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Dynamics of Algerian Life Expectancy: A KDE-PELT Study Compared to Emerging Countries' Trajectories

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Abstract:

Life expectancy is a central indicator of health transition, reflecting socio-economic transformations and public policy impacts. this paper examines the trajectories of life expectancy in Algeria from 1960 to 2020, comparing them with those of eight emerging countries.

A dual approach, combining descriptive analysis and advanced statistical methods, was employed. tools such as kernel density estimation (kde) and the pelt algorithm were used to identify structural breakpoints and analyze temporal distributions.

Algeria experienced a rapid health transition marked by a distinct bimodality: a period of stagnation following independence (1960–1970) was followed by a remarkable surge between 1970 and 1985. this dynamic contrasts with more gradual progressions (e.g., Tunisia, Turkey) and stagnations (e.g., Nigeria, South Africa).

The identified structural breaks highlight the significant transformations in Algeria's healthcare system but also reveal enduring challenges. regional comparisons underscore Algeria's unique trajectory within a global context.

Keywords: Health transition, life expectancy, comparative analysis, advanced statistics, structural breaks.

JEL Classification: I15, I18, C22

Introduction:

Life expectancy, a universally recognized and synthetic indicator, lies at the core of human development concerns. As a direct reflection of health conditions, socio-economic progress, and public policy impacts, it serves as a key measure of health transition. This transition refers to the process through which populations shift from a high-mortality regime, often dominated by infectious diseases, to a low-mortality regime, characterized by the prevalence of chronic illnesses. Thus, the analysis of life expectancy extends beyond demographic boundaries, encompassing multidisciplinary dimensions such as the quality of healthcare infrastructure, equity in access to medical services, and the effectiveness of social policies.

In developing countries, changes in life expectancy during the 20th century often followed complex trajectories, marked by significant but uneven progress across regions and populations. These trends reflect intricate interactions between economic modernization, institutional reforms, and public health interventions. Studying these transformations provides deeper insights into the dynamics of health transitions and lays the groundwork for comparative analyses between nations with diverse contexts.

Within this global framework, Algeria emerges as a particularly relevant case study. As a middle-income nation [1], Algeria has undergone significant reforms and crises since gaining independence in 1962, shaping the development trajectories of its healthcare system. In its early decades as a modern state, Algeria faced structural challenges inherited from colonial rule, including insufficient infrastructure and political instability. Nonetheless, socio-economic reforms and substantial investments in health and education sectors have led to remarkable improvements in living standards[2].

Despite these advancements, Algerian life expectancy dynamics remain underexplored [3], especially from a comparative perspective. While neighboring countries such as Tunisia and Morocco have followed relatively similar trajectories, others, such as Nigeria or Iran, present contrasting patterns that offer valuable insights into Algeria's unique context. This study seeks to address this gap by providing a comprehensive analysis of health transition dynamics in Algeria.

The evolution of life expectancy in Algeria raises several fundamental questions: How do the observed trends compare to those of other countries with similar contexts? What are the distinctive characteristics of these changes? Most importantly, what factors have influenced the structural transformations and breakpoints in Algeria's health transition?

Despite the wealth of available data, these questions remain open due to the lack of integrative analyses combining descriptive and advanced statistical approaches.

This study aims to answer these questions by pursuing the following objectives:

- To describe and analyze, in detail, the evolution of life expectancy in Algeria from 1960 to 2020.
- To identify distinct phases within this evolution to better understand underlying trends.
- To position Algeria's trajectories within a regional and international comparative framework, highlighting national specificities.

To explore critical moments of transformation using advanced statistical tools, including Kernel Density Estimation (KDE) and breakpoint detection through the PELT algorithm.

2. DATA AND METHODOLOGY

To achieve these objectives, a two-step methodological approach will be adopted. In the first step, a **descriptive analysis** will outline the main trends in the temporal evolution of life expectancy and visually identify any potential trends or anomalies. In the second step, an **in-depth statistical analysis** will be conducted to identify the structural characteristics of the dynamics of life expectancy. The use of Kernel Density Estimation (KDE) will shed light on the underlying distributions and their transformations, while the PELT algorithm (Pruned Exact Linear Time) will objectively identify major breakpoints [11]

This study is based on a dataset spanning 60 years, from 1960 to 2020. This period, marked by significant political, economic, and social changes, provides an opportunity to analyze long-term health transition dynamics. In addition to Algeria, the analysis incorporates a sample of representative countries selected for their geographical, cultural, and socio-economic relevance, allowing for both regional and international contextualization.

The countries included in this study encompass nations from North Africa (Tunisia), the Middle East (Iran, Jordan), Latin America (Venezuela), Eastern Europe (Belarus), [10] and Sub-Saharan Africa (Nigeria, South Africa). This selection was motivated by the aim of covering a diversity of health and demographic contexts while considering their relevance in illustrating disparities and similarities within nearby or distant regions. Although these countries differ in their political and economic trajectories, they share certain historical

challenges with Algeria related to development policies, health reforms, and crisis management.

