Sociodemographic inequities in nurturing care for early childhood development across Brazilian municipalities

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Abstract
Providing an enabling nurturing care environment for early childhood development (ECD) that cuts across the five domains of the Nurturing Care Framework (i.e., good health, adequate nutrition, opportunities for early learning, security and safety and responsive caregiving) has become a global priority. Brazil is home to approximately 18.5 million children under 5 years of age, of which 13% are at risk of poor development due to socio-economic inequalities. We explored whether the Early Childhood Friendly Municipal Index (IMAPI) can detect inequities in nurturing care ECD environments across the 5570 Brazilian municipalities. We examined the validity of the IMAPI scores and conducted descriptive analyses for assessing sociodemographic inequities by nurturing care domains and between and within regions. The strong correlations between school achievement (positive) and socially vulnerable children (negative) confirmed the IMAPI as a multidimensional nurturing care indicator. Low IMAPI scores were more frequent in the North (72.7%) and Northeast (63.3%) regions and in small (47.7%) and medium (43.3%) size municipalities. Conversely, high IMAPI scores were more frequent in the more prosperous South (52.9%) and Southeast (41.2%) regions and in metropolitan areas (41.2%). The security and safety domain had the lowest mean differences (MD) among Brazilian regions (MD = 5) and population size (MD = 3). Between-region analyses confirmed inequities between the North/Northeast and South/Southeast. The biggest within-region inequity gaps were found in the Northeast (from -22 to 15) and the North (-21 to 19). The IMAPI distinguished the nurturing care ECD environments across Brazilian municipalities and can inform equitable and intersectoral multilevel decision making.

KEYWORDS
Brazil, child development, cities, environmental indicator, index, monitoring, nurturing care, public health surveillance
1 | INTRODUCTION

Providing a nurturing care environment for early childhood development (ECD) that cuts across the five domains of the Nurturing Care Framework (i.e., good health, adequate nutrition, opportunities for early learning, security and safety and responsive caregiving) has become a global priority to ensure that children survive and thrive (Black et al., 2017, 2021; Britto et al., 2017; Richter et al., 2017; World Health Organization [WHO], 2019). Brazil is the largest country in South America, with approximately 18.5 million children under 5 years of age (9% of the Brazilian population) (IBGE, 2017). Their optimal development is critical to the human capital development of the country (Black et al., 2017, 2021; Lu et al., 2020; Shonkoff et al., 2012). However, Brazil lacks a systematic monitoring system with disaggregated ECD data. In 2015, an estimated 13% of children under the age of 5 were at risk of poor development due to stunting or extreme poverty (Richter et al., 2017). Brazil is a very inequitable society, which is captured through the great socioeconomic variation across regions and the 5570 municipalities (Instituto de Pesquisa Econômica Aplicada [IPEA], 2015). These inequities are also highly visible as a function of skin colour, with Black and Brown individuals being much more likely to live in poverty irrespective of which region in the country that they live. They are 56% of the Brazilian population and represent 73% of the poor in Brazil (IBGE, 2017).

Brazil experiences strong inequities in child poverty and maternal health and childcare (Aristides dos Santos et al., 2019). Hence, strengthening evidence-based ECD policies and programmes for intersectoral nurturing care should be a top priority in the country. This is especially important for the future of the nation as nurturing care has been identified as critical to reduce inequities and as the foundation for equitable human and social development (Black et al., 2017, 2021; Morris et al., 2017) and for countries to meet the Sustainable Development Goals (Black et al., 2017, 2021; Britto et al., 2017; Richter et al., 2017).

The Brazilian 2016 Legal Framework for ECD (Câmara dos Deputados, 2016), which aligns well with the WHO/UNICEF/World Bank Nurturing Care Framework (Black et al., 2017, 2021; Britto et al., 2017; Richter et al., 2017; WHO, UNICEF, & World Bank, 2018), outlines the importance of strengthening ECD systems to break the cycle of poverty by ensuring that all children, especially the most vulnerable, reach their development potential over their life course. Therefore, in recent years, the ECD agenda in Brazil has been strengthened, which has led to strong increases in investments and efforts to implement ECD programmes, targeting the most socio-economically vulnerable children in the country, on a large scale. The majority of these investments have gone into the Criança Feliz (‘Happy Child’ programme), a national home visiting programme that has already been implemented in about 3000 Brazilian municipalities. Unfortunately, the programme has run into many obstacles (Buccini, Pedroso et al., 2021), because Brazil, as many other countries, still lacks a systematic approach to collect data that support evidence-informed equitable and intersectoral decision making to improve integrated ECD policies and programmes based on the Nurturing Care Framework.

