

CST 310 / SER 417: Population, Space & Environment

Spatial Approaches in Population Studies: Analytical Methods and Representation Techniques

Basic Concepts and Measures in Demography Fecundity & Growth

Silvana Amaral
Antonio Miguel V. Monteiro

{silvana.amaral@inpe.br; miguel.monteiro@inpe.br}



Natality & Fecundity



Natality: relationship between live-born and total population

Fecundity: relationship between live-born and women of reproductive age women.

- **Fertility:** Women's reproductive potential
- **Fecundity:** real result of Women's reproductive potential
 - The greater the control over the **size of offspring** the greater the distance between Fecundity and Fertility;
 - Even without controlling: Fecundity << Fertility

causes: Onset and frequency of sexual intercourse and fetal loss)

Natality & Fecundity



Natality: relationship between live-born and total population

Gross Nataly Rate (TBN) - ratio of the number of children born alive during one year to the total population.

$$TBN_j = \frac{N_j}{Q_j} 1000$$

Where N_j is the number of children born alive along the year j .

* Usually this ratio is expressed per thousand inhabitants.

Natality & Fecundity



Gross Natality Rate (TBN)

The denominator is the total population in the middle of the year
(approximation of the number of person-years).

TBN can be determined by sex, relating the respective birth and population numbers.

It depends on >> **the Intensity with which women have children at each age;**
 n women of childbearing (*idade fértil*) age (proportion of total pop)

Relative age distribution of women in the reproductive period

- It is not a good indicator to analyze differentials of Fecundity levels between populations.

It is not a risk measure -> not all people in the denominator are liable to become parents in the year in question.

The risk measure is given by *Fecundity rates*!

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General fecundity rate(TFG)

- GFR in a given year (j) is: the *ratio* between the number of **live-borns N_j** and the **female population at reproductive** or fertile age - childbearing.
- The fertile age of the female population: women between 15 and 49 years old.

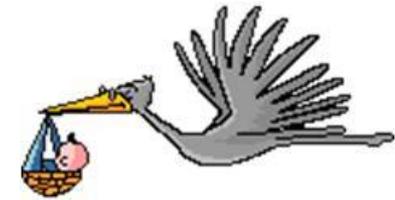
$$TFG_j = \frac{N_j}{{}_{35}Q_{15,f,j}}$$

${}_{35}Q_{15,f,j}$ is the number of women between 15 to 49 y.

TFG - depends on:

- intensity of women have children at each age AND
- proportional age distribution of women within the range of 15 to 49 years of age

Natality & Fecundity



General fecundity rate(TFG)

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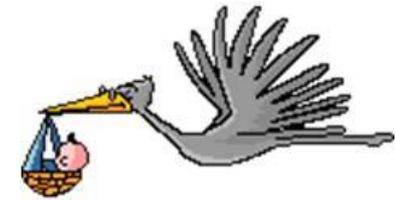
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TFG - depends on:

- intensity of women have children at each age AND
- proportional age distribution of women within the range of 15 to 49 years of age

It is not a good measure to compare differentials of Fecundity levels among populations whose age distributions of women of childbearing age are different

Natality e Fecundity



Specific Fecundity Rate (TEF)

TEF - in a given year, by the woman age, is:

the ratio between the number of live-borns from mothers at a given age and the number of women at that age or age group ($x, x + n$)

$${}_nTEF_{x,j} = \frac{{}_nN_{x,j}}{{}_nQ_{x,f,j}}$$

TEFs : refined age-specific rate and marital status by sex, by birth order, etc.

TEFs - Could be possible by individual age of women, but the most common is to calculate or estimate them **by five-yearly** (*quinquenal*) age groups, starting at 15-19 and ending at 45-49 years.

Natality e Fecundity



What about men ????

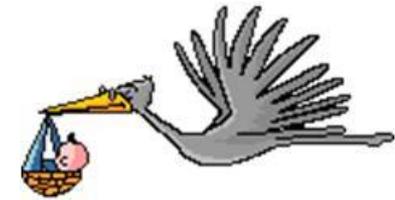
Conceptually, it would not be difficult to consider Fecundity in relation to the male population, but ...

- the longest male fertile period
- indefinite upper limit
- Less certainty about the child's paternity ...



➔ Fecundity rates refer to the female population at risk

Natality e Fecundity



Total Fecundity Rate (TFT)

Because it is difficult to work with a set of five five-year TEFs for each population, TFT is used.

Average number of children that a woman would have at the end of the reproductive period.