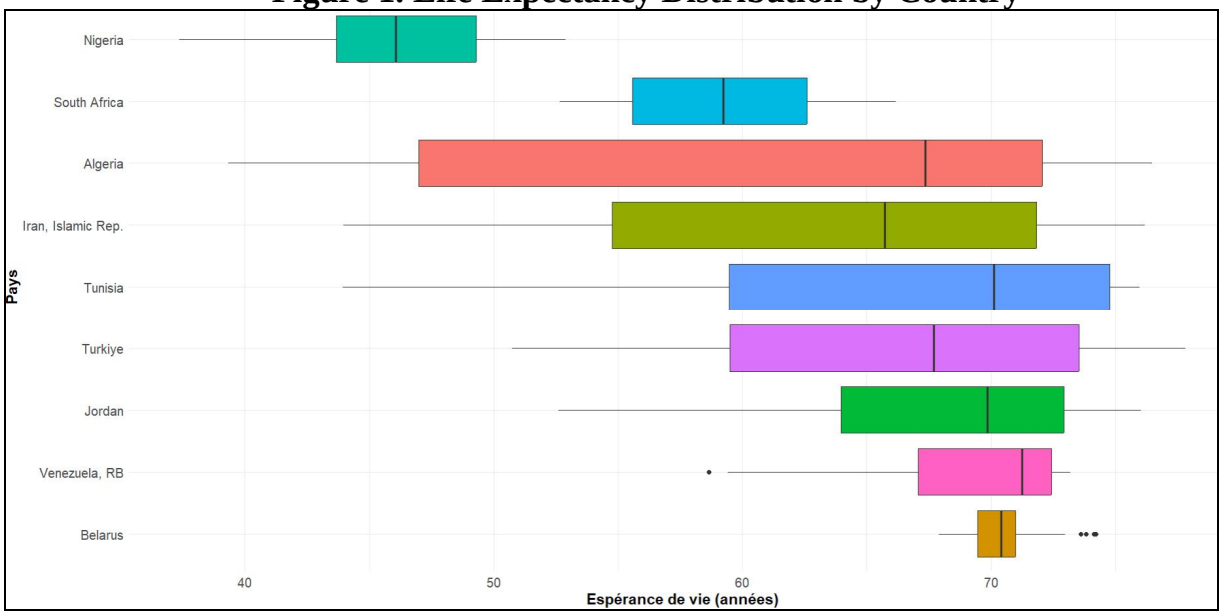
The data used in this study come from reliable and internationally recognized sources, ensuring rigor and consistency in their utilization. The main databases mobilized include the World Bank and the United Nations Population Division, which provide comprehensive time series on health and population indicators. These data, primarily focused on life expectancy at birth, were collected annually and harmonized to enable robust comparisons across countries and periods.

The data processing follows a clear structure designed to facilitate their use in the various stages of analysis. Raw data were organized to enable, first, a description of temporal trends and, second, a deeper exploration of underlying dynamics using advanced statistical tools. The analysis is thus structured around two main axes: the identification of global trends and distinct phases through descriptive approaches, followed by a more detailed modeling using methods such as Kernel Density Estimation (KDE) and breakpoint detection (PELT algorithm).

3. DESCRIPTIVE ANALYSIS OF LIFE EXPECTANCY

The analysis of the boxplot illustrating the evolution of life expectancy between 1960 and 2020 across all countries in the study reveals contrasting situations and trajectories among the studied nations. A clear hierarchy emerges, delineating three distinct groups in terms of performance.

Figure 1. Life Expectancy Distribution by Country



Source: elaborate by the author (R programmation)

At the top of the ranking, we find a first group of countries led by Tunisia and Turkey. Tunisia is distinguished by a large box indicating substantial progression over the period. Jordan and Venezuela complete this leading group, though slightly behind, with distributions reflecting different trajectories. Next comes Belarus, which presents a remarkably compact box, indicating great stability in its evolution.

A second group includes Algeria and Iran, which particularly stand out with the most extensive boxes in the sample, demonstrating the most dramatic progressions over the studied period.

