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Trends in healthy life expectancy among older Brazilian women between 1998 and 2008

Tendências da expectativa de vida saudável de idosas brasileiras, 1998-2008

ABSTRACT

OBJECTIVE: To analyze conditional and unconditional healthy life expectancy among older Brazilian women.

METHODS: This cross-sectional study used the intercensal technique to estimate, in the absence of longitudinal data, healthy life expectancy that is conditional and unconditional on the individual's current health status. The data used were obtained from the *Pesquisa Nacional por Amostra de Domicílios* (National Household Sample Survey) of 1998, 2003, and 2008. This sample comprised 11,171; 13,694; and 16,259 women aged 65 years or more, respectively. Complete mortality tables from the Brazilian Institute of Geography and Statistics for the years 2001 and 2006 were also used. The definition of health status was based on the difficulty in performing activities of daily living.

RESULTS: The remaining lifetime was strongly dependent on the current health status of the older women. Between 1998 and 2003, the amount of time lived with disability for healthy women at age 65 was 9.8%. This percentage increased to 66.2% when the women already presented some disability at age 65. Temporal analysis showed that the active life expectancy of the women at age 65 increased between 1998-2003 (19.3 years) and 2003-2008 (19.4 years). However, life years gained have been mainly focused on the unhealthy state.

CONCLUSIONS: Analysis of conditional and unconditional life expectancy indicated that live years gained are a result of the decline of mortality in unhealthy states. This pattern suggests that there has been no reduction in morbidity among older women in Brazil between 1998 and 2008.

DESCRIPTORS: Women. Life Style. Health Behavior. Quality of Life. Sickness Impact Profile. Active Life Expectancy.

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RESUMO

OBJETIVO: Analisar a expectativa de vida saudável condicional e não condicional de idosas brasileiras.

MÉTODOS: Estudo transversal, utilizando a técnica intercensitária, para estimar, na ausência de dados longitudinais, a expectativa de vida saudável não condicional e condicional ao estado de saúde corrente do indivíduo. Os dados utilizados foram obtidos da Pesquisa Nacional por Amostra de Domicílios de 1998, 2003 e 2008, cuja amostra foi composta, respectivamente, por 11.171, 13.694 e 16.259 mulheres com idade igual ou superior a 65 anos. Foram utilizadas, também, tábuas completas de mortalidade do Instituto Brasileiro de Geografia e Estatística, para os anos de 2001 e 2006. A definição dos estados de saúde baseou-se na dificuldade em realizar as atividades de vida diária.

RESULTADOS: O tempo de vida remanescente apresentou forte dependência com o estado de saúde corrente das idosas. No período 1998-2003, a proporção do tempo a ser vivido com incapacidade por mulheres saudáveis aos 65 anos era de 9,8%. Esse percentual aumentou para 66,2% quando as mulheres aos 65 anos já apresentavam alguma incapacidade. A análise temporal mostrou que a expectativa de vida ativa das mulheres aos 65 anos aumentou entre 1998-2003 (19,3 anos) e 2003-2008 (19,4 anos). No entanto, ganhos de vida se concentraram, sobretudo, no estado não saudável.

CONCLUSÕES: A análise da expectativa de vida condicional e não condicional indica concentração dos ganhos de vida, provenientes do declínio da mortalidade, em estados não saudáveis. Esse padrão sugere que não houve redução da morbidade entre as idosas brasileiras entre 1998 e 2008.

DESCRITORES: Mulheres. Estilo de Vida. Comportamentos Saudáveis. Qualidade de Vida. Perfil de Impacto da Doença. Expectativa de Vida Ativa.

INTRODUCTION

The increase in longevity has led to growing concerns with the quality of life. Together with the extended human life span, quality of life in later ages with autonomy and independence is expected.[10,21] However, health deterioration in later life increases healthcare spending, especially the costs related to long-term care.[15,24]

One of the most used indicators to estimate the distribution of time that one expect to live between healthy and unhealthy statuses is the healthy life expectancy (HLE). The HLE is easy to understand and considers both the quality and quantity of years lived.[13] This is a cumulative measure that summarizes the combined effect of different levels of mortality and morbidity that individuals were exposed to throughout life.[8] Thereby it indicates the general state of health in older individuals.[22]