The Nurturing Care Framework includes a global call to monitor ECD environments across nurturing care domains (Richter et al., 2019, 2020; WHO, 2019), especially in the context of highly inequitable societies like Brazil. In response to this call, we developed the Early Childhood Friendly Municipal Index (IMAPI—Índice Município Amigo da Primeira Infância), which as far as we know is the first attempt to assess nurturing care for ECD at the municipal level (Buccini et al., 2021). The IMAPI is computed with a large amount of municipal-level data derived from public databases in the critical ECD areas of health, education and social development. The data are integrated into a single score to monitor the overall nurturing care environment for ECD. The aims of this study were to explore the potential of the IMAPI to assess the nurturing care environments at the municipal level and elucidate whether it can detect sociodemographic inequities in the nurturing care ECD environment(s) across the 5570 Brazilian municipalities.

2 | METHODS

2.1 | Study settings

This is an ecological study designed to generate and analyse IMAPI scores in the 5570 Brazilian municipalities within 26 states and the Federal District. The IMAPI was developed following an eight-steps methodology (Appendix S1). The first three steps involved a
Analytical steps to assess sociodemographic inequities in the nurturing care environments can be found in Appendix S3.

For the purpose of statistical analysis, we categorized the overall IMAPI score and subscores into high, medium and low categories based on the corresponding tercile distributions. Following the statistical criteria of having at least two indicators in the subscore domain to be included in the overall IMAPI score, the responsive caregiving domain was excluded. The overall IMAPI score is composed of 30 indicators across four Nurturing Care domains. The overall IMAPI score and subscores ranged from 0 to 100, and scores were categorized in high, medium and low categories based on the corresponding tercile distributions. The detailed description of methods to impute, standardize and estimate IMAPI scores can be found in Appendix S3.

2.2 | Data analysis

Four analytical steps were followed to assess sociodemographic inequities in the nurturing care environments (Figure 1). Statistical analyses were conducted in Stata 14.2 and SPSS 21.0.

2.2.1 | Step 1. Validity of the IMAPI scores

The validation process was conducted to find out if the IMAPI could provide a metric that captures the multiple dimensions of the nurturing care environment (purpose) in Brazilian municipalities (context) (Frongillo, 1999). The predictive validity (i.e., how well one measure predicts an outcome or measure) and the concurrent validity (i.e., how well one measure estimates a related condition present at approximately the same time) (Lin & Yao, 2014) were the two validity approaches used to test whether the IMAPI captured the different dimensions of the nurturing care environment for ECD across municipalities. Because data about ECD outcomes in Brazil are currently unavailable, the outcome considered in the predictive validity analysis was the 2017 Basic Education Development Index (IDEB). Based on a multidimensional scale, the IDEB summarizes elementary-aged children’s school achievement (i.e., enrolment, proficiency and success), and IDEB scores range from 0 to 10 (Chirinea & Brandão, 2015; Organization for Economic Co-operation and Development [OECD], 2015). We hypothesized that an enabling nurturing care environment would be associated with a higher proportion of children with optimal development and school readiness. Previous studies have indicated that higher IDEB scores reflect the maximum benefit from both pre-school and formal education (OECD, 2015; WHO, UNICEF, & World Bank, 2018). In the concurrent validity analysis, the outcome considered was the number of vulnerable children, that is, children under the age of 5 living in socio-economic vulnerable families (i.e., monthly income of up to half a minimum wage per person or total monthly family income of up to three minimum wages) registered in the National Social Assistance Registry (CADÚNICO) (IBGE, 2017). We hypothesized that an enabling nurturing care environment would be associated with a lower proportion of at-risk vulnerable children, as suggested in previous studies (Lu et al., 2016; Richter et al., 2017; Walker et al., 2011). Validity approaches were assessed through Spearman correlations between IMAPI scores and predictive (IDEB) and concurrent (vulnerable children) outcomes. Positive or negative correlations were classified as negligible (0.00–0.19), weak (0.20–0.29), moderate (0.30–0.39), strong (0.40–0.69) or very strong (0.70–1.00) relationships (Akoglu, 2018; Schober et al., 2018). A p value < 0.05 was the criterion for statistical significance.

2.2.2 | Step 2. Descriptive analysis of IMAPI scores and subscores

The overall IMAPI-municipality score and subscores of the 5570 Brazilian municipalities are illustrated in maps. IMAPI scores were colour coded in three categories high (green), medium (yellow) and low (red) based on the corresponding tercile distributions.