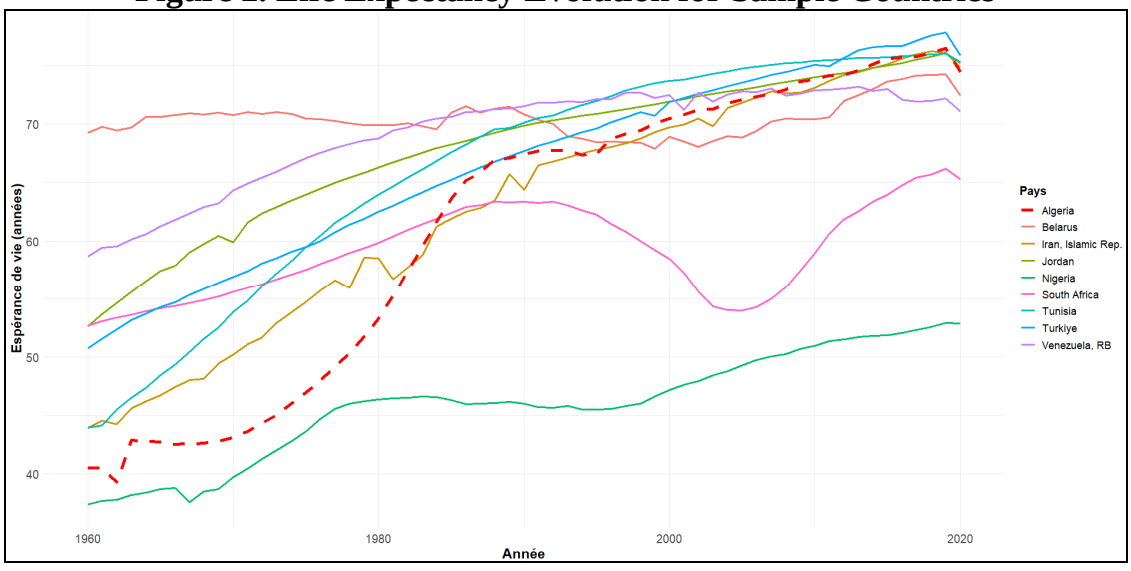
At the bottom, Nigeria and South Africa form a third group. Their boxes, positioned notably lower on the scale, illustrate the persistent challenges these countries face in terms of public health and development.

It is worth emphasizing again that the dispersion of data, visible through the width of the boxes, reveals varied evolution dynamics. The most marked progressions are observed for Algeria and Iran, as evidenced by their long boxes, while Belarus stands out for its exceptional stability with its very short box. The presence of extended "whiskers" for most countries indicates significant changes occurring during the period, likely linked to improvements in health systems and living conditions.

It is particularly noteworthy that Algeria, which initially had one of the lowest life expectancies among the studied sample of countries in 1960, has managed to significantly close this gap.

In this perspective, to deepen the analysis of life expectancy evolution over time, figures No. 2 and No. 3 offer new angles of analysis.

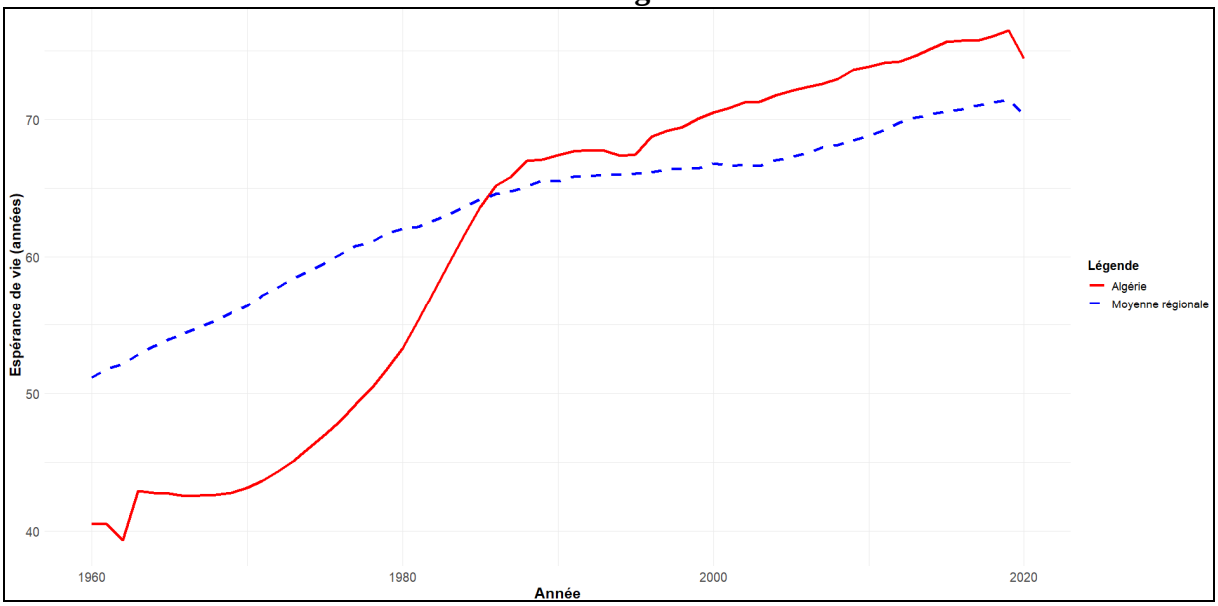
Figure 2. Life Expectancy Evolution for Sample Countries



Source: elaborate by the author (R programmation)

The analysis will focus particularly on the case of Algeria in comparison with the eight cases in the study. Visually and quite clearly, the decade 1960-1970 is distinguished by a relative stagnation in life expectancy, oscillating around 40-45 years. This period, corresponding to the first years post-independence, reflects the health and medical challenges that the country faced.

