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## Abstract

**Background**: No official estimates have been published regarding healthy life expectancy in Algeria, and chronic disease-free life expectancy in particular, despite their importance for assessing public health policy effectiveness and predicting social security expenditure.

**Aims**: To estimate chronic disease-free life expectancy in Algeria and analyse its changes in recent years, and to determine how morbidity has changed according to age, time, and gender, compared with mortality, following expansion of morbidity, compression of morbidity, or morbidity–mortality balance.

**Methods**: We used Sullivan's method to estimate chronic disease-free life expectancy in Algeria using data provided from the Multiple Indicator Cluster Surveys and national life tables published by the Office for National Statistics for 2006, 2012–2013, and 2018–2019. The changes in healthy/unhealthy years compared with life expectancy were analysed.

**Results**: Although Algerian women live an average 1–2 years longer than men, their chronic disease-free life expectancy is 5 years shorter. The gain in life expectancy between 2006 and 2018–2019 was accompanied by a decline in chronic disease-free life expectancy from 62.36 and 57.27 years to 61.13 and 55.64 years for men and women, respectively.

**Conclusion**: Algerians in 2018–2019 lived longer but not healthier than in 2006, and the number of unhealthy life years increased compared with life expectancy. Thus, public health

programmes need to be more efficient to increase healthy years faster, or at least at the same pace as life expectancy.

Keywords: chronic disease-free life expectancy, life expectancy, mortality, morbidity, Algeria.

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## Introduction

Life expectancy is often used to assess population health status (1) and effectiveness of public health programmes (2); however, healthy life expectancy may be more appropriate (3). Extension of life does not necessarily imply an improvement in quality of life (4). The relationship between life expectancy and healthy life expectancy is even more complicated and unclear (5). Therefore, investigating how additional life expectancy is lived, in poor or good health, has attracted much interest (6).

There are 3 main scenarios regarding the comparative changes in healthy life expectancy and life expectancy: compression, expansion, or balance (4,7). Compression of morbidity (8) refers to healthy life expectancy improving faster than life expectancy, resulting in a continual reduction and concentration of the unhealthy years to the end of life. Morbidity expansion (9) refers to an increase in unhealthy years as a proportion of life expectancy, which extends the longevity of people with a chronic disease without postponing the onset age (10). When healthy life expectancy and life expectancy improve at similar paces, there is evidence of a mortality–morbidity balance (11).

The need for appropriate indicators to assess health status was first raised in the mid-1960s

(12), and the first method for estimating healthy life expectancy was proposed by Sullivan in the early 1970s (13). Although healthy life expectancy usually refers to various health measures, it corresponds more to disability-free life expectancy (6,12,13) and the 2 concepts are often used interchangeably (4,14). Disability can have different meanings, ranging from limitation to carrying out basic daily life activities to dependency (15).

The fact that chronic diseases are the main causes of disability (5,16) makes chronic disease-free life expectancy one of the principal indicators of healthy life expectancy. This indicator is intended to guide policymakers in delivering better public health programmes and forecasting social security expenditures. Statistics on life expectancy have become available in many developing countries as a result of improved civil registration systems, although estimates of healthy life expectancy are less available.

In Algeria, national life tables based on vital statistics were first published in 1977 by the Office for National Statistics. Life expectancy improved from 55.1 years in 1977 to 77.8 years in 2019. However, no official estimates for healthy life expectancy have been provided. The only available estimates are published by the World Health Organization based on indirect methods. Those estimates show that healthy life expectancy was 59.7 and 61.6 years in 2002 (17) and 65.4 and 65.6 years in 2016 (18) for Algerian men and women, respectively.

In this study, we estimated chronic disease-free life expectancy for the Algerian population and analysed its changes from 2006 to 2019 using data from the Multiple Indicator Cluster Surveys (MICS), waves 3, 4, and 6. The quality of the years gained, in poor or good health, was also studied, along with gender differences in levels and trends of chronic disease-free life expectancy.