2.2.3 | Step 3. Sociodemographic inequities across nurturing care domains

First, overall IMAPI score and subscores were described across three sociodemographic indicators: (1) Brazilian region (IBGE, 2017): North, Northeast, Central-West, Southeast and South; (2) municipality population size (IBGE, 2017): very small (up to 20,000 inhabitants), small (20,001 to 50,000), medium (50,001 to 100,000), large (100,001

FIGURE 1 Analytical steps to assess sociodemographic inequities in the nurturing care environments
to 900,000) and metropolis (>900,000); and (3) proportion of vulnerable children, that is, children under the age of 5 from socially vulnerable families registered in the National Social Assistance Registry (CADÚNICO) (IBGE, 2017). The proportion of vulnerable children was analysed as either as continuous based on mean values or classified into categories—very low (up to 20%), low (20% to 30%), medium (30% to 40%), high (40% to 50%) and very high (over 50%)—according to the Social Vulnerability Index (IPEA, 2015). The description of municipalities according to the three-selected demographic indicators is provided in Appendix S4. Differences in scores across categories were explored using the chi-square test, and a p value < 0.05 was the criterion for statistical significance. Then, we estimated the mean IMAPI score and subscores by sociodemographic indicators and calculated the mean difference (MD) between the highest and the lowest mean scores.

2.2.4 Step 4. Regional inequities between and within Brazilian regions

For the between-group analyses, we classified state-level IMAPI scores (which correspond to the mean scores of all municipalities within that state) as high, medium and low according to their tercile distributions. The difference between overall state IMAPI and the national IMAPI scores were calculated. For the within-group analysis, we selected the five municipalities with the highest and the five with the lowest overall IMAPI scores in each region. The difference between the overall municipal and national IMAPI scores was used to estimate the size of the differences within regions.

3 RESULTS

The overall IMAPI score was strongly correlated with the IDEB (r = 0.61, p < 0.01) and vulnerable children (r = −0.48, p < 0.01), which confirms its potential to capture the multiple dimensions of an enabling nurturing care environment for ECD across municipalities. The overall IMAPI score and subscores across municipalities are presented in Figure 2. The overall IMAPI scores for 2170 (39.0%) municipalities were low, 1658 (29.8%) were medium and 1742 (31.3%) were high. Around a third of municipalities exhibited low IMAPI subscores (Appendix S3).

The IMAPI scores and subscores were able to document great sociodemographic inequities in the enabling nurturing care ECD environments across Brazilian municipalities. Low overall IMAPI scores were more frequent in municipalities in the North (72.7%) and Northeast (63.3%) regions of the country and in municipalities with small (47.7%) and medium (42.3%) population size. By contrast, high overall IMAPI scores were more frequent in municipalities in the South (52.9%) and in municipalities with over 900,000 inhabitants (41.2%) (Table 1). Whereas low subscores in good health, adequate nutrition and opportunities for early learning were more frequent in municipalities in the North and Northeast, low subscores in security and safety were more frequent in the Central-West, closely followed by the South. High subscores in good health (39.9%) and security and safety (31.1%) were more frequent for very small population size municipalities; by contrast, high subscores in adequate nutrition (94.1%) and opportunities for early learning (52.9%) were more frequent in metropolitan areas. The IMAPI scores were also found to be associated with the proportion of vulnerable children (Table 1). The MDs in IMAPI

![Image of Figure 2: Spatial distribution of overall IMAPI and domain subscores in the 5570 Brazilian municipalities]
### Table 1: Sociodemographic characteristics of the municipalities in relation to the four domains included in the IMAPI