Figure 3. Evolution of Life Expectancy in Algeria Compared to the Sample Countries' Average



Source: elaborate by the author (R programmation)

Moreover, it is clearly visible that the second phase extending from 1970 to 1985 marks a decisive turning point with a dramatic progression in life expectancy, rising from 45 to approximately 65 years. This substantial improvement coincides with public health policies implemented during this period, notably the development of hospital infrastructure, mass vaccination, and improved access to healthcare. This acceleration phase demonstrates a profound transformation of the Algerian health system.

Furthermore, the period 1985-2020 is characterized by a more moderate but constant progression [4], with life expectancy reaching about 75 years by the end of the period. This evolution, although less spectacular than the previous phase, reflects a consolidation of health achievements and continuous improvement in the population's health conditions.

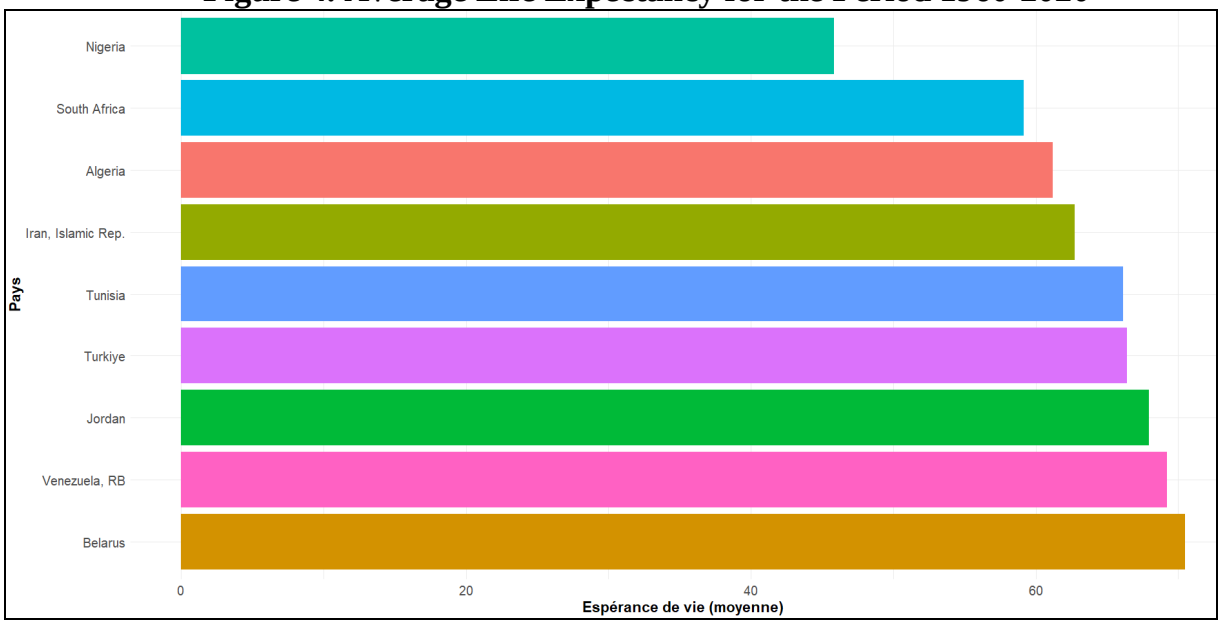
Complementing this analysis, it appears relevant to consider a third reading, that of average life expectancy over the 1960-2020 period, which highlights notable disparities between the studied countries. The average ranking positions Belarus at the top, with an

average life expectancy above 65 years, followed by Venezuela and Jordan. However, this aggregated hierarchy conceals deeply heterogeneous trajectories that warrant detailed examination.

Algeria, with an average life expectancy of approximately 62 years over the entire period, occupies a median position that only partially accounts for the remarkable progression dynamics observed. Indeed, the previous longitudinal analysis revealed three distinct phases in the evolution of Algerian life expectancy: an initial post-independence stagnation phase (1960-1970), followed by a phase of spectacular improvement (1970-1985), and finally, a more modest but continuous progression phase until 2020. This particular trajectory suggests that the period average masks a particularly effective catch-up process, which deserves special attention.

At the other end of the spectrum, Nigeria and South Africa show the lowest averages, around 45 and 50 years respectively. These relatively modest performances are set within a specific regional context, marked by persistent health challenges.

Figure 4. Average Life Expectancy for the Period 1960-2020



Source: elaborate by the author (R programmation)

Following an initial step of descriptive analysis of life expectancy trends, the application of kernel density estimation to its distribution enhances the understanding of Algeria's health trajectory.

