

# Educational and sex differences in the functional disability life expectancy for the elderly: Brazil, 1998 and 2003

## *Diferenças por escolaridade e sexo na expectativa de vida com incapacidade funcional para os idosos: Brasil, 1998 e 2003*

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### ABSTRACT

This study estimates educational inequalities of the functional disability life expectancy by age and sex for the Brazilian elderly, and it introduces a time comparison by means of a decomposition analysis. Data were from the National Household Survey and Brazilian Institute of Geography and Statistics, for 1998 and 2003. The expected number and proportion of years lived with functional disability and difficulty to perform activities of daily life were estimated using the Sullivan method. Results revealed that life expectancy increased for both sexes, especially for women and concentrated in the oldest elderly (age above 80 years-old). Women lived longer, with and without functional disability, but a small percentage disability-free as compared to men. Education also improved the proportion of time lived without functional disability for both sexes. Overtime, functional disability increased for both sexes, especially among the oldest, while functional difficulty in performing activities of daily-life expectancy decreased, except for more educated males. These trends suggest compression of functional disability among the oldest aged in Brazil and a general decrease in difficulty or disability, regardless of the educational status. Although the proportion of functional disability life expectancy declined for all educational groups, the educational gap in functional disability persists. Thus, given the influence of education on healthy behaviors, improvements in education shall add to the increase in elderly overall healthy life and reduce demand on health care system in the most critical stage of human life cycle.

**Keywords:** elderly; life expectancy; disabled health; educational status.

### RESUMO

Este estudo estima as desigualdades educacionais da expectativa de vida com incapacidade funcional por sexo e idade para os idosos brasileiros e realiza uma comparação no tempo por meio de uma análise por decomposição. Os dados provieram da Pesquisa Nacional por Amostra de Domicílios (PNAD) e do Instituto Brasileiro de Geografia e Estatística, para 1998 e 2003. O número esperado e a proporção de anos a serem vividos com incapacidade funcional e dificuldade para realizar atividades da vida diária foram estimados, usando o método de Sullivan. Os resultados revelaram que a expectativa de vida aumentou para ambos os sexos, especialmente para as mulheres e se concentrou nos idosos mais velhos (acima de 80 anos). As mulheres viveram mais tempo com e sem incapacidade funcional, mas em menor proporção do tempo livre de incapacidade em relação aos homens. A escolaridade também se mostrou importante ao reduzir o tempo vivido com incapacidade funcional para ambos os sexos. Entre 1998 e 2003, o tempo vivido com incapacidade funcional aumentou para ambos os sexos, especialmente entre os idosos mais velhos, enquanto a expectativa de vida com dificuldade no desempenho de atividades da vida diária diminuiu, exceto para os homens mais escolarizados. Essa tendência sugere uma compressão da incapacidade funcional entre os idosos mais velhos no Brasil e uma diminuição

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geral na proporção do tempo vivido, com dificuldade ou incapacidade, independente do nível educacional. Embora a proporção da expectativa de vida com incapacidade funcional tenha diminuído para todos os grupos, a diferença educacional em relação à incapacidade funcional persistiu. Assim, dada a influência da educação sobre o comportamento em saúde, melhorias na educação devem ser acrescentadas ao aumento global de vida saudável dos idosos e reduzir a demanda no sistema de saúde na fase mais crítica do ciclo de vida humano.

**Palavras-chave:** idoso; expectativa de vida; saúde da pessoa com deficiência ou incapacidade; escolaridade.

## INTRODUCTION

Life expectancy in Brazil, at all ages, has increased over the last two decades. In recent years, the increase in life expectancy at later ages has contributed to a change in the population age structure, beyond the contribution of fertility decline<sup>1,2</sup>. The total increase in life expectancy has led many scholars to question the quality of the added years. The health life expectancy is fundamental to policy makers, given the impact of morbidity on public budgets, especially in the public health sector, and on the efficiency and productivity of this group in the labor market<sup>3,4</sup>.

Mortality decline has been well documented and discussed as a result of better socioeconomic status, adoption of healthier behaviors (e.g., decline in tobacco consumption, increase in physical activity), and improvement in public hygiene and nutrition education among new cohorts<sup>5,6</sup>. The lack of high-quality information on both mortality and morbidity, combined with the relative recentness of the process as compared to developed countries, results in lack of evidence on trends in mortality and morbidity decline in Brazil. Campos<sup>7</sup>, for instance, suggests that mortality among the elderly in the Southeast of Brazil decreased from 2.7 and 2.2% among men and women, respectively, from 1980 to 2000, although information for other regions was not available due to high rates of age misreporting and under-registration of death events.

Despite the absence of historical longitudinal data, recent cross-sectional surveys covering socioeconomic and health indicators provide a unique opportunity to estimate healthy life expectancy, a more refined health indicator, which combines mortality and morbidity information in a single index. The availability of socioeconomic status of individuals in the same survey allows the estimation of healthy life expectancy by level of *Secretaria Estadual de Saúde* (SES).