| Sociodemographic characteristics of the municipalities | Total (n) | IMAPI | Good health | Adequate nutrition | Opportunities for early learning | Security and safety |
|--------------------------------------------------------|----------|-------|-------------|-------------------|-------------------------------|-------------------|
|                                                        |          | High (%) | Medium (%) | Low (%)            | High (%) | Medium (%) | Low (%) | High (%) | Medium (%) | Low (%) | High (%) | Medium (%) | Low (%) | High (%) | Medium (%) | Low (%) |
| **Regions**                                            |          |         |            |                   |         |            |         |         |            |         |         |            |         |         |            |         |
| North                                                  | 450      | 6.0     | 21.3       | 72.7              | 20.0    | 51.1       | 28.9    | 4.0     | 25.6       | 70.4    | 19.8     | 48.9       | 31.1    |
| Northeast                                              | 1784     | 5.7     | 31.0       | 63.3              | 22.7    | 36.6       | 41.7    | 1.7     | 29.1       | 69.2    | 37.8     | 46.4       | 15.8    |
| Southeast                                              | 1668     | 41.2    | 43.7       | 15.0              | 36.6    | 51.1       | 22.7    | 39.6    | 46.8       | 13.7    | 31.1     | 14.8       | 44.1    |
| South                                                  | 1191     | 52.9    | 40.1       | 7.1               | 50.4    | 35.7       | 24.4    | 75.8    | 23.2       | 1.0     | 13.9     | 30.2       | 55.8    |
| Central-West                                           | 467      | 22.5    | 50.5       | 27.0              | 31.7    | 27.2       | 31.9    | 37.7    | 46.7       | 15.6    | 6.1      | 30.8       | 63.0    |
| **Population size**                                    |          |         |            |                   |         |            |         |         |            |         |         |            |         |         |            |         |
| Very small                                             | 3811     | 32.5    | 37.4       | 30.1              | 39.9    | 35.2       | 33.4    | 32.6    | 34.0       | 33.4    | 31.1     | 34.6       | 34.2    |
| Small                                                  | 1100     | 15.9    | 36.7       | 47.7              | 19.5    | 20.8       | 41.6    | 25.9    | 31.7       | 42.4    | 19.7     | 40.6       | 39.6    |
| Medium                                                 | 350      | 16.3    | 41.4       | 42.3              | 12.9    | 21.7       | 46.3    | 36.3    | 34.9       | 28.9    | 13.4     | 36.6       | 50.0    |
| Large                                                  | 292      | 25.7    | 38.7       | 35.6              | 8.2     | 41.4       | 53.4    | 42.1    | 46.2       | 11.6    | 8.6      | 25.0       | 66.4    |
| Metropolis                                             | 17       | 41.2    | 47.1       | 11.8              | 0.0     | 94.1       | 5.9     | 52.9    | 47.1       | 0.0     | 5.9      | 23.5       | 70.6    |

*Proportion of vulnerable children (mean)*

*\(p < 0.001\) for all characteristics.*
scores across Brazilian regions, municipal population size and proportion of vulnerable children confirmed strong sociodemographic inequities in the strength of nurturing care ECD environments. The security and safety domain had the lowest MDs according to Brazilian regions (MD = 5) and municipal population size (MD = 3). By contrast, opportunities for early learning had the highest MDs across Brazilian regions (MD = 23) and proportion of vulnerable children (MD = 19) but not for municipal population size (Table 2).

When comparing the difference, as a function of sociodemographic characteristics, between and within each region, we found marked differences in the strength of the enabling nurturing care ECD environment. Between-region analyses confirmed greater negative differences between state IMAPI scores and national IMAPI scores in the North and Northeast regions. By contrast, greater positive differences were found in most of the states in the South (Table 3). Only Rio Grande do Norte (located in the Northeast) and Minas Gerais (located in the Southeast) were in the high IMAPI category for security and safety; half of the states in the Southeast and Central-West were in the low IMAPI category for security and safety (Table 3). Within regions, inequities were marked by the largest negative difference between the overall municipal and the national IMAPI scores within the Northeast (from −22 to 15) and the North (−21 to 19) regions, respectively (Table 4).

| Municipalities characteristics | IMAPI Good health | Adequate nutrition | Opportunities for early learning | Security and safety |
|-------------------------------|------------------|-------------------|---------------------------------|--------------------|
| Region                        |                  |                   |                                 |                    |
| North                         | 38               | 48                | 23                              | 57                 |
| Northeast                     | 40               | 56                | 22                              | 58                 |
| Southeast                     | 47               | 60                | 31                              | 72                 |
| South                         | 48               | 63                | 28                              | 80                 |
| Central-West                  | 44               | 58                | 27                              | 72                 |
| Mean differences              | 10               | 15                | 9                               | 23                 |
| Population size               |                  |                   |                                 |                    |
| Very small                    | 45               | 60                | 27                              | 68                 |
| Small                         | 42               | 55                | 23                              | 66                 |
| Medium                        | 44               | 54                | 25                              | 69                 |
| Large                         | 42               | 53                | 31                              | 73                 |
| Metropolis                    | 47               | 49                | 44                              | 74                 |
| Mean differences              | 5                | 11                | 21                              | 8                  |
| Proportion of vulnerable children |              |                   |                                 |                    |
| Very low                      | 47               | 63                | 27                              | 80                 |
| Low                           | 46               | 60                | 28                              | 77                 |
| Medium                        | 45               | 59                | 28                              | 73                 |
| High                          | 44               | 58                | 27                              | 70                 |
| Very high                     | 41               | 56                | 24                              | 61                 |
| Mean differences              | 6                | 7                 | 4                               | 19                 |

4 | DISCUSSION

The IMAPI experience in Brazil revealed the complexity of measuring a multidimensional construct such as the nurturing care environment for ECD. Our analyses showed that the IMAPI had enough resolution to distinguish municipalities according to the level of strength that each exhibited for nurturing care environments. We found strong sociodemographic inequities in nurturing care environments between and within Brazilian regions, municipality population size and proportion of vulnerable children. Hence, IMAPI scores and subscores can be used as a summary measure to differentiate settings according to the strength in their enabling nurturing care environments and have the potential to help inform the development of improved evidence-based equitable and intersectoral multilevel decision making. The IMAPI can help advance monitoring and strengthening of nurturing care environments in other large countries also experiencing significant social and ECD inequities, such as Mexico, China and India.

