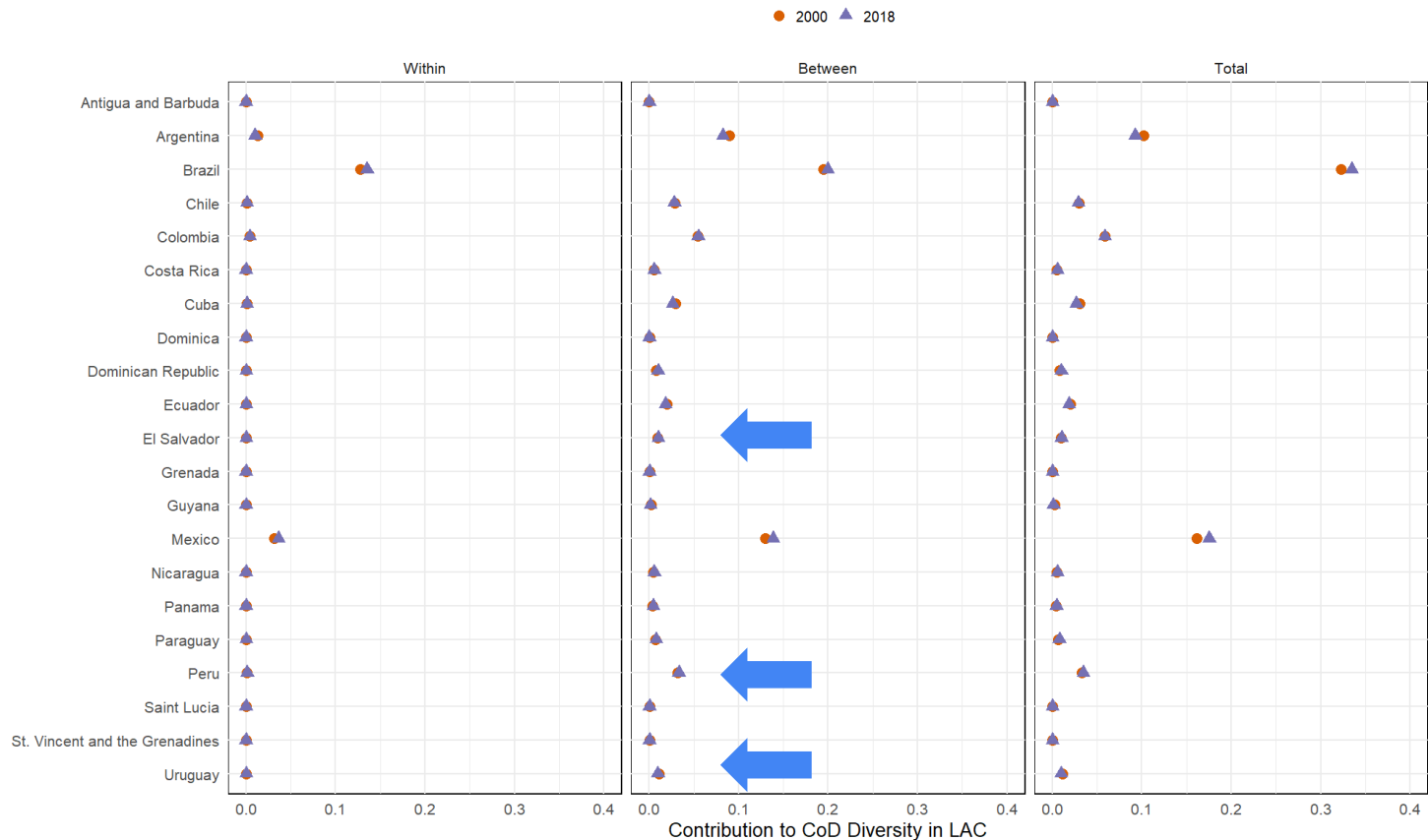
Countries' contribution to CoD diversity in the LAC region and its components – Women (2000 and 2018)



Countries' contribution to CoD diversity in the LAC region and its components – Women (2000 and 2018)



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DISCUSSION

- Cause of death (CoD) heterogeneity is a central marker of populations' health, informing about the predictability of death – a key ingredient for elaborating successful policies aimed at improving health and increasing longevity.
- The decomposition approach allows determining what the main sources of CoD diversity are, thus providing a useful tool for analysts and policy-makers aiming at identifying and eliminating health inequalities.
- The differences in the CoD profiles between the LAC countries explain expressively more of the overall CoD diversity than the diversity within the countries. → Even though all LAC countries experience a mortality profile with a high prevalence of chronic diseases, the concentration around these causes varies greatly between countries, resulting in very different CoD profiles from each other.
- **Applications of the new methodology provide complementary information about the heterogeneity in mortality profiles, thus presenting valuable insights into the evaluation and design of public health policies.**

THANK YOU!

jalmeida@ced.uab.es

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LIMITATIONS

1. Diversity indicators are sensitive to the number of categories (CoD).
2. The decomposition in components (*between* and *within*) is also sensitive to the number of groups (countries). The greater the number of groups, the greater the between component will be.

→ To reduce these problems, we used the same CoD grouping and the same countries during the entire period.

3. These indicators are also susceptible to small numbers; therefore, the Caribbean islands' time series present many oscillations.