Comparisons between trends in HLE and total life expectancy lead us to understand whether the increase in longevity is followed by a similarly increased in healthy lifetime. At least three theories relate to this issue. The first, proposed by Gruenberg,[11] is known as failures of success or expansion of morbidity. This theory considers that successful technological innovations used to control chronic and degenerative diseases can increase the prevalence of these diseases and disabilities by extending their average durations. From an individual perspective, this scenario results in people surviving longer because of treatment of chronic diseases without delaying the onset of these diseases. thereby increasing the proportion of time lived in unhealthy status. The second theory, proposed by Fries,[9] is the compression of morbidity. It presents a more optimistic view than the expansion of morbidity.[11] In this scenario, the average age at onset of illnesses and disabilities can be postponed, extending the relative time lived with health. The third theory, called dynamic equilibrium, was proposed by Manton[20] and is seen as an intermediate scenario between the compression and expansion of morbidity. According to this theory, increased longevity can be associated with greater time lived with mild to moderate chronic illnesses and disabilities but reduced time lived with severe disabilities.

In Brazil, several studies[3-6,23,a] estimated HLE of older individuals for different periods and according to different definitions for state of health. The results suggest significant differences for sex and age, in addition to showing that approximately 20.0% of total life expectancy is lived with severe functional limitation.[3,a] Studies that examined the trend of HLE indicated that the time lived free of functional limitation increased between 1998 and 2003; however, these results differ in relation to the magnitude of this effect.[12,a]

Although Brazil has a tradition of cross-sectional data collection through numerous household surveys, existing longitudinal health studies such as *Projeto Bambuí*[19] and *Projeto Saúde, Bem-estar e Envelhecimento*[b] do not have samples that are nationally representative. This complicates the calculation of HLE for the Brazilian population as a whole, from the transitions observed between the health states during the life cycle. Because of the absence of this information, there is a dearth of estimates of healthy life expectancy to individuals in a given health state at a given age. In this article, we aim to fill this gap by applying Guillot & Yu's intercensal technique.[13] It permits the estimation of conditional HLE based on cross-sectional data. This is possible because the technique is based on the multistate approach, which relates the proportion of healthy individuals in two successive cross-sectional surveys, in terms of transition functions defined *a priori* based on alternative data sources. We also discuss the process of compression of morbidity using estimates of conditional and unconditional HLE.

A recurring issue in the debate about morbidity scenarios is how to define health states. Different concepts based on the presence of diseases, functional limitation, disability, or self-rated health[25] may lead to differing morbidity scenarios. In this article, the states of health were defined based on the ability to perform activities of daily living (ADL). Individuals unable to perform these activities were considered to have serious levels of functional limitation. Therefore, this indicator is associated with health deterioration and mortality in older individuals.[1]

Consequently, the objective of this study was to analyze conditional and unconditional HLE among older Brazilian women.

METHODS

This cross-sectional study used data obtained from the *Pesquisa Nacional por Amostra de Domicílios* (PNAD – National Household Sample Survey) from 1998,[c] 2003,[d] and 2008.[e] The sample of this survey comprised 11,171; 13,694; and 16,259 women aged 65 years or more, respectively. Because of the small size of the sample of men in later ages, we opted to analyze only women in order to avoid compromising the quality of the estimates.

To define the state of health, we used the question: "*Do you normally have difficulty eating, bathing, or going to the bathroom as a result of health problems?*". This question evaluates functional limitation based on three of the six tasks of the ADL index developed by Katz et al.[16] From this information, we define two health states. Women who responded that they "cannot" or "have great difficulty" performing the tasks were considered "disabled", and women who declared that they "have no difficulty" or "have little difficulty" performing the tasks were considered healthy and were therefore classified as "active". As a result, the unhealthy category was restricted to women who reported to have severe levels of disability. Women who reported little limitations performing the three activities were considered healthy.

To estimate HLE and combine health and mortality data, we used the probabilities of death from the complete female mortality tables created by IBGE for the years 2001[f] and 2006[g] as a means of capturing the average mortality during the two periods studied (1998-2003 and 2003-2008). Because the probabilities of death in the official IBGE tables[f,g] are limited to age 80, we used the mortality relational model proposed by Himes et al[14] to estimate the probabilities of death until the age of 95.

To estimate conditional and unconditional HLE among women aged 65-95 by five-year age groups, we used the

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intercensal technique developed by Guillot & Yu.[13] This indirect technique is based on the multistate approach, and despite its name, it can also be applied to data from sample surveys. In order to calculate HLE, we considered age-specific proportions of active individuals in two consecutive cross-sectional surveys, as well as the current age-specific probabilities of death between the dates of the surveys.