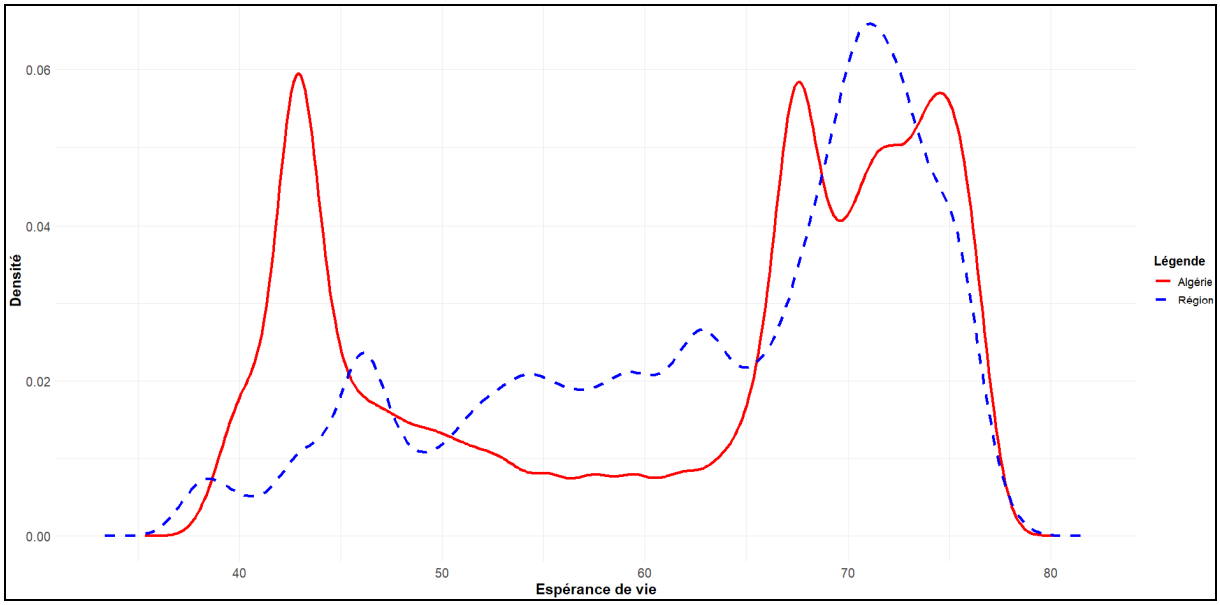
4. ADVANCED STATISTICAL ANALYSES:

Kernel density estimation (KDE) and breakpoint detection are two complementary techniques that, when applied together, can yield particularly insightful results in the analysis of complex time series, such as life expectancy.

4.1 DISTRIBUTION STRUCTURES: KERNEL DENSITY ESTIMATION (KDE)

A comparative examination of life expectancy distributions between Algeria and all countries is essential to uncover significant disparities and distinctive features in their respective health trajectories (see Figure 5).

Figure 5. Comparison of life expectancy distributions between Algeria and all countries.



Source: elaborate by the author (R programmation)

The analysis reveals a pronounced bimodal structure in Algeria's distribution, characterized by two distinct peaks. The first mode, centered around 40–45 years, corresponds to the post-independence period, while the second, located at 70–75 years, reflects the contemporary situation. This bimodal configuration constitutes a distinctive statistical signature of the speed and intensity of Algeria's health transition.

In contrast, the regional distribution exhibits a substantially different structure. Characterized by a more uniform distribution with a primary peak around 70 years, it suggests a more gradual and less pronounced transition. The more regular density observed between 50 and 65 years indicates a steadier progression of life expectancy on a regional scale.

This divergence in distribution structures significantly enhances our understanding of comparative health trajectories. The pronounced bimodality in Algeria's distribution corroborates the previous longitudinal analysis, statistically highlighting the rupture observed in the 1970s–1980s. It suggests a rapid structural transformation rather than a gradual evolution, confirming the hypothesis of a shift in the health regime.

The comparison with the regional distribution underscores the uniqueness of Algeria's trajectory. The absence of comparable bimodality in the regional distribution indicates that the rapidity and intensity of Algeria's health transition constitute an exception rather than a regional norm.

The temporal decomposition of life expectancy distributions into two distinct periods (1960–1990 and 1991–2020) allows for a deeper understanding of the dynamics of health transitions. Kernel Density Estimation (KDE) highlights significant heterogeneity in national trajectories, suggesting differentiated pathways of health development based on context.

To better grasp the specificities of each country, we will analyze the KDE graphs on a case-by-case basis. This detailed approach will shed light on the particularities of life expectancy evolution in each national context.