Several studies emphasize educational attainment as the main socioeconomic driver of mortality and morbidity<sup>8,9</sup>. Freedman and Martin<sup>10</sup> use longitudinal data to estimate the role of education in functional limitations among older Americans. Other studies similarly focus on the relation between education and active life expectancy for different countries, including Asian countries<sup>11</sup>, Austria<sup>12</sup>, Belgium<sup>13</sup>,

Cambodia<sup>14</sup>, Finland and Norway<sup>15,16</sup>, and the United States<sup>6</sup>. Studies in specific cities have found significant variation in disability-free life expectancy by education over the entire life cycle (e.g., in Madrid and Barcelona<sup>17</sup> and for the elderly (e.g., in São Paulo)<sup>18</sup>).

This study aims at estimating the educational and sex differences in functional disability life expectancy among the noninstitutionalized elderly in Brazil, in two periods of time: 1998 and 2003. The time comparison allows for the decomposition of change in the functional disability free life expectancy into two components: mortality and prevalence effect. The only study on educational differences in functional disability in Brazil is only representative of São Paulo City in 2000<sup>18</sup>. No previous studies have examined these differences over time or differentiate disability from difficulty to perform tasks.

## METHODS

The functional disability life expectancy was calculated by the Sullivan Method<sup>19</sup>, applying the prevalence of functional disability by quinquennial intervals beginning at 60 years of age. The use of a single-year prevalence is not desirable, because of small number problems and the influence of age misreporting<sup>20</sup>. The functional disability-free life expectancy (FDFLE<sub>a</sub>), the functional difficulty life expectancy (FDILE<sub>a</sub>), and the functional disability life expectancy (FDLE<sub>a</sub>) are estimated according to the following formulas:

$$FDFLE_a = \frac{\sum_{a=60}^{80} ({}_n\pi_a^{DF} * {}_nL_a)}{l_a}; \quad FDLE_a = \frac{\sum_{a=60}^{80} [({}_n\pi_a^D) * {}_nL_a]}{l_a};$$

$$FDILE_a = \frac{\sum_{a=60}^{80} [({}_n\pi_a^{DI}) * {}_nL_a]}{l_a}$$

Where:

${}_n\pi_a^{DF}$  is the prevalence of functional disability-free among the elderly;

${}_n\pi_a^D$  is the prevalence of functional disability among the elderly;

${}_n\pi_a^{DI}$  is the prevalence of difficulty in performing ADL among the elderly;

$l_a$  is the number of survivors at exact age  $a$ ;

$\Sigma({}_n\pi_a^{DF} * {}_nL_a)$  is the total number of years lived without functional disability between the ages  $a$  and  $a+n$ , by a cohort;

$\Sigma({}_n\pi_a^{DI} * {}_nL_a)$  is the total number of years lived with difficulty in performing ADL from age  $a$  to age  $a+n$ ;

$\Sigma({}_n\pi_a^D * {}_nL_a)$  is the total number of years lived with functional disability in the age group  $(a, a+n)$  by a cohort.

It is clear in the formulas that  $DFLE_a$ ,  $FDILE_a$ , and  $FDLE_a$  have two independent components: mortality ( ${}_nL_a$ ) and morbidity ( ${}_n\pi_a$ ). They are used to perform a decomposition analysis over time, estimating the contribution of mortality and activities of daily life (ADL) prevalence to the observed change in the proportion of time lived without functional disability from time 't' to time 't+1'. The prevalence (morbidity) effect in the change of the  $\%DFLE_a$  is estimated by fixing the mortality rates at time 't' and letting the prevalence ( ${}_n\pi_a$ ) to vary over time. Conversely, the mortality effect is obtained by holding the prevalence constant at time 't'. The decomposition may be interpreted as a counterfactual analysis, such as: what would have happened to the functional disability life expectancy, had the mortality ratios (or prevalence) not changed over time? Results are later presented in the text.

## DATA

Data on mortality were obtained from the Brazilian Institute of Geography and Statistics<sup>21</sup>; and the National Household Survey (PNAD, acronym in Portuguese)<sup>22,23</sup>. The prevalence of functional disability, which is measured by a question on ADL, by age, sex, and educational attainment, comes from the National Household Survey for 1998 and 2003<sup>22,23</sup>. The PNAD datasets used are a nationally representative survey of Brazil, with the exception of the rural area from the North region. In both years, the survey collected a health supplement with information on morbidity and physical mobility and access, utilization, supply, and quality of health care.