TFT depends on the TEFs set:

$$TFT_j = n \sum_x {}_nTEF$$

Since TFT is not influenced by the age distribution of women (the population to which it refers), TFTs from different populations can be used to compare Fecundity levels, as they depend only on FTEs and do not depend on the concrete age distributions.

Natality e Fecundity



Total Fecundity Rate (TFT)

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Average number of children that a woman would have at the end of the reproductive period.

TFT depends on the TEFs set:

$$TFT_j = n \sum_x {}_nTEF$$

Since TFT is not influenced by the age distribution of women (the reference-population)

→ They depend only on FTEs and do not depend on the real age distributions.

TFTs from different populations can be used to compare Fecundity levels

Natality & Fecundity



TEF: in average, 0,0526 live-born by women of **15 -19y** (or 52,6 live-born at each 1000 women)

TAXAS ESPECÍFICAS DE FECUNDIDADE,
DE FECUNDIDADE GERAL E DE FECUNDIDADE TOTAL (TFT)
RIO GRANDE DO SUL, 1980

TFT = 2.6015

Meaning: the average number of live-born at the end of fertile period, of a hypothetical generation, considering the current fecundity rate (RS, 1980).

The total RS population estimated for July 1, 1980 was 7,753,921 people.

The total number of live-born observed was 173,960.

Grupo etário	População feminina (1/7/80)	Nascidos vivos (ambos os sexos)	Taxa específica de fecundidade (TEF)	Taxa de fecundidade geral (TFG)
15-19	447.604	23.542	0,0526	-
20-24	398.691	54.676	0,1371	-
25-29	337.085	48.114	0,1427	-
30-34	278.654	28.762	0,1032	-
35-39	231.700	13.602	0,0587	-
40-44	206.117	4.601	0,0223	-
45-49	180.169	663	0,0037	-
15-49	2.080.020	173.960	-	0,0836
TFT	-	-	2,6015	-

Fontes: Dados elaborados a partir de: ESTATÍSTICA DO REGISTRO CIVIL, 1980 e 1981. Rio Janeiro: IBGE; Censo demográfico: dados gerais, migração, fecundidade, mortalidade, Rio Grande do Sul. Rio de Janeiro: IBGE 1982. (IX Recenseamento Geral do Brasil, 1980, v.1, t. 4, n. 22)

TBN = 22.44 per 1000 (1980)

For every thousand people of the population that year

22.44 children would have been born

TFT: sum of TEF * n years
or 0.5203 * 5anos = 2,6015

TFG = 173960 / 2080020 = 0.8363

Natality & Fecundity



Total Fecundity Rate (TFT) - average number of live-borns that a woman would have at the end of her reproductive period

The projection of **IBGE population, announced in 2013** (PROJECTION ..., 2013) TFT Brazil:

2000 = 2.39 children per woman,

2013 = 1.77

➔ a drop of 26% in this indicator.

At rates **above** population replacement level (2.10):

in Acre (2.59 children per woman),

Amapá (2.42), Amazonas (2.38), Roraima (2.34), Maranhão (2.28), and Pará (2.20)

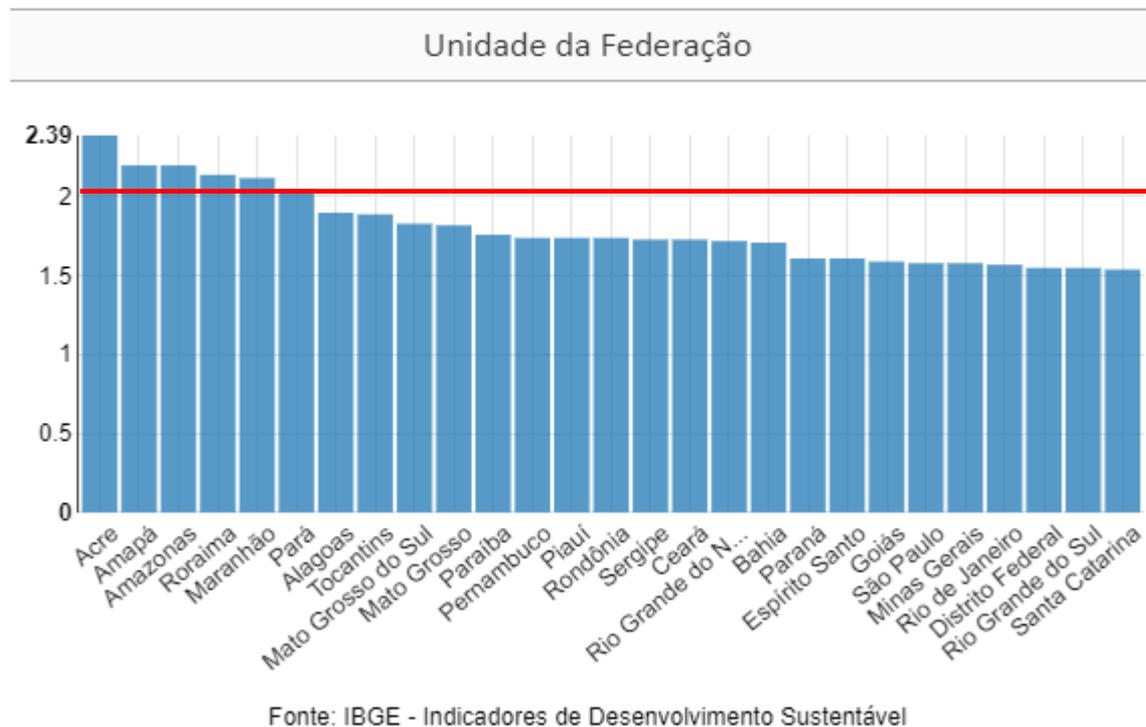
- The **lowest** values in this indicator were observed: in Santa Catarina (1.58 children per woman), Federal District (1.59), Rio Grande do Sul (1.60), Rio de Janeiro (1.62) and São Paulo and Minas Gerais (1,63)