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4.2 IN-DEPTH ANALYSIS OF LIFE EXPECTANCY EVOLUTION BY COUNTRY

Algeria's bimodal distribution reflects a fundamental rupture in the country's health regime. This statistical configuration, which sharply contrasts with the more gradual distributions observed in most comparator countries, suggests an exceptionally intense structural transformation. The minimal overlap between the two periods underscores the radical nature of this transition, while the pronounced concentration in the recent distribution indicates an effective stabilization of the progress achieved.

This unique trajectory fits within a broader typology of health transitions, where several distinct models can be identified. Iran, for instance, also displays a bimodal structure but with greater overlap between periods, illustrating a more progressive variant of a radical transition. Belarus, characterized by a concentrated unimodal distribution, represents a model of remarkable stability. Meanwhile, Tunisia and Turkey exemplify a more gradual yet sustained transition.

In contrast, Nigeria and South Africa, with their widespread distributions and significant overlap between periods, highlight the persistent challenges of a complex and incomplete health transition.

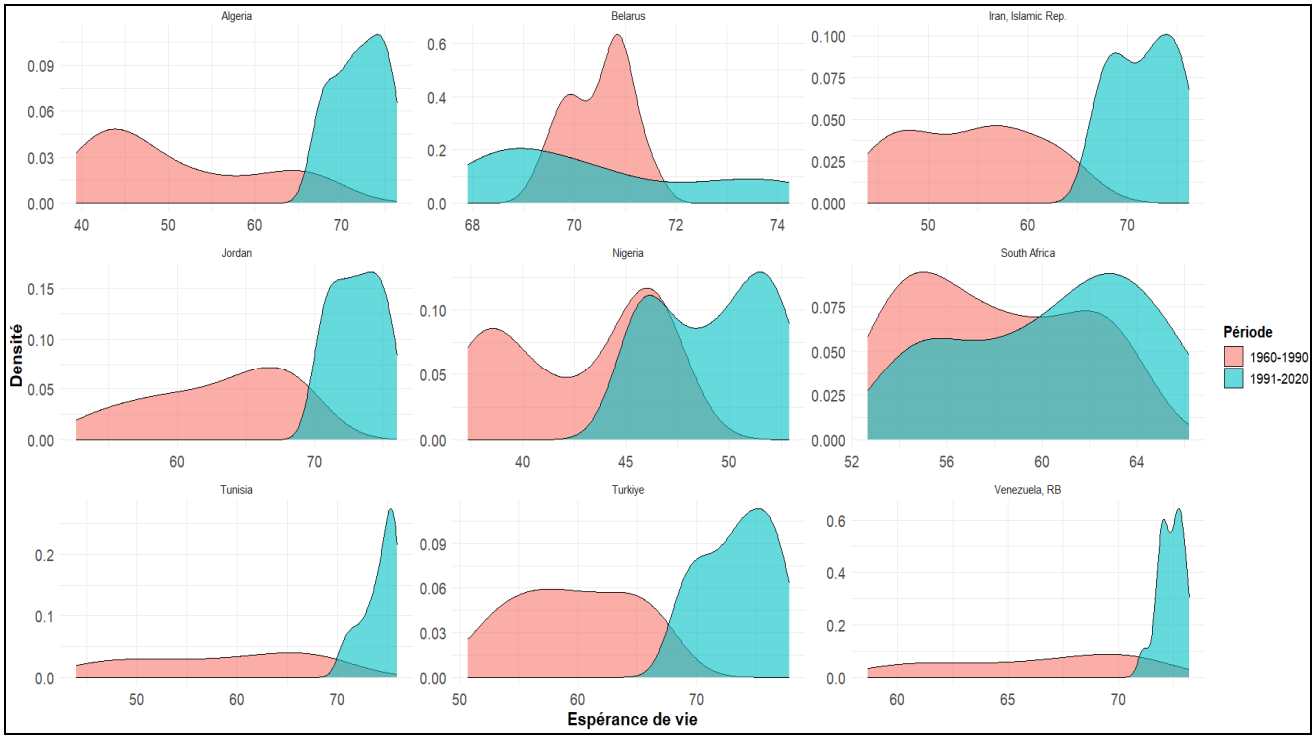


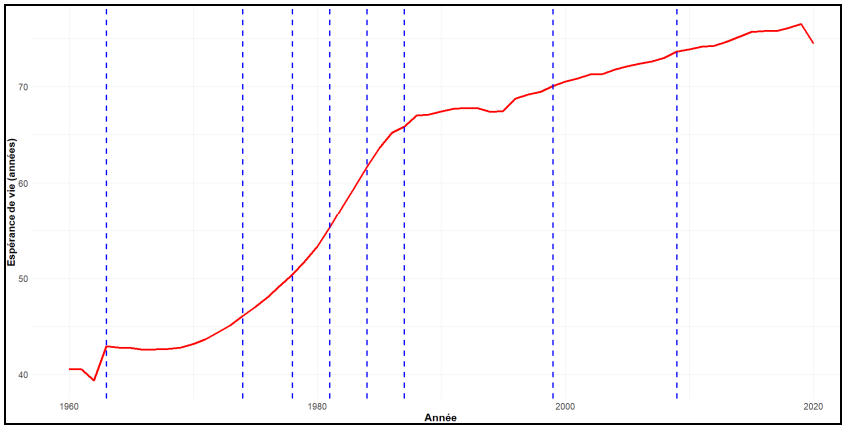
Figure 6. Density Distribution by Country