## Methods

Sullivan’s method (13) has remained for about 50 years as the most widely used method for estimating healthy life expectancy (19). In addition to its simplicity of implementation, this method has shown good performance (20) compared with other methods, such as the multistate model of Rogers et al. (21,22). However, Sullivan’s method has the disadvantage of not considering sudden changes in transition probabilities between different health states (20) and the reverse transition from an unhealthy to a healthy state (19). The latter did not affect our results because we assessed chronic, controllable, but not curable diseases. We used Sullivan’s method to estimate chronic disease-free life expectancy for men and women based on mortality data from the national abridged life tables and chronic disease data from the MICS. The MICS programme was initiated in the 1990s by UNICEF to provide developing countries with reliable, nationally representative, and internationally comparable estimates for a set of

indicators on household living conditions and health. Algeria has participated in 5 of the 6 editions of the surveys in 1995 (MICS 1), 2000 (MICS 2), 2006 (MICS 3), 2012–2013 (MICS 4), and 2018–2019 (MICS 6). Questions about chronic diseases were introduced in MICS 3. Respondents were asked to report their status and that of their household members regarding chronic diseases, such as hypertension, diabetes, cardiovascular diseases, asthma, neuropsychiatric disorders, cancer, kidney disease, and musculoskeletal diseases. The following questions were asked: Does (name) suffer from a chronic disease? What disease does he/she suffer from? Has a health professional diagnosed the disease? The same questions were asked again for a possible second chronic disease. A new question was introduced in MICS 4 about when the chronic disease was diagnosed. MICS 6 included a question regarding the age at which the chronic disease was diagnosed. In the MICS, questions about chronic diseases were asked of people aged ≥ 15 years. MICS 3 made an exception by including those

We used MICS data to estimate the age and gender distribution of the population with at least one chronic disease and that of the survey population. The ratio of the former distribution to the latter allowed us to estimate chronic disease prevalence by gender and 5 age intervals for 2006, 2012–2013, and 2018–2019. To estimate chronic disease prevalence at age

Sullivan's method is mainly based on the classical method of estimating life expectancy from a life table. By assuming a fictitious population of age 0 (noted as $l_x$ with $x = 0$), and by letting $nQx$ represent the probability of death between age x and $x + n$, the surviving population at any age $x + n$ is calculated by: $l_{x+n} = l_x (1 - nQx)$. The number of person-years lived in each age interval $(x,x + n)$ is estimated using: . Individuals who have died in each age interval are assumed to have lived for half of that interval. Infant and juvenile deaths are an exception and are usually concentrated at the beginning of the age intervals (23). Abridged life tables are often closed with an open age group (m and older) and only the remaining life expectancy at age m (LEm) is provided to summarize mortality beyond that age. Thus, people alive at age m (noted $l_m$) are supposed to still have to live LEm each. This gives: $nL_m = LEm\ l_m$. Life expectancy at any age x is calculated using:

Sullivan's idea for taking morbidity into account was to multiply the number of person-years in each age group by the proportion of people without disabilities in that age group (19,24). This can be written as follows:

In our case, $n\pi x$ measured the prevalence of chronic diseases in the age group $(x,x + n)$. For mortality data, we used the official Algerian life tables for men and women, corresponding to the average interview date of each MICS wave: near mid-2006, early 2013, and early 2019 for MICS 3, 4, and 6, respectively. Thus, the 2006 life table was used without any modification, while average life tables were estimated for the 2012–2013 and 2018–2019 periods. To ensure consistency, all 3 life tables were closed at the open age group 80+ years. As published by the Office for National Statistics, the tables for 2012, 2013, 2018, and 2019 were closed at the 85+

years age group, while the life table for 2006 was closed at 80+ years.

The different calculations in this study were performed using R software (R Foundation, Vienna, Austria) and Microsoft Excel (Redmond, WA, USA).