The survey is not specifically designed to study the elderly; therefore, there are not many questions about disability. PNAD contains seven questions on physical ability, one referring to ADL and the others focusing on physical mobility. The ADL measure is the least susceptible of these to the changes over time introduced by perception and physical characteristics of residences and neighborhoods, though it retains the influence of medical advances, which may influence in the early identification of the disability, raising the prevalence in a specific period<sup>18</sup>. Given the fact that the main aim of the present study is to perform a descriptive analysis over time, only the ADL

indicator of functional disability was used. It has been used by researchers elsewhere and has been advocated to be the most appropriate measure of functional disability for time comparison using cross-sectional data<sup>14,15,24,25</sup>. In addition, the use of Sullivan method is sensitive to variables that are more likely to be influenced by change in perception over time. This is why Rogers et al.<sup>24</sup> suggested ADL is a better candidate for time comparison.

The ADL is defined in PNAD as "normally, due to health problems, do you have difficulty eating, bathing or going to the bathroom?" in both years. We selected individuals that were 60 years-old or older, following the suggestion of the United Nations for defining elderly in developing countries. In 1998, 33 cases were discarded because of nonreported age and 6 due to missing information on the ADL question. The final 1998 sample includes 28,937 cases. In 2003, 72 cases were lost because of missing information on age and five cases because of missing information on the ADL question, resulting in a sample size of 35,037.

## Variables

The responses to the ADL question in the questionnaire include four categories, ranging from the absence of difficulty to impossibility to execute the task. These categories were transformed into a three-category variable, with two indicating the presence of functional disability (impossibility to do the tasks), one indicating difficulty in performing the activities (small + great difficulty), and zero indicating the absence of functional disability (no problem in performing the tasks). Different from other studies that collapse difficulty and inability to perform daily activities in a unique category<sup>15,18</sup>, difficulty was distinguished in the present study from disability in the functional disability variable built, since a person may be able to complete daily activities even in the presence of difficulty.

Schooling is measured by a dichotomous variable: less than five years (zero) and five years and more (one). This categorical strategy was applied for two main reasons: the right-skewed distribution of the number of years of schooling completed among the elderly in Brazil and to ensure a small number of final life tables. Then, abridged life tables by sex and quinquennial age groups were created.

However, the mortality information in Brazil for 1998 and 2003 could not be decomposed by level of education, because of the high proportion of missing information (estimated to be 40.1% in 2003, according to the Mortality Information System)<sup>26</sup>. Therefore, two indirect estimation techniques were applied to obtain life tables stratified by educational levels and sex altogether: the Brass method for child mortality<sup>27</sup> and

the orphanhood method for adult mortality<sup>28</sup>. The specific information on the methods applied in the present study are described in Guedes et al.<sup>29</sup>.

## RESULTS

### The scenario in 1998

The weighted prevalence of functional disability and difficulty to perform daily activities increased with age (from 60 years-old on) for both genders and educational levels (Table 1). Among low-educated elderly, for instance, the weighted prevalence of functional disability for males was 0.5% among the sixties and 6.1% among the 80 years-old; for women, these

figures were 0.8 and 8.0%, respectively. The prevalence of difficulty to perform ADL among the lowest educated elderly men was 8.9% for 60 years-old (27.6% for 80 years of age), as compared to 10.8% for women (30.2% for among the women 80 years old). On average, women experienced higher prevalence of both difficulty to perform daily activities and functional disability than men, regardless of age and educational status.

Regarding life expectancy, however, women could expect to live longer than men at all ages, with the gender differentials reducing in absolute values with increasing age (Table 2). At age 60, the gender gap in life expectancy was about 2.8 years, reducing to 0.7 years at age 80. In all selected ages, women were expected to live longer than men, with and without functional disability. For instance, while 60 years-old women

**Table 1.** Prevalence of daily life activities (ADL) by gender and educational attainment - Elderly, Brazil, 1998 and 2003.

Gender	Age group	1998						2003					
		0-4 years of school			5 and more years of school			0-4 years of school			5 and more years of school		
		With disability	With difficulty	Disability free	With disability	With difficulty	Disability free	With disability	With difficulty	Disability free	With disability	With difficulty	Disability free
Men	60 to 64	0.54	8.93	90.53	0.91	4.76	94.33	0.71	6.38	92.91	0.45	2.56	97.00
	65 to 69	0.87	11.06	88.07	0.95	5.51	93.55	1.30	6.99	91.72	1.02	5.34	93.64
	70 to 74	2.39	11.29	86.32	1.91	6.18	91.91	2.21	11.93	85.86	1.61	4.51	93.88
	75 to 79	2.50	16.61	80.89	1.89	10.33	87.78	2.94	14.15	82.91	5.23	9.61	85.16
	80+	6.12	27.59	66.29	4.93	15.44	79.63	6.97	24.39	68.64	2.63	17.53	79.84
Women	60 to 64	0.76	10.77	88.46	0.48	5.77	93.75	0.94	8.02	91.04	0.44	4.33	95.23
	65 to 69	0.91	12.40	86.69	0.43	5.48	94.09	1.03	10.36	88.60	0.21	6.63	93.16
	70 to 74	1.93	16.61	81.47	1.30	8.79	89.91	1.87	13.77	84.36	1.32	6.38	92.30
	75 to 79	3.22	22.33	74.45	3.07	11.48	85.45	3.94	18.35	77.71	2.73	9.61	87.66
	80+	8.00	30.17	61.84	7.18	20.81	72.01	10.72	27.22	62.06	7.60	19.20	73.20

Source: PNAD database (1998 and 2003).