2015 = 1.72 (projeção)

Natality & Fecundity



- Tabela 3727 - Taxa de fecundidade total
- Variável = Taxa de fecundidade total
- Ano = 2016



Total Fecundity Rate (TFT) -

At rates **above** population replacement level (2.10):

Acre (2.59 ->2.39),
Amapá (2.42->2.2),
Amazonas (2.38->2.2),
Roraima (2.34->2.14),
Maranhão (2.28->2.12),
Pará (2.20-> **2.05**)

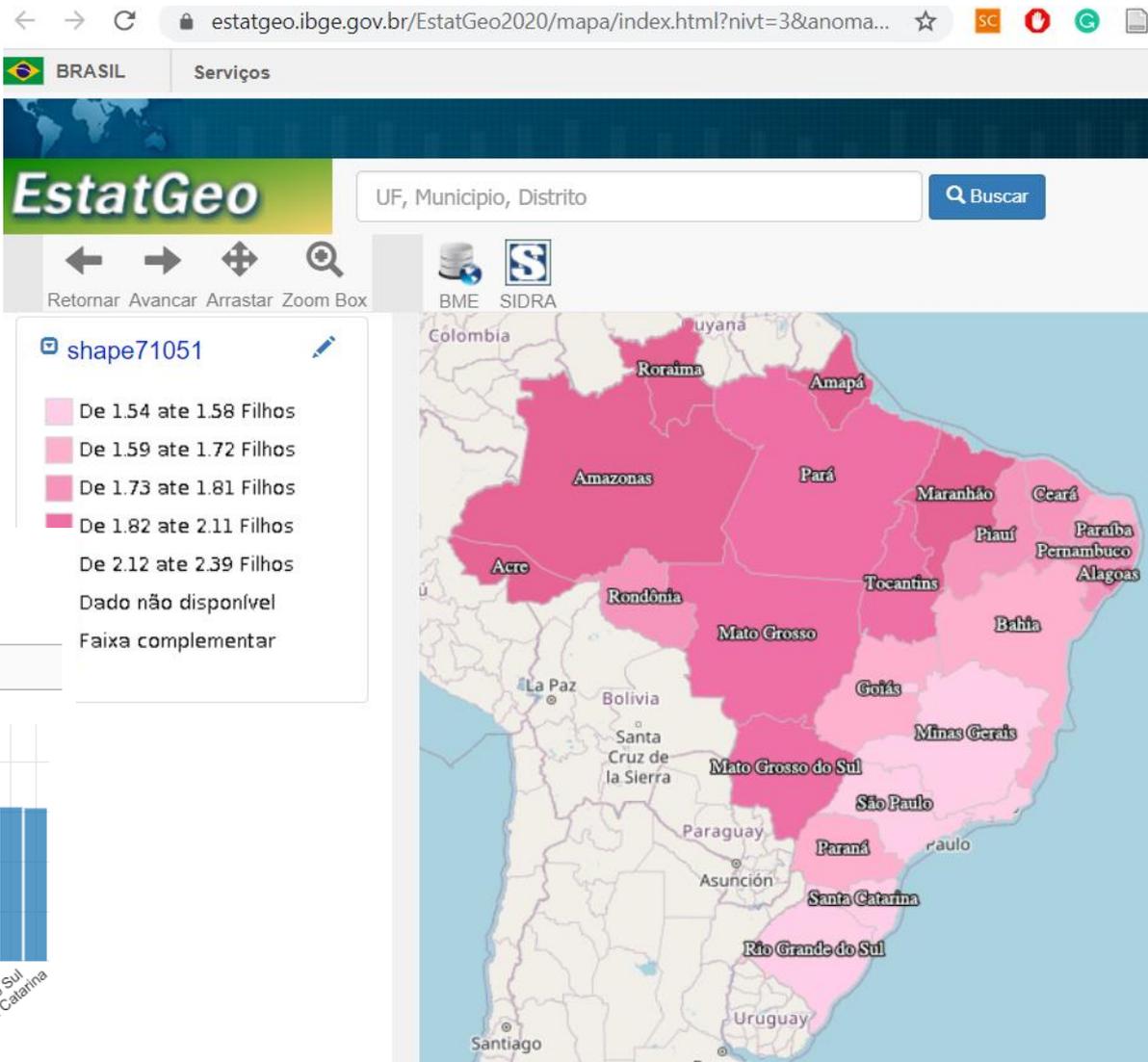
lowest

Santa Catarina (1.58->1.54),
Federal District (1.59 ->1.55),
Rio Grande do Sul (1.60 ->1.55),
Rio de Janeiro (1.62->1.57)
São Paulo (1,63 ->1.58)
and Minas Gerais (1,63 ->1.58)

Natality & Fecundity

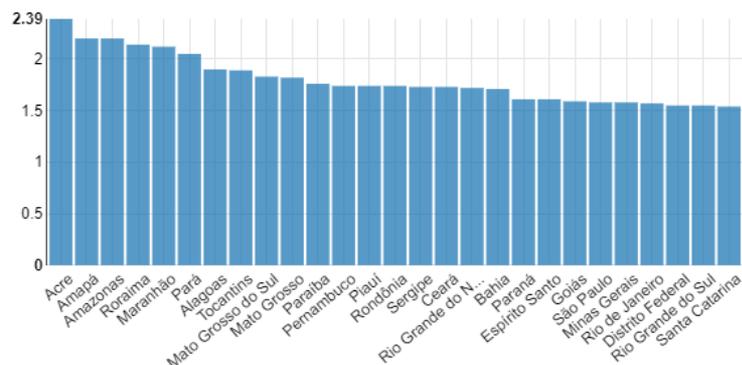


Tx de Fecundidade total (filhos) BR 2016



- Tabela 3727 - Taxa de fecundidade total
 - Variável = Taxa de fecundidade total
 - Ano = 2016