The quantitative validity analyses of the IMAPI presented in this study, combined with the construct validity findings previously reported (Buccini et al., 2021), confirmed the ability of the IMAPI to capture the strength of the multiple dimensions of an enabling nurturing care ECD environment across Brazilian municipalities. The strong negative correlations between the overall IMAPI scores with proportion of vulnerable children and positive correlations with IDEB scores confirmed both of our hypotheses—an enabling nurturing care environment for ECD would be associated with a lower proportion of at-risk children (Lu et al., 2016; Lu et al., 2020; Richter et al., 2019) and predict a maximum benefit for the child’s formal education (OECD, 2015; WHO, UNICEF, & World Bank, 2018). Our findings illustrate the importance of interpreting the strength of these correlations within the context of the complexity of measuring a multidimensional and intersectoral construct such as the Nurturing Care Framework (Schober et al., 2018).
| Region          | States          | IMAPI-state score and subscores | IMAPI-state score and subscores | IMAPI-state score and subscores |
|-----------------|-----------------|---------------------------------|---------------------------------|---------------------------------|
| North           | Tocantins       | -1                              | -3                              | 3                               | 5                               | -6                              | 24                              | 2                               |
|                 | Rondônia        | -3                              | -1                              | 26                             | 0                               | 64                             | -4                              | 18                              | -4                             |
|                 | Roraima         | -7                              | -15                             | 23                             | -3                              | 57                             | -11                             | 24                              | 2                               |
|                 | Acre            | -9                              | -12                             | 15                             | -11                             | 52                             | -16                             | 25                              | 3                               |
|                 | Amazonas        | -10                             | -14                             | 15                             | -11                             | 52                             | -16                             | 24                              | 2                               |
|                 | Pará            | -10                             | -17                             | 19                             | -7                              | 54                             | -14                             | 21                              | -1                             |
|                 | Amapá           | -10                             | -17                             | 18                             | -8                              | 53                             | -15                             | 24                              | 2                               |
| Northeast       | Paraíba         | 0                               | 5                               | 29                             | 3                               | 59                             | -9                              | 25                              | 3                               |
|                 | Ceará           | -2                              | 2                               | 22                             | -4                              | 63                             | -5                              | 23                              | 1                               |
|                 | Pernambuco      | -3                              | 0                               | 27                             | 1                               | 57                             | -11                             | 23                              | 1                               |
|                 | Rio Grande do  | -3                              | -2                              | 23                             | -3                              | 62                             | -6                              | 22                              | 0                               |
|                 | Norte           |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
|                 | Piauí           | -4                              | -4                              | 21                             | -5                              | 57                             | -11                             | 28                              | 6                               |
|                 | Sergipe         | -4                              | -2                              | 25                             | -1                              | 58                             | -10                             | 23                              | 1                               |
|                 | Alagoas         | -4                              | -4                              | 25                             | -1                              | 56                             | -12                             | 24                              | 2                               |
|                 | Bahia           | -6                              | -5                              | 19                             | -7                              | 58                             | -10                             | 23                              | 1                               |
|                 | Maranhão        | -10                             | -9                              | 12                             | -14                             | 50                             | -18                             | 25                              | 3                               |
| Southeast       | Minas Gerais    | 5                               | 4                               | 36                             | 10                              | 70                             | 2                               | 27                              | 5                               |
|                 | Espírito Santo  | 4                               | 2                               | 30                             | 4                               | 79                             | 11                              | 22                              | 0                               |
|                 | São Paulo       | 1                               | 1                               | 26                             | 0                               | 76                             | 8                               | 18                              | -4                             |
|                 | Rio de Janeiro  | -2                              | -6                              | 25                             | -1                              | 70                             | 2                               | 19                              | -3                             |
| South           | Santa Catarina  | 5                               | 6                               | 27                             | 1                               | 83                             | 15                              | 21                              | -1                             |
|                 | Rio Grande do  | 4                               | 6                               | 26                             | 0                               | 80                             | 12                              | 22                              | 0                               |
|                 | Sul             |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
|                 | Paraná          | 3                               | 5                               | 29                             | 3                               | 79                             | 11                              | 22                              | 0                               |
| Central-West    | Distrito Federal| 11                              | 2                               | 58                             | 32                              | 79                             | 11                              | 22                              | 0                               |
|                 | Mato Grosso do  | 2                               | -4                              | 27                             | 1                               | 81                             | 13                              | 21                              | -1                             |
|                 | Sul             |                                 |                                 |                                 |                                 |                                 |                                 |                                 |                                 |
|                 | Goiás           | 0                               | 1                               | 26                             | 0                               | 70                             | 2                               | 20                              | -2                             |
|                 | Mato Grosso     | 0                               | 0                               | 27                             | 1                               | 71                             | 3                               | 18                              | -4                             |