**Table 2.** Male and female summarized life tables. Number of years to be lived with functional disability, functional difficulty, and functional disability-free by gender, percentage of years to be lived with functional disability, functional difficulty, and functional disability-free by gender and educational attainment, Brazil, 1998 and 2003.

Year	Gender	Exact age (x)	Percentage of life expectancy													
			Life expectancy						Lower education				Higher education			
			Total	FDLE <sub>x</sub>	FDILE <sub>x</sub>	PDFLE <sub>x</sub>	FDLE <sub>x</sub>	FDILE <sub>x</sub>	PDFLE <sub>x</sub>	FDLE <sub>x</sub>	FDILE <sub>x</sub>	PDFLE <sub>x</sub>	FDLE <sub>x</sub>	FDILE <sub>x</sub>	PDFLE <sub>x</sub>	
1998	Males	60	18.5	0.3	1.3	17.0	1.4	7.3	91.2	1.2	4.1	94.7				
		70	12.6	0.3	1.4	10.8	2.6	12.2	85.2	2.1	6.9	91.0				
		80	8.3	0.5	2.1	5.7	6.1	27.6	66.3	4.9	15.4	79.6				
	Females	60	21.3	0.4	1.9	18.9	2.1	9.5	88.4	1.9	6.1	92.1				
		70	14.3	0.5	2.0	11.8	3.6	14.9	81.5	3.2	9.9	86.9				
		80	9.0	0.7	2.6	5.7	8.0	30.2	61.8	7.2	20.8	72.0				
2003	Males	60	19.1	0.3	1.2	17.6	1.8	6.8	94.5	0.9	4.6	97.6				
		70	13.1	0.4	1.4	11.3	3.2	11.7	89.0	1.5	8.0	94.3				
		80	8.8	0.6	2.1	6.2	7.4	25.8	72.5	2.8	18.5	84.4				
	Females	60	22.1	0.6	1.8	19.6	3.1	9.1	91.6	2.1	6.1	95.6				
		70	15.0	0.7	2.0	12.4	5.2	14.4	85.3	3.7	9.7	91.5				
		80	9.6	1.0	2.5	6.2	11.4	29.0	66.1	8.1	20.4	77.9				

Source: PNAD database (IBGE, 1998 and 2003), and Life Tables (IBGE, 2011).

Note: FDLE<sub>x</sub>: Functional disability life expectancy at age 'x'; FDILE<sub>x</sub>: Functional difficulty life expectancy at age 'x'; PDFLE<sub>x</sub>: Functional disability-free life expectancy at age 'x'.

were expected to live 1.9 years with some difficulty to perform ADL, men in the same age would live only 1.3 years in the same state. Similarly, 60 years-old women were expected to live 18.9 years free of functional disability in comparison to 17.0 years among 60 years-old men. This is mainly explained by the mortality gap by gender between the elderly, resulting in absolute higher values of life expectancy among women, regardless of the disability status.

The proportion of the remaining years to be lived free of functional disability, however, differed by gender. Therefore, although living longer, women spent a higher proportion of the remaining years with some functional disability or difficulty to perform ADL than men. The impact of education on the  $FDLE_a$  also varied by gender. If one consider, for instance, how much the  $\%FDLE_a$  was expected to decrease from age 60 to age 80 when a comparison is made between less and more educated elderly, Table 2 shows that the decline in the  $\%FDLE_a$  from age 60 to age 80 was smaller among the less educated, for both genders. However, the impact was higher among men. While more educated women at age 80 were expected to live 20.0% less as compared to age 60 disability-free, the figure for men was only 15.1%.

The positive impact of educational attainment on the  $FDLE_a$  is higher among the oldest aged. For example, more educated 60 years-old men were expected to live only 3.8% longer without disability as compared to lower educated men, but this proportion increased to 20.1% at age 80 (4.1 and 16.5% for women, respectively). Similar impacts were found for the  $FDILE_a$ , with reversed signals. Surprisingly, different from  $FDLE_a$  and  $FDILE_a$ , education seems to equally reduce time lived with functional disability across age groups – ap-

proximately 18.8% for men and 11.0% for women across age groups (Table 3).