## Results

Figure 1 compares the age and gender distribution of the survey population with those that have chronic diseases in the 3 MICS. The survey population was ~170 000 in MICS 3 and ~150 000 in MICS 4 and 6. The proportion of people aged ≥ 15 years with chronic diseases was 9.8% in MICS 3, 10.6% in MICS 4, and 14.6% in MICS 6. The female disadvantage was notable, with proportions of 12%, 13%, and 17.7% in MICS 3, 4, and 6, respectively against 7.6%, 8.3%, and 11.7% in men.

Figure 2 shows chronic disease prevalence from age 0 to 80+ years for men and women in MICS 3, 4, and 6. The gender difference became apparent at age 25 years and peaked at 40–49 years when the prevalence in women became twice that of men. There was a lower risk of developing a chronic disease at age

Table 1 shows a comparison of the changes in chronic disease-free life expectancy for men and women at ages 0 and 50 years in the 3 MICS. At age 0 years, life expectancy for men was 74.67 years in 2006, 76.08 years in 2012–2013, and 77.15 years in 2018–2019. For women, it increased from 76.74 years to 77.26 and 78.50 years over the same period. In 2006, chronic disease-free life expectancy was 62.36 years for men versus 57.27 years for women. A slight improvement was noted in 2012–2013, with 62.70 and 57.40 years for men and women, respectively, but in 2018–2019, chronic disease-free life expectancy decreased to 61.13 and 55.64 years for men and women, respectively.

The remaining life expectancy at age 50 years for men was nearly 30 years in 2006, 30.60 years in 2012–2013, and 31.33 years in 2018–2019. For women, it was 31.21 and 31.13 years in 2006 and 2012–2013, respectively, and increased to 32.02 years in 2018–2019. For men aged 50 years, the number of disease-free years decreased from 19.00 in 2006 to 18.35 in 2012–2013 and 17.12 in 2018–2019. Chronic disease-free life expectancy was lower for women, with 14.07, 13.38, and 12.01 years in 2006, 2012–2013, and 2018–2019, respectively.

Changes in the proportion of years of life without chronic diseases showed a declining trend for both men and women at ages 0 and 50 years. In 2006, 83.5% of male life expectancy was lived

without chronic diseases but this decreased to 79.2% in 2018–2019. This proportion was lower for women: only 74.6% in 2006 and 70.9% in 2018–2019. In other words, women in 2018–2019 expected to spend 29.1% of their lives with chronic diseases compared with 20.8% for men. These proportions were 25.4% and 16.5% in 2006 for women and men, respectively. At age 50 years, the proportion of years with chronic diseases in the remaining life expectancy in women increased to 62.5% in 2018–2019 from 54.9% in 2006. For men, the proportions were lower than for women, at 36.5% and 45.4% in 2006 and 2018–2019, respectively.

We analysed the gender gap in life expectancy and chronic disease-free life expectancy. In 2006, life expectancy for women was 2.07 years longer than for men but the gap narrowed to 1.34 years in 2018–2019. Chronic disease-free life expectancy for men was higher than for women by 5.09 years in 2006, 5.30 years in 2012–2013, and 5.49 years in 2018–2019. In other words, women expected to live 7.16 years longer with chronic conditions than men did in 2006, which decreased to 6.84 years in 2018–2019. Between 2006 and 2018–2019, the number of years with chronic disease increased for women from 19.47 to 22.86 years compared with 12.31 to 16.02 years for men.

## Discussion

This study estimated chronic disease-free life expectancy for men and women in Algeria using MICS morbidity data combined with national life tables, and analysed its changes compared with life expectancy from 2006 to 2018–2019. Men gained 2.48 years in life expectancy, from 74.67 to 77.15 years, and women gained 1.76 years, from 76.74 to 78.50 years. Analysis of the change in chronic disease-free life expectancy revealed 2 main results: (1) chronic disease-free life expectancy decreased from 2006 to 2018–2019 for both men and women; and (2) women were more affected by chronic diseases than men were.