Because only two states of health were considered, we estimated four sets of age-specific transition probabilities: $_nq_x^{AI}$ (the probability that an "active" individual aged x at time t becoming "disabled" at time $t + n$), $_nq_x^{IA}$ (the probability that a "disabled" individual aged x at time t becoming "active" at time $t + n$), $_nq_x^{AM}$(the probability that an "active" individual aged x at time t dying between t and $t + n$) and $_nq_x^{IM}$(the probability that a "disabled" individual aged x at time t dying between t and $t + n$). The technique starts from the basic equation of the intercensal approach, which expresses the proportion of individuals active at time $t + n$ ($\Pi(x + n, t + n)$) in terms of the proportion of individuals who are active and of the same cohort at time t ($\Pi(x, t)$):

Equation (1)

$$\Pi(x + n, t + n) = \frac{\Pi(x, t) \cdot (1 - _nq_x^{AM} - _nq_x^{AI}) + [1 - \Pi(x, t)] \cdot (_nq_x^{IA})}{1 - _nq_x}$$

where $_nq_x$ represents the probability of an individual aged x at time t dying between t and $t + n$, regardless of the health status at age x.

After some modifications to equation (1) and having defined $_nr_x$ as the ratio between death probabilities for disabled and active individuals ($_nr_x = _nq_x^{IM} / _nq_x^{IM}$), the following equation is obtained:

Equation (2)

$$\Pi(x + n, t + n) - \frac{\Pi(x, t)}{1 - _nq_x} = \frac{1 - \Pi(x, t)}{1 - _nq_x} \cdot (_nq_x^{IA}) - \frac{\Pi(x, t) \cdot _nq_x / (1 - _nq_x)}{\Pi(x, t) + [1 - \Pi(x, t)] \cdot _nr_x} -$$

$$- \frac{\Pi(x, t)}{1 - _nq_x} \cdot _nq_x^{AI}$$

When the data are available for k age groups, equation (2) expands to a system of k equations and 3 times k unknowns, becoming an unsolvable system. However, the unknowns of equation (2) ($_nq_x^{IA}$, $_nq_x^{AI}$ e $_nr_x$) do not vary randomly with age; on the contrary, these quantities correspond to health processes that have a functional relationship with age. If we know how the quantities $_nq_x^{IA}$, $_nq_x^{AI}$ e $_nr_x$ vary with age, the number of unknowns in the system of equations is reduced, and allow us solve the system using a non-linear optimization technique.

Two assumptions were required to apply the intercensal technique. We assumed that the age pattern of the transition probabilities between the states of health (active/disabled/dead) for ages greater than or equal to 65 years was well described by an exponential function. We also assumed that only one health transition occurred during each established observation period.

With these assumptions established, it was possible to produce estimates for $_nq_x^{IA}$, $_nq_x^{AI}$ e $_nr_x$, which along with $_nq_x$ were sufficient to find the entire set of transition probabilities consistent with the changes observed in the proportions of active individuals between t and $t + n$. From there, it was possible to construct multistate life tables and estimate HLE.

RESULTS

Table 1 shows the proportion of active women. This proportion decreases with age. The decline in the proportion of active women was accentuated above age 80. The total prevalence of active women increased between 1998 (91.3%) and 2003 (91.5%) and decreased in 2008 (90.9%). However, these variations were not statistically significant at a level of 5% according to the bilateral test for the difference in proportions. The distribution of age-specific prevalence also maintained similar patterns in the periods examined.

The results in Table 1 were more consistent with the intercensal approach for estimating HLE employed in this study. Therefore, rather than following the rates by age in the same column (period), we should follow the diagonals in Table 1. In this way, we see the age-specific rates in different birth cohorts. These results show that the reduction in the prevalence of active women by age-cohort was similar to the reduction that occurred by age-period. For example, following the cohort of women in the age group 65-69 years old in 2003, the prevalence of active women fell from 96.2% to 94.0% in 2008 (age group 70-74 years). If we compare these age groups in the same period, e.g. 2003, the reduction was from 96.2% to 94.4%.

Table 1. Proportion (%) of active older women by age. Brazil, 1998, 2003, and 2008.

Age group	1998	2003	2008
65 to 69	96.2	96.2	95.9
70 to 74	93.3	94.4	94.0
75 to 79	89.2	90.3	90.5
80 to 84	85.5	85.0	83.1
85 to 89	76.5	75.2	74.9
90 to 94	62.2	61.9	66.4
Total	91.3	91.5	90.9

Source: IBGE-PNAD of 1998[c], 2003[d], and 2008[e].