### The scenario in 2003

As in 1998, the weighted prevalence of functional disability as well as difficulty to perform ADL increases with age for both genders and educational levels, and it was higher for women at all ages. Table 1 indicates that the prevalence of functional disability for the less educated elderly in 2003 was 0.7% among men and 0.9% among women, at ages 60 to 64. These percentages increased to 7.0 and 10.7%, respectively, for elderly above age 80. The prevalence of disability was lower in the higher educational group at all ages for both sexes, although the prevalences of both functional disability and difficulty to do daily activities were higher among women.

In spite of the higher prevalence of functional disability and difficulty with ADL, the life expectancy continued to be higher for women at all ages, regardless of the functional disability status, although the gender gap decreased by more than two-thirds from ages 60 to 80. As in 1998, women in 2003 were expected to live a smaller proportion of their remaining years free of functional disability than men, at all ages and educational levels (Table 2).

In general, education reduced the proportion of life with functional disability and difficulty to perform daily activities for both genders. The effect of education benefits disproportionately the oldest old, regardless of gender. That is, a more educated 80 years-old man in 2003 lived 4.6% less time free of functional disability than another of same age with less education. Among men in their 60 years of age, the educational bonus represented only a 0.9% reduction in the functional disability-free life expectancy (Table 3). Education also reve-

**Table 3.** Differentials in the estimates of percentages of the functional disability-free life expectancy, functional difficulty life expectancy, and functional disability life expectancy, Brazil, 1998 and 2003.

Educational attainment	Gender	Exact age (x)	$\Delta e_x$	$\Delta FDLE_x$	$\Delta FDILE_x$	$\Delta FDFLE_x$	$\Delta \% FDLE_x$	$\Delta \% FDILE_x$	$\Delta \% FDFLE_x$
Lower	Males	60	0.56	0.06	-0.09	0.59	0.34	-0.51	3.22
		70	0.49	0.07	-0.06	0.48	0.55	-0.51	3.81
		80	0.47	0.10	-0.15	0.52	1.25	-1.82	6.24
	Females	60	0.80	0.20	-0.08	0.68	0.96	-0.39	3.19
		70	0.71	0.23	-0.07	0.55	1.61	-0.50	3.82
		80	0.58	0.31	-0.11	0.38	3.41	-1.20	4.22
Higher	Males	60	0.56	-0.06	0.10	0.52	-0.32	0.54	2.82
		70	0.49	-0.07	0.15	0.41	-0.59	1.17	3.28
		80	0.47	-0.18	0.26	0.39	-2.15	3.08	4.74
	Females	60	0.80	0.06	0.00	0.74	0.28	-0.02	3.50
		70	0.71	0.07	-0.02	0.66	0.47	-0.14	4.59
		80	0.58	0.08	-0.03	0.53	0.91	-0.37	5.90

Source: PNAD database (1998 and 2003), and IBGE (2006).

Note:  $FDLE_x$ : Functional disability life expectancy at age 'x';  $FDILE_x$ : Functional difficulty life expectancy at age 'x';  $FDFLE_x$ : Functional disability-free life expectancy at age 'x'.

aled a significant impact on the improvement in the FDFLE<sub>a</sub> as individuals' age. Like in 1998, the educational effect on the pace of decline in the FDFLE<sub>a</sub> across age groups was again smaller among women. While a more educated woman at age 80 was expected to live 17.6% less, as compared to age 60 disability-free, men at the same age and educational level would live only 13.2% less as compared to their counterparts 60 years of age. Compared to 1998, education had its impact on the pace of decline in the %FDFLE<sub>a</sub> reduced.

Differently from its age-selective impact on FDFLE<sub>a</sub> and FDILE<sub>a</sub>, education equally reduced time lived with functional disability across age groups (Table 3). However, as compared to 1998, the impact was much higher in 2003 (time lived free from functional disability among the more educated was 55.2% smaller for men, and 29.5% smaller for women). This result suggests that educational improvement has a large potential to keep reducing the time lived with functional disability among elderly in the future.

### Decomposing the change in the percentage of disability life expectancy over time

From 1998 to 2003, the proportion of remaining years lived with functional disability increased for almost all age groups, regardless of gender and educational attainment, followed by a reduction in the proportion of time lived with functional disability, especially among the oldest aged and less educated ones (Table 3). But, how much was due to the change in prevalence over the period? In this section, simulations of stationary scenarios of mortality and functional disability were made in order to answer this question. Change in the proportion of time lived in functional disability was decomposed, showing how much of this change was due to change in the prevalence of functional disability (prevalence effect) or to the decline in mortality levels (mortality effect) among the elderly, in Brazil.