Unidade da Federação



Fonte: IBGE - Indicadores de Desenvolvimento Sustentável

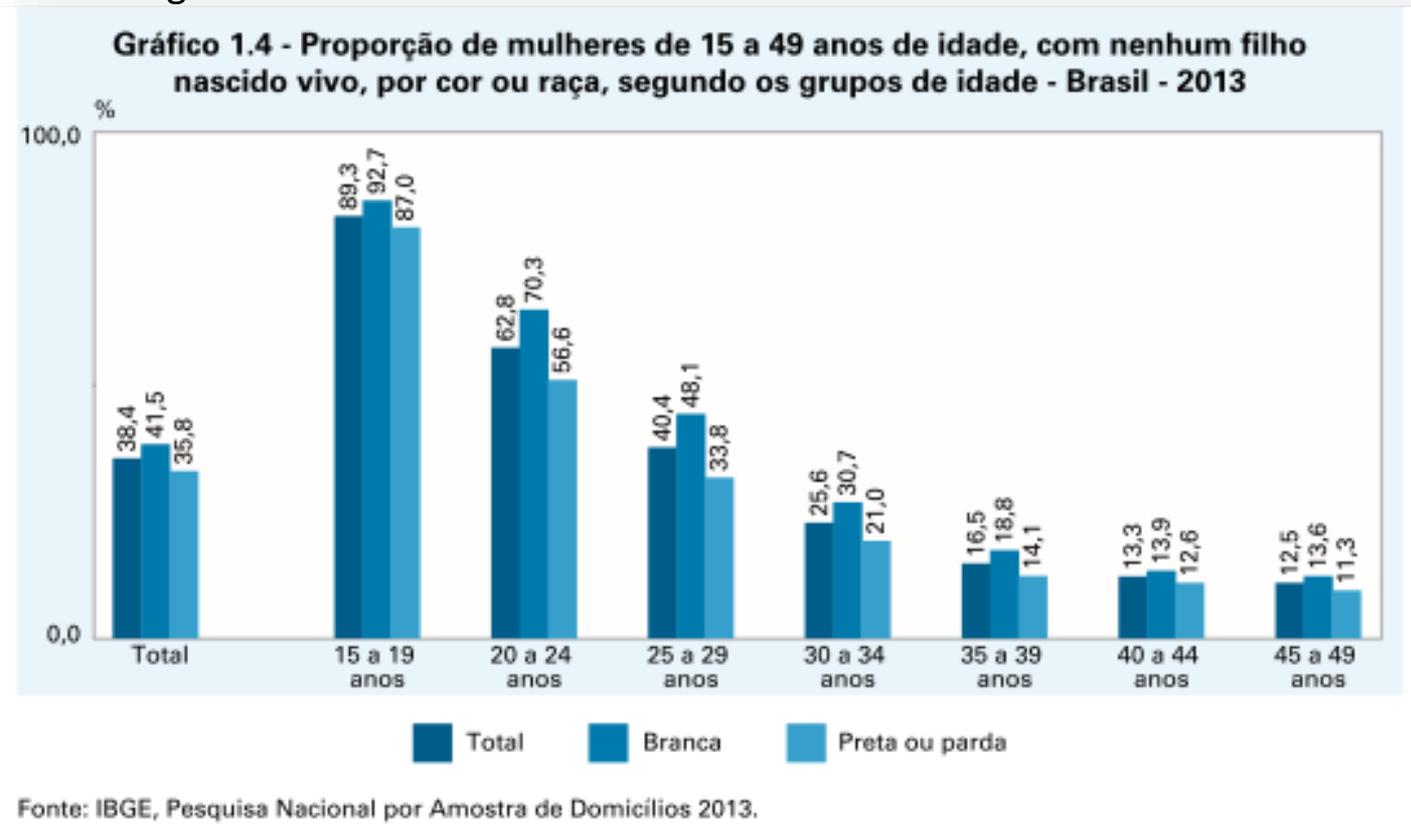
Natality & Fecundity



Another indicator related to **Fecundity** is the proportion