Source: elaborate by the author (R programmation)

4.3 BREAKPOINTS: DETECTION USING THE PELT ALGORITHM

The application of the PELT (Pruned Exact Linear Time) algorithm to the time series of Algerian life expectancy reveals a sequence of breakpoints that significantly enhances our understanding of the dynamics of health transition.

Figure 7. Breakpoints in Algerian Life Expectancy



Source: elaborate by the author (R programmation)

This methodological approach enables the precise identification of significant breakpoints in the country's health trajectory, revealing a transformation dynamic more complex than initially suggested by the descriptive analysis.

The immediate post-independence period (1960-1965) is characterized by notable instability in the indicator, fluctuating around 40 years of life expectancy. This initial volatility likely reflects the considerable challenges faced by the young Algerian state in building its fundamental health infrastructure. The breakpoint identified in 1965 marks the entry into a phase of relative stabilization, suggesting the first consolidation of basic health structures.

The period from 1965 to 1975 is marked by a relative stagnation in life expectancy, hovering around 43 years. This phase, far from being passive, can be interpreted as a period of construction and strengthening of institutional capacities within the health system. The apparent stability of the indicators likely conceals foundational efforts in establishing essential health infrastructures.

A significant shift begins in 1975, signaling the onset of a progressively accelerating phase that will last until 1985. This decade is characterized by sustained and regular improvements in life expectancy, reflecting the growing impact of health policies. The steady progression of the indicator suggests a systemic transformation rather than isolated improvements.

The period from 1985 to 1990 is unquestionably the most dynamic phase of this transition. The PELT algorithm identifies this period as having the most substantial acceleration in the improvement of life expectancy. This remarkable intensification of health progress coincides with the maturation of previous investments in infrastructure and medical training.

The post-1990 period is characterized by a more moderate yet continuous progression, punctuated by phases of acceleration and relative stabilization. This evolution suggests a process of maturation of the healthcare system, where marginal gains become progressively more difficult to achieve as life expectancy rises [5]

5. DISCUSSION OF RESULTS:

Algeria’s exceptional gain in life expectancy (+25 to 30 years) reveals an impressive adaptive capacity in the face of multiple challenges, particularly those of the post-colonial context. However, the Algerian dynamic goes beyond the issue of health policies alone: it reflects a systemic interaction between massive socio-economic reforms (education, rural development) and sustained political will.

In contrast to other countries such as Belarus or Tunisia, Algeria’s trajectory highlights the impact of exogenous events such as the economic crises of the 1980s and the Black

Decade of the 1990s, which could have jeopardized its progress. Nonetheless, Algeria demonstrated unique resilience, supported by a centralization of political decisions and continuous efforts to catch up.

Table 1. Summary of the Comparison Results

Country	Life Expectancy Gain	Type of Transition	Intra-period Variability	Overlap Between Periods
Algeria	Very High (+25-30 years)	Sudden Break	High → Low	Minimal
Iran	High (+20-25 years)	Semi-sudden	Moderate → Low	Moderate
Belarus	Low (+2-4 years)	Stable	Low → Low	Very High
Jordan	Moderate (+10-15 years)	Progressive	Moderate → Low	Moderate
Nigeria	Low (+5-10 years)	Stagnant	High → High	High
South Africa	Very Low (+0-5 years)	Regressive	Moderate → High	High
Tunisia	High (+15-20 years)	Progressive	Moderate → Low	Low
Turkey	Moderate (+10-15 years)	Progressive	Moderate → Low	Moderate

Source: elaborate by the author (R programmation)

The results of this study also highlight the uniqueness of Algeria's health transition, characterized by rapid structural breaks and significant gains in life expectancy. However, these advances must be placed in a broader context to better understand the challenges and opportunities ahead.

By comparing Algeria's results with those of emerging countries such as Turkey [6] and Tunisia, it becomes clear that the Algerian model heavily relies on massive state interventions, often focused on rapid reforms and short-term investments. In contrast, Turkey adopted a more progressive approach, based on institutional consolidation and economic diversification. These differences suggest that, while the Algerian model enabled rapid catch-up, it may lack resilience in the face of future challenges, particularly in managing chronic diseases and an aging population.

Furthermore, the comparison with countries experiencing stagnant health transitions, such as Nigeria, underscores the importance of structural determinants such as governance, political stability, and investments in education. While Algeria managed to overcome post-

independence obstacles, other nations show that the absence of coherent reforms can undermine public health progress [8].