The first effect represents how much the change in the prevalence of functional disability by age, gender, and educational attainment changed among the elderly between 1998 and 2003 affected the alteration in the functional disability observed (combining results from Table 5 and Table 6 – right panel). The latter represents the contribution of mortality change to variation in the functional disability life expectancy in the period (combining results from Tables 5 and 6– left panel)<sup>1</sup>. As reduction in the prevalence of functional

disability increases healthy life expectancy, and a reduction in mortality rates should expose elderly for a longer time to the risk of being functionally disabled, there is an expectation that the two effects would go in opposite directions. Because the effect of mortality on the observed change by gender and educational attainment is estimated, separate life tables by sex and educational level were also estimated using standard demographic indirect techniques.

The performed decomposition was based on average results of counterfactual simulations, as suggested by Shorrocks<sup>30</sup>. Therefore, results could be interpreted as a counterfactual analysis, explaining a variation in disability life expectancy as a result of the change in prevalence of disability, holding mortality constant, or as a result of the change in mortality, holding the prevalence of disability constant in its initial level.

The results indicate that among 60 year-old lower educated men, the proportion in DLE<sub>a</sub> increased 1.08% in five years. If mortality was kept in its 1998 level, increase in the %DLE<sub>a</sub> would have being even higher, in about 2.09%. Mortality reduction, in contrast, contributed to a decrease in %DLE<sub>a</sub> of 1.01%. Broadly speaking, the prevalence effect dominates the mortality effect for both genders and educational groups. It is noteworthy that the increase in the prevalence of functional disability among the oldest aged explained 100% of changes in the period, another indicator of morbidity compression among the elderly in recent years (Table 4).

## DISCUSSION

The weighted prevalence of functional disability and difficulty to perform ADL increased with age and was higher for

**Table 4.** Decomposition of the difference in the percentage of functional disability life expectancy by age, gender, and educational level. Brazil, 1998 and 2003.

Educational attainment	Gender	Exact age	Total effect	Prevalence effect	Mortality effect
Lower	Males	60	1.08	2.09	-1.01
		70	-0.06	1.06	-1.26
		80	2.35	2.35	0.00
	Females	60	0.68	2.24	-1.42
		70	0.53	2.21	-1.44
		80	0.23	0.23	0.00
Higher	Males	60	0.38	0.77	-0.35
		70	-0.27	0.07	-0.33
		80	0.21	0.21	0.00
	Females	60	0.61	1.19	-0.59
		70	1.32	1.84	-0.49
		80	1.19	1.19	0.00

Source: PNAD database (IBGE, 1998 and 2003); DATASUS (2006); IBGE/DPE (Population Department and Social Indicators) and Ensp/Fiocruz/Fensptec (Disease Burden Project).

<sup>1</sup> A choice was made for the inclusion of Tables 5 and 6 as they are the only instrumental for the results observed in Table 4. Changes in %FDLE<sub>x</sub> were estimated in Table 5 (total change, considering the effect of education in mortality). Then, the same change in was %FDLE<sub>x</sub> estimated fixing the mortality level in 1998 (prevalence effect – right panel of Table 6). Finally, the same calculation, fixing the prevalence in 1998 for 2003, was performed (mortality effect – left panel of Table 6). These results were summarized in Table 4.

**Table 5.** Male and female summarized life tables. Number of years to be lived with functional disability, functional difficulty, and functional disability-free and percentage of years to be lived with functional disability, functional difficulty, and functional disability-free, by gender and educational attainment, Brazil, 1998 and 2003 - original values with estimated life tables by educational level.

Educational attainment	Gender	Exact age	$e_x$		FDLE <sub>x</sub>		FDILE <sub>x</sub>		FDFLE <sub>x</sub>		% FDLE <sub>x</sub>		% FDILE <sub>x</sub>		% FDFLE <sub>x</sub>	
			1998	2003	1998	2003	1998	2003	1998	2003	1998	2003	1998	2003	1998	2003
Lower	Males	60	16.07	17.52	0.32	0.44	2.15	2.05	13.61	15.02	1.96	2.51	13.36	11.73	84.68	85.76
		70	10.32	11.74	0.36	0.48	1.80	1.98	8.16	9.28	3.46	4.06	17.40	16.86	79.14	79.08
		80	6.04	7.92	0.37	0.55	1.67	1.93	4.01	5.44	6.12	6.97	27.59	24.39	66.29	68.64
	Females	60	17.70	19.81	0.44	0.71	2.99	2.99	14.27	16.11	2.46	3.59	16.89	15.08	80.65	81.33
		70	11.33	13.24	0.47	0.77	2.54	2.67	8.32	9.80	4.13	5.82	22.39	20.17	73.48	74.01
		80	6.15	8.63	0.49	0.93	1.85	2.35	3.80	5.36	8.00	10.72	30.17	27.22	61.83	62.06
Higher	Males	60	17.68	18.85	0.34	0.36	1.37	1.39	15.97	17.10	1.91	1.90	7.75	7.37	90.34	90.73
		70	11.55	12.56	0.33	0.37	1.20	1.33	10.01	10.85	2.90	2.98	10.42	10.61	86.68	86.41
		80	7.11	8.19	0.35	0.22	1.10	1.44	5.66	6.54	4.93	2.63	15.44	17.53	79.63	79.84
	Females	60	21.65	23.12	0.57	0.65	2.32	2.29	18.76	20.18	2.61	2.81	10.72	9.91	86.67	87.28
		70	14.70	15.93	0.62	0.72	2.14	2.07	11.94	13.14	4.24	4.51	14.56	12.98	81.19	82.51
		80	9.40	10.42	0.67	0.79	1.96	2.00	6.77	7.63	7.18	7.60	20.81	19.20	72.01	73.20