The first finding refers to morbidity expansion (9), which occurs when the lethal effects of diseases are reduced faster than their nonlethal effects (25). Many countries experienced morbidity expansion between 1960 and 1990 (7), and some even experienced an absolute expansion of morbidity during specific periods, such as Canada from 1986 to 1990, and Australia from 1981 to 1993 (3). The expansion (or compression) of morbidity theory is based on disability and omits nondisabling chronic diseases. Only a few studies have considered a broader definition of morbidity, including nondisabling chronic diseases (26), where the classical notion of morbidity expansion was replaced by disability expansion. This study highlighted morbidity expansion in its broad definition and showed that the years without chronic diseases decreased in absolute and not just relative terms. The increased prevalence of some chronic diseases over the past few decades most likely resulted from many factors, such as worsening diet, lack of physical activity, and obesity (10). However, some of the increases may have been influenced by improved screening for chronic diseases and extended medical coverage. Also, self-reported health surveys tend to omit cases that have not been diagnosed at the time of the

surveys. Therefore, the results of this study should be interpreted with caution. However, it is worth mentioning that the extent of compression/expansion of morbidity depends on the type of health indicator used for its assessment. Expansion is more likely to be observed when chronic disease-free life expectancy is used instead of disability-free life expectancy (27). This is because chronic diseases are not necessarily disabling, and advances in medicine and health care allow people with chronic diseases to lead ordinary lives. Thus, a decrease in chronic disease-free life expectancy can be observed alongside an improvement in disability-free life expectancy (28).

The second main result of this study relates to the gender gap in chronic disease-free life expectancy. Several studies have reported that women live longer than men, but the difference in healthy life expectancy tends to be smaller, and even favours men in some cases (29). This study indicated a reversal of the female advantage in life expectancy into a 5-year disadvantage in chronic disease-free life expectancy. This is known as the survival–health paradox, and may be explained by the high prevalence of chronic diseases among women compared with men, and by the types of chronic diseases that each gender is more likely to develop. Men appear to be more exposed to life-threatening diseases and women to non-life-threatening diseases (30). This may translate into longer life for women but also more years lived with the disease.

It has been shown that Algerian women had a higher prevalence of cancer (31), diabetes (32), hypertension, and rheumatism (33) than men. However, this gender difference may have been influenced by disease under-reporting by men because most respondents to household health surveys were women (34). The estimation of years lived with chronic diseases can facilitate estimation of social security expenditure related to chronic diseases and predict future variation. Analysis of the contribution of different diseases to loss of healthy years is essential for setting priorities in prevention and treatment. All of these points need to be explored in future research, along with the risk factors behind the female disadvantage in chronic disease-free life expectancy.

Our study had some limitations. First, it did not consider chronic disease severity, which is essential if we intend to use our results to estimate working life expectancy. Work capacity is maintained in some chronic diseases but is lost at some stages of the disease. This dimension is being considered in a separate study on estimating health-adjusted life expectancy. Second, we used an indirect method to estimate prevalence rates at age

In conclusion, Algerian men and women are living longer but not healthier, and the unhealthy life years have increased compared with life expectancy. The effectiveness of public health programmes must be increased so that healthy life expectancy improves more rapidly, or at least at the same rate as life expectancy. Improving living conditions and the healthcare system may be a means to achieving such an objective.

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**Competing interests**: None declared.

## Analyse de l'évolution récente de l'espérance de vie sans maladies chroniques en Algérie

### Résumé

**Contexte** : En Algérie, aucune estimation officielle n'a été publiée concernant l'espérance de vie en bonne santé, en particulier l'espérance de vie sans maladies chroniques, malgré l'importance de ces deux indicateurs pour évaluer l'efficacité des politiques de santé publique et prévoir les dépenses de sécurité sociale.