of women, in the different age groups, **who did not have live-born children**

According to PNAD data, in 2013:

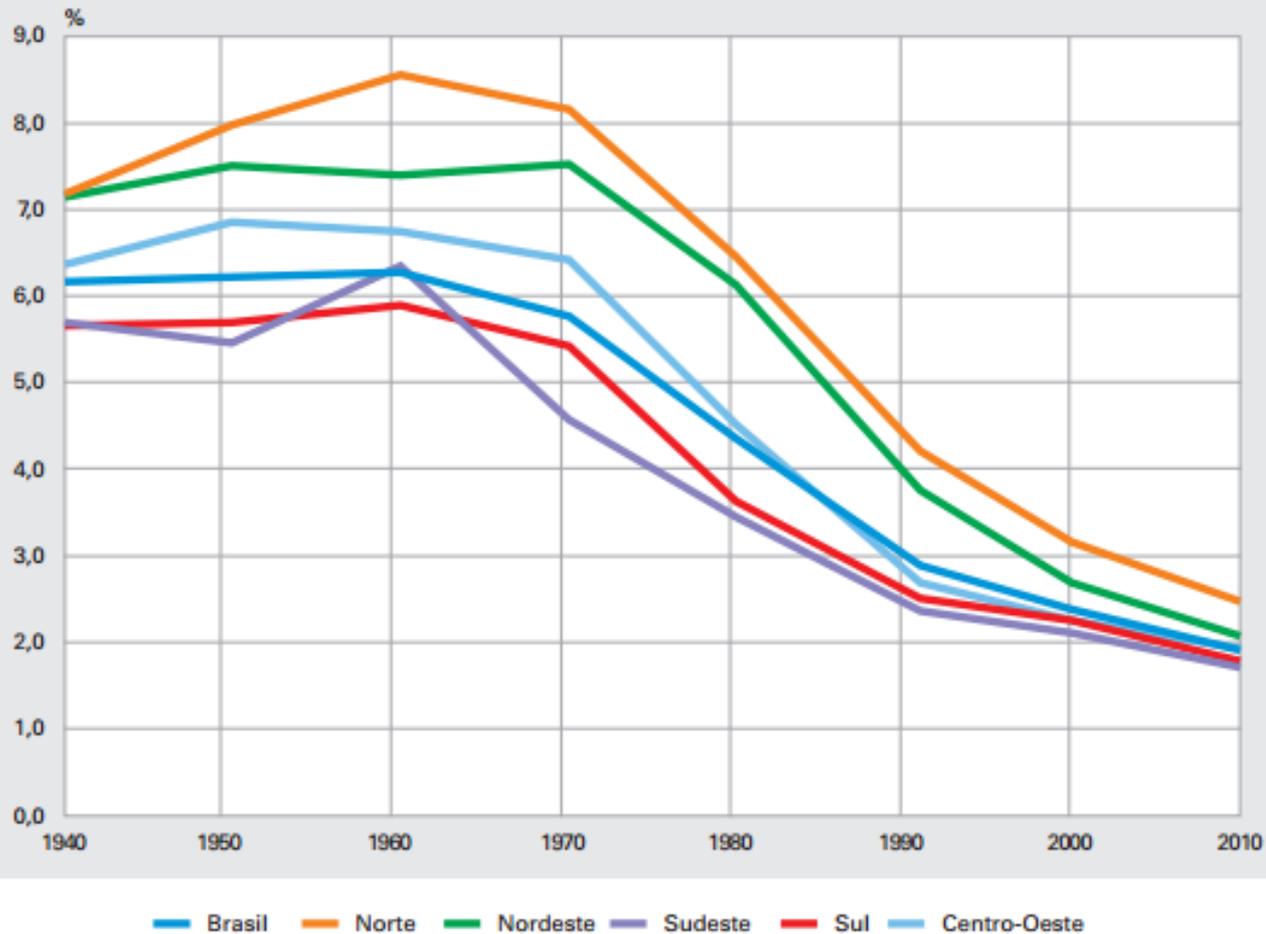
38.4% of women aged 15-49 had no live births