Source: PNAD database (IBGE, 1998 and 2003); DATASUS (2006); IBGE/DPE (Population Department and Social Indicators) and Ensp/Fiocruz/Fensptec (Disease Burden Project).

Note:  $e_x$ : Life expectancy at age 'x'; FDFLE<sub>x</sub>: Functional disability-free life expectancy at age 'x'; FDILE<sub>x</sub>: Functional difficulty life expectancy at age 'x'; FDLE<sub>x</sub>: Disability life expectancy at age 'x'.

**Tabela 6.** Percentage of years to be lived with functional disability, functional difficulty, and functional disability-free, by gender and educational attainment, Brazil, 1998 and 2003 - simulated values (mortality effect and prevalence effect).

Educational attainment	Gender	Exact age	Mortality effect (Prevalence fixed at the 1998 level)						Prevalence effect (Life expectancy fixed at the 1998 level)					
			% FDLE <sub>x</sub>		% FDILE <sub>x</sub>		% FDFLE <sub>x</sub>		% FDLE <sub>x</sub>		% FDILE <sub>x</sub>		% FDFLE <sub>x</sub>	
			1998	2003	1998	2003	1998	2003	1998	2003	1998	2003	1998	2003
Lower	Males	60	1.96	2.19	13.36	14.14	84.68	83.67	1.96	2.25	13.36	10.98	84.68	86.76
		70	3.46	3.71	17.40	18.41	79.14	77.88	3.46	3.75	17.40	16.05	79.14	80.20
		80	6.12	6.12	27.59	27.59	66.29	66.29	6.12	6.97	27.59	24.39	66.29	68.64
	Females	60	2.46	2.87	16.89	17.91	80.65	79.22	2.46	3.03	16.89	14.08	80.65	82.89
		70	4.13	4.61	22.39	23.36	73.48	72.04	4.13	5.14	22.39	19.17	73.48	75.69
		80	8.00	8.00	30.17	30.17	61.83	61.83	8.00	10.72	30.17	27.22	61.83	62.06
Higher	Males	60	1.91	2.00	7.75	8.00	90.34	90.00	1.91	1.84	7.75	7.04	90.34	91.12
		70	2.90	2.99	10.42	10.66	86.68	86.35	2.90	2.99	10.42	10.26	86.68	86.75
		80	4.93	4.93	15.44	15.44	79.63	79.63	4.93	2.63	15.44	17.53	79.63	79.84
	Females	60	2.61	2.80	10.72	11.12	86.67	86.08	2.61	2.61	10.72	9.53	86.67	87.85
		70	4.24	4.40	14.56	14.89	81.19	80.71	4.24	4.34	14.56	12.63	81.19	83.03
		80	7.18	7.18	20.81	20.81	72.01	72.01	7.18	7.18	20.81	19.20	72.01	73.20

Source: PNAD database (IBGE, 1998 and 2003); DATASUS (2006); IBGE/DPE (Population Department and Social Indicators) and Ensp/Fiocruz/Fensptec (Disease Burden Project).

women in both years analyzed. These results are consistent with a higher level of selectivity in mortality for men and for women, with men who would have been functionally disabled dying at an earlier age<sup>31,32</sup>.

Recent literature in Brazil<sup>33</sup> points out the gender differentials in mortality over the life cycle. The proportionally higher benefit for women is confirmed here, as the present study revealed that the gender gap in mortality among elderly increased in recent years (from 1998 to 2003, as showed from IBGE estimates). This trend contradicts the decrease in the mortality difference by gender, which is noticed since the 1970s in a number of developed countries<sup>34</sup>.

Despite the increase in gender differences in mortality, mortality rates dropped for both genders. Women, however, lived longer than men and spent more years in functional disability and disability-free states. This has already been documented by Camargos et al.<sup>18</sup> for the elderly in São Paulo. However, if the focus turns to the proportion of life expectancy lived in both conditions, the picture is different: women lived a higher proportion of their expected lifespan with functional disability. This percentage increased with age, but the gender gap reduced, following the recent mortality trend.