A novel angle to interpret these results lies in the concept of "windows of opportunity." Algeria exploited specific periods, such as the 1970s, to accelerate its health development. This observation raises the following question: could other countries adapt this model to maximize the impact of their health policies in similar contexts?

CONCLUSION:

This study significantly enriches the existing literature on health transitions in emerging countries in several ways. First, it empirically demonstrates that health development trajectories do not necessarily follow a gradual and linear model, but can instead exhibit profound structural breaks. Second, it highlights the importance of institutional and political factors in the success of health transitions, with Algeria managing to maintain a progress dynamic despite occasionally unfavorable contexts. Finally, it emphasizes the relevance of a mixed methodological approach, combining descriptive analyses with advanced statistical techniques, to address the complexity of health transitions.

However, the results also suggest areas of concern for the future. The speed of Algeria’s health transition, while indicative of a remarkable ability to mobilize resources for health development, raises questions about the long-term sustainability of the progress made. The comparison with countries such as Tunisia and Turkey, which followed more gradual but potentially more resilient trajectories, invites reflection on how to sustainably consolidate health achievements.

In a broader perspective, this research opens several avenues for future investigations. It would be particularly relevant to delve deeper into the institutional and political mechanisms that facilitated the rapid transformation of Algeria's health system. Additionally, a more detailed study of regional and socio-economic disparities in access to healthcare would provide a better understanding of the ongoing challenges despite the overall progress achieved.

REFERENCES

[1] World Bank, "Algeria - Strengthening health system governance: Towards more effective regulatory environment for improved efficiency and quality of care," 2018. [Online]. Available: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/165961468211458971/algeria-strengthening-health-system-governance-towards-more-effective-regulatory-environment-for-improved-efficiency-and-quality-of-care. [Accessed: Oct. 18, 2024].

[2] World Bank, "Algeria - Pilot Public Health Management Project," 2015. [Online]. Available: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/452471468009589315/algeria-pilot-public-health-management-project. [Accessed: Sep. 05, 2024].

[3] World Health Organization (WHO), "Algeria - WHO Country Office," 2020. [Online]. Available: https://www.who.int/countries/dza. [Accessed: Sept. 20, 2024].

[4] United Nations Development Programme (UNDP), "Algeria - Country Programme Document for the period 2023-2027," 2023. [Online]. Available: https://www.undp.org/sites/g/files/zskgke326/files/2023-03/CPD%20Algeria%202023-2027.pdf. [Accessed: Dec. 07, 2024].

[5] United Nations High Commissioner for Refugees (UNHCR), "Algeria - Operational Update," 2022. [Online]. Available: https://reporting.unhcr.org/operational/operations/algeria. [Accessed: Nov. 12, 2024].

[6] World Bank, "Turkey - Health Transition Project," 16 Sept. 2011. [En ligne]. Disponible sur : https://documents.worldbank.org/en/publication/documents-reports/documentdetail/358901475080327195/Turkey-Health-Transition-Project. [Consulté le 31 déc. 2024].

[7] World Health Organization, "World Health Statistics 2020: Monitoring Health for the SDGs, Sustainable Development Goals," Genève, 2020. [En ligne]. Disponible sur : https://iris.who.int/bitstream/handle/10665/332070/9789240005105-eng.pdf. [Consulté le 11 déc. 2024].

[8] World Bank, "Middle East and North Africa - Meeting the Challenges of Health Transition in the Middle East and North Africa Region: Building Partnerships for Results—Time for Strategic Action," 2004. [En ligne]. Disponible sur : https://documents.worldbank.org/en/publication/documents-reports/documentdetail/683441468051867408/Middle-East-and-North-Africa-Meeting-the-challenges-of-health-transition-in-the-Middle-East-and-North-Africa-region-building-partnerships-for-results-time-for-strategic-action. [Consulté le 06 déc. 2024].

[9] United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA), "Health: What We Do," [En ligne]. Disponible sur : https://www.unrwa.org/what-we-do/health. [Consulté le 15 déc. 2024].

[10] United Nations Development Programme (UNDP), "Enhancing Human Potential and Fostering Regional Development Are Key to Development of the Chernobyl-Affected Areas in Belarus," [En ligne]. Disponible sur : https://www.undp.org/belarus/blog/enhancing-human-potential-and-fostering-regional-development-are-key-development-chernobyl-affected-areas-belarus. [Consulté le 01 déc. 2024].

[11] B. W. Silverman, *Density Estimation for Statistics and Data Analysis*. London: Chapman and Hall, 1986.

[12] J. A. Hartigan and M. A. Wong, "Algorithm AS 136: A K-Means Clustering Algorithm," *Applied Statistics*, vol. 28, no. 1, pp. 100-108, 1979.