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Gráfico 20 - Taxa de fecundidade total, segundo as Grandes Regiões - 1940/2010

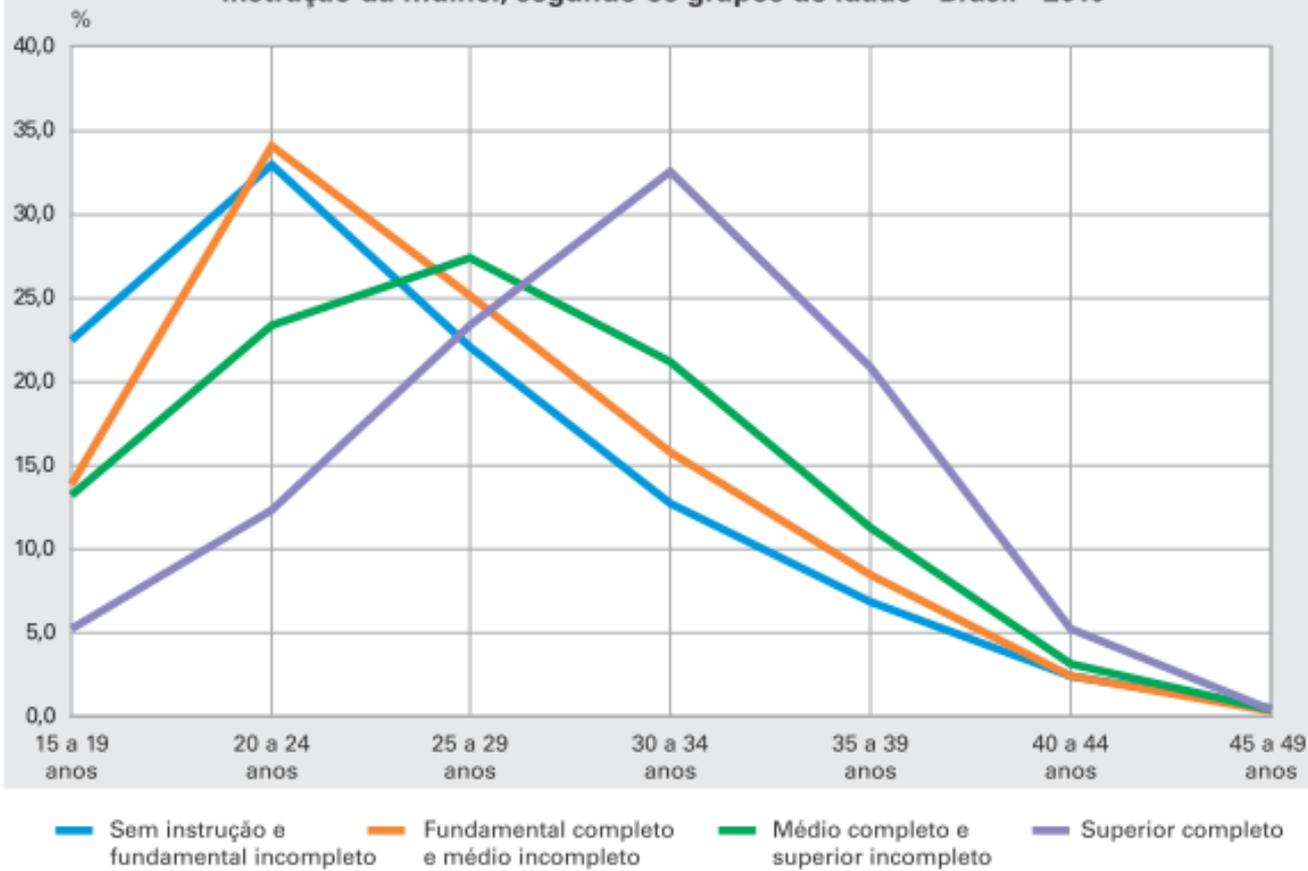


Fonte: IBGE, Censo Demográfico 1940/2010.

Natality & Fecundity



Gráfico 26 - Distribuição percentual das taxas específicas de fecundidade, por nível de