**Objectifs** : Estimer l'espérance de vie sans maladies chroniques en Algérie et analyser son évolution au cours des dernières années, ainsi que déterminer comment la morbidité à évolué selon l'âge, le temps et le genre, par rapport à la mortalité, suivant l'expansion et la compression de la morbidité ou l'équilibre morbidité-mortalité.

**Méthodes** : Nous avons utilisé la méthode de Sullivan pour estimer l'espérance de vie sans maladies chroniques en Algérie à l'aide des données fournies par les enquêtes par grappes à indicateurs multiples et les tables de mortalité nationales publiées par l'Office National des Statistiques pour 2006, 2012-2013 et 2018-2019. L'évolution des années de bonne et de mauvaise santé comparativement à l'espérance de vie a été analysée.

**Résultats** : Bien que les femmes algériennes aient vécu en moyenne un à deux ans de plus que les hommes, leur espérance de vie sans maladies chroniques était plus courte de cinq ans. Le gain d'espérance de vie entre 2006 et 2018-2019 s'est accompagné d'une baisse de l'espérance de vie sans maladies chroniques de 62,36 à 61,13 ans pour les hommes et de 57,27 à 55,64 ans pour les femmes.

**Conclusion** : En 2018-2019, les Algériens ont vécu plus longtemps sans pour autant être en meilleure santé qu'en 2006, et le nombre d'années de vie en mauvaise santé a augmenté par

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rapport à l'espérance de vie. Les programmes de santé publique devraient donc être plus efficaces afin que les années en bonne santé augmentent plus rapidement, ou du moins au même rythme que l'espérance de vie.

# تحليل التغيرات الحديثة في متوسط العمرِ المتوقع بدون أمراض مزمنة في الجزائر

فريد فليسي، مريم شينون

## الخلاصة

: ليس هناك أي تقديرات رسمية منشورة عن متوسط العمر الصحي، ولا سيما العمرالخلفية
المتوقع دون أمراض مزمنة في الجزائر، رغم أهميتها في تقييم فعالية سياسات الصحة
العامة والتنبؤ بإنفاقات الضمان الاجتماعي .

: هدفت هذه الدراسة الى تقدير العمر المتوقع دون أمراض مزمنة في الجزائرالأهداف
وتغيراته في السنوات الأخيرة، وتحديد كيفية تغيُّر المراضة حسب العمر والزمن والجنس،
بالمقارنة مع الوفيات، وفقاً لتوسع المراضة أو ضغط المراضة أو التوازن بين المراضة
والوفيات .

: استخدمنا طريقة سوليفان لتقدير العمر المتوقع دون أمراض مزمنة، باستخدامطرق البحث
البيانات الواردة من المسوحات العنقودية المتعددة المؤشرات وجداول الحياة التي نشرها
الديوان الوطني للإحصاء عن الأعوام 2006 ، وما بين عامَي 2012-2013 ، وما بين عامَي
2018-2019. وحللنا التغيرات في سنوات العمر الصحية وسنوات العمر غير الصحية ومتوسط
العمر المتوقع .

: رغم أن المرأة الجزائرية تعيش في المتوسط أطول من الرجل ما بين عام إلى عامين،النتائ ج
إلا أن متوسط عمر المرأة الجزائرية المتوقع دون أمراض مزمنة كان أقل بخمس سنوات .
ارتفاع العمر المتوقع بين عامَي 2006 و2019/2018 قد صاحبها انخفاض العمر المتوقع بدون
أمراض مزمنة من 62.36 إلى 61.13 سنة للرجال و 57.27 إلى 55.64 سنة للنساء .

: في عامَي 2018-2019 ، عاش الجزائريون عمرًا أطول لكنه لم يكن أكثر صحةً منالاستنتاجات
2006 ، وارتفع عدد سنوات الحياة غير الصحية مقارنة بالعمر المتوقع . ومن ثَم، ينبغي أن
تكون برامج الصحة العامة أكثر كفاءة لزيادة السنوات الصحية بسرعة أكبر، أو على الأقل
بنفس وتيرة إرتفاع العمر المتوقع .

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