The gender gap in morbidity was explained by three different, but complementary, arguments. One of them empha-

size that women tend to be more self-conscious about their health and, therefore, declare a higher number of morbidity episodes<sup>35</sup>. Another important gender asymmetry is the social construction of health, which embeds the gender roles and modifies the way of dealing with health and illness<sup>36</sup>. At last, excess male mortality during the life cycle and a Brazilian peculiarity, an excess of mortality during the young adult ages, create a selection effect, visible in the elderly as a “stronger” male group, less susceptible to morbidity episodes<sup>18</sup>.

The social etiology of health is especially relevant for the elderly, because of the differences in image that men and women project in the labor market<sup>37</sup>. Therefore, frailty extends beyond the biological perspective and involves the person's self-image. Gender differentials in reporting morbidity episodes were pointed out by Pinheiro et al.<sup>38</sup>, with men tending to report more critical and acute episodes, and women concentrating the reporting on less severe and chronic diseases<sup>31,39</sup>. This macro-societal dimension of health is directly connected to the behavior of the actors, being modified by the self-interest in health<sup>38</sup> and the ability to receive support through social networks<sup>37</sup>.

Furthermore, distributional asymmetry for educational attainment must be emphasized, especially for older cohorts. Brazilian large scale investment in education is relatively recent. Therefore, low-educational position of the older cohorts combined with the strong social forces in the past that molded the gender inequalities in schooling opportunities produced a higher heterogeneity among elderly women. The strong influence of education on income during adulthood and the continuing effect of income on health (and vice versa) over the life cycle<sup>40</sup> can explain the persistence of the gender gap in the percentage of disability life expectancy over time, in Brazil.

Educational differentials regarding the functional disability life expectancy were higher for men, in both years. Camargos et al.<sup>18</sup> found a different result for the elderly for São Paulo City, in 2000. A similar finding was documented for other previous studies<sup>6,13,15-17</sup>. Gender differences in the proportion of life expectancy with functional disability were larger for the higher educated group, increasing with age for the more educated elderly, in 2003. This suggests a “boost” in the already heterogeneous female group in higher socioeconomic strata.

Medical innovation and public assistance diffusion seem to have influenced the increase in the percentage of functional disability-free life expectancy in Brazil, during the five years window studied here. This trend was mainly followed by a considerable reduction in the proportion of the remaining years lived with some difficulty to perform ADL. The changes,

however, disproportionately benefited the oldest aged. Two nonobservable influences might also be present in these results: the barriers in access and the educational asymmetries in mortality<sup>41-43</sup>.

The results presented in this study suggest, on one hand, that improvement in socioeconomic status of the elderly is instrumental to attenuate the consequences of difficulty in performing daily activities, reducing the necessity of health care providers. On the other hand, the benefit of better education starts earlier in the life cycle, culminating in a longer and healthier life for the more educated elderly, regardless of age and gender.

The present study has a number of limitations. First, the absence of reliable data on mortality by education in Brazil required the authors to estimate the life table for more and less educated groups, using indirect techniques. The stratification of the population by educational attainment led to instability in the age functions on information about surviving children, and required the application of a smoothing technique. In addition, the same model life table did not fit for both groups, forcing using multiple mortality standards. The lack of the necessary information to estimate male adult mortality implies that the male life table by education may not reflect the real picture. For comparison purposes regarding functional disability, the ideal would be a life table with identical survival function for the nonelderly, and differences just for people older than 60 years-old. It is approximately right for women, with the major gap beginning around 50 years-old, but for men this widening gap occurs at about 30 years-old. Therefore, the difference in  $FDLE_a$  at each age is a combination of educational differences in prevalence and educational differences in mortality.

Second, the measures of functional disability life expectancy were estimated using the Sullivan Method<sup>19,44</sup>. Although this method is based on very simple and straightforward procedures, it has its own drawbacks: first, it is sensitive to changes in the measurement of disability – though, in the absence of considerable variation, this is a reasonable technique<sup>45</sup> –, and second, it does not account for transitions among different states of health. As a typical single-decrement technique, a person is supposed to change from absence to presence of disability, without considering recoveries, estimated to be in the order of 20% or more among elderly<sup>24,46</sup>. Moreover, the assumption of the stationary mortality and morbidity functions for the cohorts cannot be realistic in many places. This assumption is avoided by using simulation methods (decomposition)<sup>47</sup>.

Despite the limitations of the Sullivan method, the relatively small time window and the absence of longitudinal

data for this study require its use. Studies have been published worldwide using the same method<sup>15,18</sup> supporting the present methodological strategy and allowing results to be comparable to other studies.

## CONCLUSION

This study used a nationally representative survey to estimate gender and educational differences in life expectancy, by functional disability status among the elderly in Brazil. Results corroborate the morbidity-mortality paradox by gender, with women living longer, but not necessarily better than men. Education was an important factor in reducing time spent with functional disability, disproportionately benefiting the oldest aged. There is also evidence that education influence the pace of decline in the proportion of years lived without functional disability, especially among men.

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