instrução da mulher, segundo os grupos de idade - Brasil - 2010



Fonte: IBGE, Censo Demográfico 2010.

Natality & Fecundity



The transition of Fecundity and the reproductive pattern in Brazil

Gráfico 8: Transição da Fecundidade no Brasil: 1940-2020

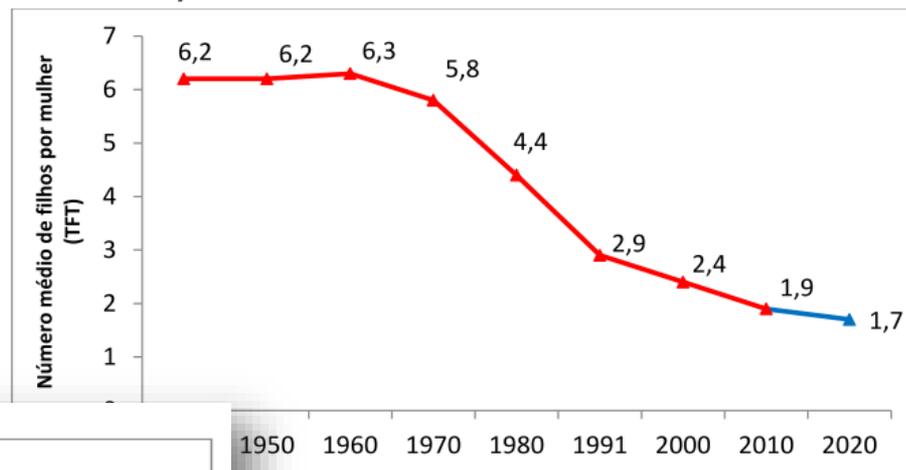
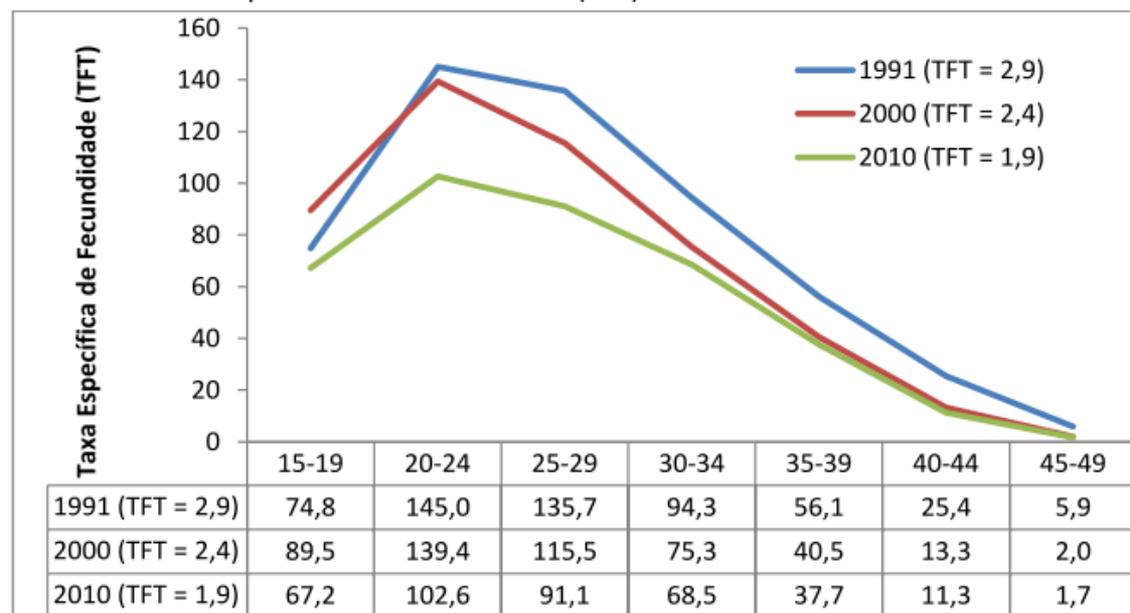