Table 2 presents the transition probabilities between health states, calculated for women between 1998-2003 and 2003-2008. The probability of a disabled woman becoming active decreased with age. Between 1998 and 2003, for example, $_nq_x^{IA}$ was 0.04 at age 85-89, i.e., around 1/5 of the chance for the 65-69 age group (0.202). On the other hand, the probability of a woman becoming disabled increased with age, rising from 0.035 at 65-69 years to 0.088 at 85-89 years of age between 1998 and 2003. In addition, the probability of death for both disabled and active individuals also increased with age, following the typical pattern of the mortality function. The risk of death for a disabled individual was greater than that of an active individual. Table 2 also shows that the probability of an older woman recover from disability in the 65-69 and 70-74 age groups was greater than or similar to the probability of becoming disabled in the two periods studied.

The comparison of probability functions (Table 2) in the two periods of analysis indicated an increase in the probability of an active woman becoming disabled. Meanwhile, in the same period, the probability of recover from disability also increased but to a lesser magnitude than the probability of becoming disabled. Additionally, the probabilities of death reduced for both active and disable women.

The combination of the health transitions listed in Table 2 allows the estimation of conditional HLE to different health states at a given age. Table 3 presents life expectancy at 65 and 80 years old, given the initial health state (with functional limitation or active) and the expected time lived with a disability or actively. The total number of years to be lived was smaller for women who already had functional limitation at a given age. Between 1998 and 2003, women with disability at age 65 expected to live 14.2 years, i.e., 5.1 fewer years than those women who were healthy at the same age (19.3 years). The dependence on initial health condition became more evident when comparing the time lived with disability among active women with those who already had some disability. Between 1998 and 2003, the proportion of time lived with some disability was 66.2% and 92.4%, respectively, for women with disability at age 65 and at age 80. These values were significantly higher than those for initially healthy women at these same ages: 9.8% and 11.9% at age 65 and at age 80, respectively.

The results in Table 3 show that the life expectancy of active women at age 65 increased between 1998-2003 (19.3) and 2003-2008 (19.4). However, the years gained were concentraded in unhealthy state. The number of years and the proportion of time lived with disability among women who were initially healthy at age 65 rose from 9.8% (1.9 years) between 1998 and 2003 to 17.0% (3.3 years) between 2003 and 2008. On the other hand, the time lived in the active state fell from 17.4 years to 16.1 years. A similar pattern was observed among women who initially had some disability at age 65, as well as among older women at age 80.

Table 4 presents the trends of unconditional HLE among Brazilian women. Looking at the absolute values, we observed that at age 65, both total life expectancy and life expectancy with functional limitation increased during the period of study, whereas active life expectancy decreased (Table 4). Regarding the relative changes, the proportion of time lived with functional limitation at age 65 increased between 1998-2003 and 2003-2008 from 11.8% to 18.8%, whereas the proportion of time lived in a healthy state decreased from 88.2% to 81.2%. The same pattern was observed for women at age 80. The proportion of total life expectancy lived with functional limitation at age 80 increased from 20.4% to 33.2% between 1998-2003 and 2003-2008.

DISCUSSION

The results showed a strong dependence on the total time lived, as well the amount of time that one expect to live free of disability in relation to the current health

Table 2. Transition probabilities by age in older women. Brazil, 1998-2003 and 2003-2008.

Age	1998–2003				2003–2008			
	Disabled Active	Disabled Dead	Active Disabled	Active Dead	Disabled Active	Disabled Dead	Active Disabled	Active Dead
	$(_nq_x^{IA})$	$(_nq_x^{IM})$	$(_nq_x^{AI})$	$(_nq_x^{AM})$	$(_nq_x^{IA})$	$(_nq_x^{IM})$	$(_nq_x^{AI})$	$(_nq_x^{AM})$
65	0.2020	0.2358	0.0350	0.0674	0.2000	0.2263	0.0650	0.0618
70	0.1351	0.2703	0.0441	0.1022	0.1414	0.2664	0.0818	0.0963
75	0.0903	0.3148	0.0554	0.1574	0.1000	0.3118	0.1030	0.1491
80	0.0604	0.3717	0.0698	0.2460	0.0707	0.3677	0.1296	0.2327
85	0.0404	0.4235	0.0878	0.3709	0.0500	0.4232	0.1631	0.3543

Source: IBGE-PNAD of 1998[c], 2003[d], and 2008[e] and Complete female morbidity tables for 2001[f] and 2006[g].

Table 3. Conditional life expectancy ($_ne_x$) by age in older women. Brazil, 1998-2003 and 2003-2008.