Note: IMAPI-state score and subscores correspond to the mean performances of all municipalities within that state. Categories were classified as high (green color), medium (yellow color) and low (red color) according to tercile.
| Region          | Municipalities with HIGHEST IMAPI scores | State | Population size | IMAPI-municipal score | Diff municipal-national IMAPI score |
|----------------|-----------------------------------------|-------|-----------------|-----------------------|-------------------------------------|
| North (n = 450)| Presidente Kennedy                      | TO    | Very small      | 63                    | 19                                  |
|                | Brasilândia do Tocantins                | TO    | Very small      | 62                    | 18                                  |
|                | Araguaiana                              | TO    | Large           | 57                    | 13                                  |
|                | Jaú do Tocantins                        | TO    | Very small      | 55                    | 11                                  |
|                | Tupirama                                | TO    | Very small      | 55                    | 11                                  |
| North (n = 450)| Barcelos                                | AM    | Small           | 23                    | -21                                 |
|                | Igarapé-Miri                            | PA    | Medium          | 24                    | -20                                 |
|                | Feijó                                    | AC    | Small           | 25                    | -19                                 |
|                | Chaves                                   | PA    | Small           | 25                    | -19                                 |
|                | Jordão                                   | AC    | Very small      | 25                    | -19                                 |
| Northeast (n = 1794)| Serra Negra do Norte                  | RN    | Very small      | 59                    | 15                                  |
|                | Farias Brito                            | CE    | Very small      | 56                    | 13                                  |
|                | Areia de Baraúnas                       | PB    | Very small      | 56                    | 13                                  |
|                | São Bentinho                            | PB    | Very small      | 55                    | 11                                  |
|                | Sebastião Leal                          | PI    | Very small      | 55                    | 11                                  |
| Northeast (n = 1794)| Fernando Falcão                       | MA    | Very small      | 22                    | -22                                 |
|                | Paquetá                                 | PI    | Very small      | 22                    | -22                                 |
|                | Tupanatinga                             | PE    | Small           | 22                    | -22                                 |
|                | Presidente Juscelino                    | MA    | Very small      | 25                    | -19                                 |
|                | Lajedão                                  | BA    | Very small      | 25                    | -19                                 |
| Southeast (n = 1668)| Umburatiba                          | MG    | Very small      | 70                    | 26                                  |
|                | São Sebastião do Anta                   | MG    | Very small      | 67                    | 23                                  |
|                | Monjolos                                | MG    | Very small      | 67                    | 23                                  |
|                | Senador Modestino Gonçalves             | MG    | Very small      | 67                    | 23                                  |
|                | Cedro do Abaetê                         | MG    | Very small      | 67                    | 23                                  |
| Southeast (n = 1668)| Itambé do Mato Dentro                  | MG    | Very mall       | 23                    | -21                                 |
|                | Queimados                               | RJ    | Large           | 24                    | -20                                 |
|                | Belford Roxo                             | RJ    | Large           | 25                    | -19                                 |
|                | Lagoa dos Patos                         | MG    | Very small      | 25                    | -19                                 |
|                | Itaoca                                  | SP    | Very small      | 25                    | -19                                 |
| South (n = 1191)| Coronel Barros                          | RS    | Very small      | 74                    | 30                                  |
|                | Novo Horizonte                          | SC    | Very small      | 68                    | 24                                  |
|                | Bela Vista da Caroba                    | PR    | Very small      | 66                    | 22                                  |
|                | Uruguaiana                              | RS    | Large           | 65                    | 21                                  |
|                | Cotiporã                                | RS    | Very small      | 64                    | 20                                  |
| South (n = 1191)| São José do Cerrito                    | SC    | Very small      | 30                    | -14                                 |
|                | Canudos do Vale                         | RS    | Very small      | 34                    | -10                                 |
Among the nurturing care domains, the security and safety domain had the lowest MDs according to Brazilian regions and municipal population size. Our findings on ‘security’ (levels of child’s family social protection) may reflect the reach of the social protection services, including the Brazilian conditional cash transfer programme for the most vulnerable families, which has been shown to be a potent intersectoral policy for reducing inequities (Neves et al., 2020; Palmeira et al., 2020). However, socio-economic inequities in the ‘security’ domain may have been hidden by the lack of a robust process for notifying violence against women and children (Assis et al., 2012; Silva & Roncalli, 2020). Similarly, our findings on ‘safety’ (degree of community safety) confirmed recent analyses showing a decreased inequity gap between the number of homicides in metropolitan areas and in small and less urbanized municipalities (Nsosie et al., 2020). On the other hand, the fact that air pollution affects mainly urban areas where 85% of the Brazilian population live may have influenced the relatively low MDs in the ‘safety’ domain when analysed by region and municipal population size. Collectively, these facts may explain, at least in part, the lower MDs in sociodemographic inequities in the security and safety domain.