Gráfico 9: Taxas Específicas de Fecundidade (TEF) no Brasil: 1991-2010

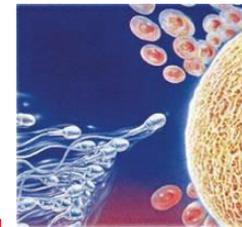


1950 1960 1970 1980 1991 2000 2010 2020

Gráficos do IBGE 1940 a 2010 e projeção em 2020

Alves e Cavenaghi (2012)

Reproduction



TFT can not be reproduction measure since they include birth of **boys !**

With the sense of *replacement*

Comparison: The size of the generation of the daughters with

The size of women generation to which the mothers belong

(usually only the female sex)

Gross Reproduction Rate (TBR)

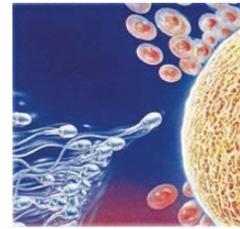
Similar to TFT but incorporating concept of reproduction

$$TBR_j = n \sum_n TEF_{x,f}$$

It is the average number of live-born daughters of surviving women at the end of the reproductive period, who belong to a generation of a certain set of FTEs (female births only)

When there is no birth data separated by sex, usually it is used the estimates of the Sex Ratio at Birth (**RSN**)

Reproduction



Sex Ratio at Birth (**RSN**)

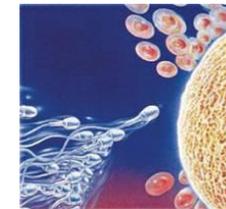
- ratio between births of male and female children.
- Index is always very stable within the same population, and usually ranges between 1.02 and 1.06.

The factor $[1 / (1 + RSN)]$ is the proportion of births of female children in total births.

$$\begin{aligned} TRB &= n \sum_x n TEF_{x,f} \\ &= \frac{1}{1 + RSN} n \sum_x n TEF_x \end{aligned}$$

$$= \frac{1}{1 + RSN} TFT$$

Reproduction



Gross Reproduction Rate (TBR)

TBR = sum of TEFs * (n years interval)
(0,02547 *5) = (1,273)

Circa (RSN=1.05):

TFT * (1/(1+1.05)) = 1.269

(TFT=2.6015 from previous table)

If a generation of women experienced
FTFS observed in Rio Grande do Sul
in 1980,

by the end of the reproductive period,
on average,

they would have given birth to
approximately **1.27 live-born girls**

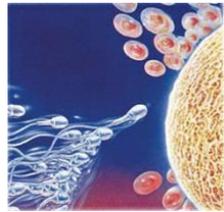
PROCEDIMENTOS PARA O CÁLCULO
DA TAXA BRUTA DE REPRODUÇÃO (TBR)
RIO GRANDE DO SUL, 1980

Grupo etário	População feminina (1/7/80)	Nascidos vivos (femininos)	Taxas específicas de fecundidade feminina
15 -19	447604	11474	0,0256
20-24	398691	26666	0,0669
25-29	337085	23663	0,0702
30-34	278654	13975	0,0502
35-39	231700	6711	0,0290
40-44	206117	2254	0,0109
45-49	180169	334	0,0019
TBR			1,2731

0,02547

Fontes: Dados elaborados a partir de ESTATÍSTICAS do Registro Civil, 1980. Rio de Janeiro, v. 7,1981; CENSO DEMOGRAFICO: dados gerais, migração, fecundidade, mortalidade, Rio Grande do Sul. Rio de Janeiro : IBGE, 1982. (IX Recenseamento Geral do Brasil, 1981, v. 1, t. 4, n. 22).

Reproduction



Net Reproduction Rate (TLR)

Replacement - generation of daughters that will replace mothers.

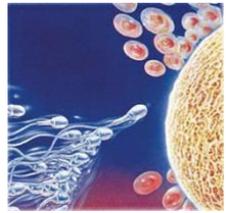
TBR is not good for assessing replacement because one can have death at any age.

Net Reproduction Rate (TLR)

It takes into account female mortality:

It relates to the initial size of the generation of mothers (age zero), the number of daughters born alive from a generation of women, submitted to a certain set of TEF_{sf} , and of TEM_{sf} , (Specific Rates of Female Mortality)

Reproduction



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TLR represents well the reproduction capacity of a population

To calculate it: a set of **female TEFs** and a **female life table** have to be available