Period	Exact age (x)	n	Life expectancy ($_ne_x$)*					
			I	II	IA	A	AA	AI
1998 to 2003	65	30	14.2	9.4	4.8	19.3	17.4	1.9
	80	15	7.9	7.3	0.7	9.2	8.1	1.1
2003 to 2008	65	30	14.4	9.9	4.6	19.4	16.1	3.3
	80	15	8.0	7.2	0.7	9.3	7.5	1.9

Source: IBGE-PNAD of 1998[c], 2003[d], and 2008[e] and Complete female morbidity tables for 2001[f] and 2006[g].
I: life expectancy conditional on disabled state; II: disabled life expectancy conditional on disabled state; IA: active life expectancy conditional on disabled state; A: life expectancy conditional on active state; AA: active life expectancy conditional on active state; AI: disabled life expectancy conditional on active state.
* The life expectancies presented here represent the expected number of years to be lived between the exact ages x and 95 years.

Table 4. Life expectancy in older women. Brazil, 1998-2003 and 2003-2008.

Period	Exact age (x)	Life expectancy (years)*			Percentage of life expectancy	
		Total	Active	Disabled	Active	Disabled
1998 to 2003	65	19.0	16.8	2.3	88.2	11.8
	80	9.0	7.2	1.8	79.6	20.4
2003 to 2008	65	19.2	15.6	3.6	81.2	18.8
	80	9.1	6.1	3.0	66.8	33.2

Source: IBGE-PNAD of 1998[d], 2003[e], and 2008[f] and Complete female morbidity tables for 2001[g] and 2006[h].
* The life expectancies presented here represent the expected number of years to be lived between the exact ages x and 95 years.

state at a given age. The temporal comparison of HLE indicated expansion of morbidity among older Brazilian women between 1998 and 2008.

A limitation of this study was the non-detailed information of functional limitation to estimate the transition probabilities between the health states. The PNAD data combined different levels of functional limitation into a single question, which prevented the precise measurement of the true process of health deterioration in the individuals. Furthermore, PNAD did not specify the minimum duration of each disability, which prevented distinction between temporary and chronic disabilities. These limitations may have contributed to the observed pattern between the probability of recover from disability and the probability of becoming disabled at age groups 65-69 and 70-74. Contrary to expectations, the probability of recovery was greater than or similar to the probability of becoming disabled. To minimize the confounding effects from the inclusion of temporary disabilities in the definition of health states, this study provided estimates for women at age 80. Therefore, the estimates were more accurate at this age. Because of the nature of the PNAD data, it was necessary to assume that only one health transition occurred within each observation period. This assumption was somewhat weak because the five-years period between each survey was long and therefore, individuals could be subjected to more than one transition,

mainly in the first age groups (60-64 years, 65-69 years, 70-74 years), when the chances of recovery were higher.

To estimate HLE, the technique used in this study incorporated the dynamic process between health states at two points in time. This makes it the most appropriate methodological alternative for time trend analysis, compared with the Sullivan method,[26] which is widely used in Brazilian literature. Another advantage is the non-assumption of stationarity and homogeneous risks of death among health states.[h] Nevertheless, care should be taken in concluding that the expansion of morbidity was observed among the older Brazilian women during the decade analyzed. This is because the estimated changes in HLE between the two periods studied were subject to both sampling variability as well as the limitations of the data. One possible solution would be the calculation of confidence intervals, but one of the limitations of the technique was the absence of these intervals. Another limitation of the technique was the assumption of a transition pattern that were not observable. The assumption that the age pattern for the transition probabilities followed an exponential function was based on international literature, given that this information is not available for the whole Brazil. Studies in the United States,[7,13,17,18] Mexico,[i] and Puerto Rico[i] demonstrated that for ages greater than or equal to 60, these distributions are well described by an exponential function.

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Previous studies[12,b] that also analyzed temporal trends in HLE for Brazil between 1998 and 2003 indicated a slight increase in the proportion of time lived without functional limitation. These results are also subject to sampling variability, besides the fact that they do not capture changes between cohorts and ignore the transitions between health states. Difficulty in assessing the process of compression and expansion of morbidiy in Brazil based on cross-sectional data indicates a need for nationwide longitudinal health studies.

This present study showed the importance of current health status in older individuals for their remaining lifespan. Because health is a cumulative process in the life cycle, the conditional results pointed to the need for direct and indirect health interventions from the early stages of life. Such measures could increase the proportion of individuals who reach more advanced ages free of disability, which generally ensures a longer lifespan and better quality of life.

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