Opportunities for early learning exhibited the highest MD between Brazilian regions and proportion of children in social vulnerability. Inequities in access to early education for children from 0 to 6 years across regions were pronounced—ranging from 33.9% to 49.2% in the North and Southeast regions, respectively—and confirmed by the contrasting levels of illiteracy (15 years of age or older) in the Northeast (20.0%) and South (4.5%) regions (Conselho de Desenvolvimento Econômico e Social [CDES], 2014; OECD, 2015). These findings are consistent with our previous analysis illustrating that academic success since early childhood is as a function of the social development of a region; hence, educational interventions need to focus on the most socio-economically and geographically vulnerable populations (Arsenault et al., 2017; Black et al., 2021).

Regional social inequities are a well-known problem in Brazil (Aristides dos Santos et al., 2019; Gabert et al., 2017), and our study confirmed the strong inequities in nurturing care environments, especially within the most impoverished regions of the country—the Northeast and North—where the largest inequity gaps in nurturing care environments were found. There was a very strong contrast between the low IMAPI scores in the North/Northeast compared with the high IMAPI scores in the South/Southeast. Despite the slow progress the country has made in reducing regional inequities over the past decades that have helped children survive (Sengupta, 2019; Silva & Paes, 2019), in-depth structural inequities, such as income inequality (Aristides dos Santos et al., 2019; Reis, 2014), racial gaps in education and discrimination (Salata, 2020) and child poverty, are still denying vulnerable children access to a high-quality nurturing care environment that would allow them to thrive (Black et al., 2021).

Moving beyond regional disparities, the IMAPI further advances the contributions from existing population-based tools such as the Countdown to 2030 early childhood country profile (UNICEF, 2020) and the State of Babies in the United States (Keating et al., 2020), as it makes estimates at the municipal level. Hence, the IMAPI can identify inequities in nurturing care environments not only across but also within geographical areas. Therefore, our findings call for the need to address geographical and social exclusion (Arsenault et al., 2017) and support the expected central role of municipalities (Avellaneda, 2012), as established in the Brazilian Federative Pact, to build their own destinies following local decision-making roadmaps to manage and set priorities to fight nurturing care inequities.

### Table 4 (Continued)

| Region | Municipalities | State | Population size | IMAPI-municipal score | Diff municipal-national IMAPI score |
|--------|----------------|-------|-----------------|-----------------------|-----------------------------------|
| Central-West (n = 467) | | | | | |
| Municipalities with HIGHEST IMAPI scores | | | | | |
| Jaupaci | GO | Very small | 63 | | 19 |
| Campo Grande | MS | Large | 57 | | 13 |
| Israelândia | GO | Metropolitan | 55 | | 11 |
| Reserva do Cabaçal | MT | Very small | 55 | | 11 |
| Brasília | DF | Very small | 55 | | 11 |
| Municipalities with LOWEST IMAPI scores | | | | | |
| Maurilândia | GO | Very small | 27 | | -17 |
| Castelândia | GO | Very small | 30 | | -14 |
| Tesouro | MT | Very small | 30 | | -14 |
| Araguaiana | MT | Very small | 32 | | -12 |
| Guapó | GO | Very small | 33 | | -11 |

*IMAPI-national score is 44 and corresponds to the mean scores of all Brazilian municipalities.
Our findings showed that low IMAPI scores were more frequent in small and medium population size than very small and large municipalities, perhaps reflecting different challenges for nurturing care environments as a function of municipal population size (Avellaneda & Gomes, 2015; Wehrmeister et al., 2017). On the one hand, very small population size municipalities may have less capacity and less financial independence to invest in diversifying the offer of ECD-related programmes as they must rely more on federal-funded programmes (Avellaneda & Gomes, 2015). On the other hand, they may have more control over the integration and governance of ECD-related systems and programmes, which are critical aspects for enabling nurturing care (Britto et al., 2014) especially among the most socially vulnerable children (Wehrmeister et al., 2017). By contrast, a metropolis may have more challenges related to rapid urbanization and population growth leading to higher indices of violence and difficulty reaching the population living in the most impoverished peripheral neighbourhoods. This is illustrated in an in-depth systematic analysis of the implementation of the home visiting Criança Feliz parenting skills programme (Buccini, Pedroso, et al., 2021). Criança Feliz has faced scaling up challenges in capitals and metropolises due to complex logistical challenges of urbanization, such as long distances between homes, difficulty scheduling visits, insufficient federal funding, limited existing infrastructure and poor internet access (Buccini, Pedroso, et al., 2021). Furthermore, in Brazil, the population size of the municipality is important as it determines the amounts of federal financial transfers and incentives to equalize the income across municipalities, which has been critical for municipalities with very small populations, especially given their fragile economic and social structure (Massardi & Abrantes, 2016). In this sense, very small population size municipalities seemed to benefit from this financial equalization, as in our analysis, they presented better scores, which translate into more equitable nurturing care environments than small and medium population size municipalities (Wehrmeister et al., 2017). These findings call for specific financial protection and implementation strategies for advancing equity in nurturing care in municipalities with small and medium populations (Arsenault et al., 2017; Wehrmeister et al., 2017), which correspond to about 30% of the Brazilian municipalities.

A major strength of the IMAPI is that it combines a high volume of information from indicators of different disciplines and produces a summary measure and submeasures of enabling environments that are needed for proper ECD. The IMAPI was carefully and systematically developed following a series of methodological steps to summarize indicators representing the enabling environment for nurturing care. However, we acknowledged several limitations of our study. First, responsive caregiving was limited to one indicator and therefore did not meet the statistical criteria to be included in the overall IMAPI scores (Buccini et al., 2021; Appendix S3). This limitation was not unexpected given the challenge of measuring responsive caregiving globally (UNICEF, 2020). Second, as expected, the security and safety domain were challenging to interpret due to the bidirectional dimension of this domain (WHO, 2019), which sometimes can lead to counterintuitive findings. In the case of the IMAPI, ‘security’ measured levels of children’s social protection (i.e., coverage of the conditional cash transfer and notification of violence against women and children), and ‘safety’ measured the degree of community safety or lack of it (i.e., homicides and air pollution). For instance, the authors had a substantive debate about how to interpret the ‘notification of violence against children and women’ indicators. On the one hand, these indicators could be interpreted as being protective for ECD—more notifications of violence bring more supportive services to a community. On the other hand, they could be indicators of risk for ECD—higher number of violence notifications could simply reflect higher level of violence in the community. This is because, although the notification of violence against children and women is mandatory in Brazil, it is not a formal charge, but rather an instrument to guarantee human rights; thus, in this sense, it should be interpreted as a protective community factor and, consequently, inversely related to inequalities in child health as suggested in previous studies (Wehrmeister et al., 2017). Third, the adequate nutrition domain was composed of indicators from the Brazilian Food and Nutrition Surveillance System (SISVAN), which collects continuous information on the nutritional status and food consumption of children and adolescents receiving primary health care services (Mourão et al., 2019). We originally planned to select individual-level indicators (e.g., breastfeeding and prevalence of overweight/obesity) to compose IMAPI scores. However, due to the low coverage of individual-level nutritional indicators in the SISVAN across municipalities (Mourão et al., 2019), the IMAPI evaluated the nutritional surveillance capacity of the municipalities through municipal-level aggregated information (the proportion of children with information in the SISVAN). Finally, we acknowledge that the IMAPI should be refined as more indicators across nurturing care domains become available, including counselling programmes addressing responsive feeding (Pérez-Escamilla et al., 2021).

In summary, the IMAPI, which is rooted in the Nurturing Care Framework, is a simple and useful population-based tool to summarize the strength of and identify inequities in nurturing care at the regional and municipal levels. Hence, the IMAPI can help guide a more accurate and in-depth understanding of where the major gaps are in the nurturing care environments across municipalities, ultimately favouring equitable policies and smart investments.

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CONFLICTS OF INTEREST
The authors have none conflicts to declare.

CONTRIBUTIONS
GB, MEB and MBG conceptualized the Brazilian Early Childhood Friendly Municipal Index (IMAPI). GB and SEACK analysed the data.
with the support of JP, AS and JB and intellectual input of MBG. GB interpreted the data and wrote the first draft of the manuscript, and MBG, MEB, RPE and SIV revised it critically through an iterative process. All authors revised and approved the final version of the manuscript.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Additional supporting information may be found online in the Supporting Information section at the end of this article.

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