A Quantitative Analysis of Geographic, Gender and Age Distribution of Nobel Prize Laureates (1901-2025)

Uma Análise Quantitativa da Distribuição Geográfica, de Gênero e Etária dos Laureados com o Prêmio Nobel (1901-2025)

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Abstract

The Nobel Prize serves as a primary indicator of global scientific and cultural prestige. However, quantitative analyses of its distribution often lack the nuance to reveal deep structural inequalities. This study addresses that gap by conducting a comprehensive quantitative analysis of Nobel laureates from 1901-2025 across geography, gender, and age. Using a dataset of nearly 1000 laureates, the analysis employs descriptive statistics and a range of concentration and diversity indices, including the Normalized Herfindahl-Hirschman Index, Shannon Index, and Location Quotient. Results reveal a geographic concentration, with the top 10 countries accounting for 72.5% of all laureates, and a historical shift in hegemony from Europe to North America. The analysis also quantifies a persistent gender gap, with women representing less than 7% of laureates and being severely under-represented in the sciences (for instance, Physics LQ=0.32). Furthermore, significant variations in laureate age

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by discipline are identified, with Economics laureates being the oldest on average. The study provides a data-driven portrait of the Nobel system, offering a baseline for discussions on equity and diversity in the global recognition of excellence.

Keywords: nobel prize, quantitative analysis, scientometrics, geographic distribution, gender inequalities.

Resumo

O Prêmio Nobel serve como um indicador primordial de prestígio científico e cultural global. No entanto, as análises quantitativas de sua distribuição frequentemente carecem da profundidade necessária para revelar profundas desigualdades estruturais. Este estudo aborda essa lacuna, realizando uma análise quantitativa abrangente dos laureados com o Prêmio Nobel de 1901 a 2025, considerando geografia, gênero e idade. Utilizando um conjunto de dados com cerca de 1000 laureados, a análise emprega estatísticas descritivas e uma série de índices de concentração e diversidade, incluindo o Índice de Herfindahl-Hirschman Normalizado, o Índice de Shannon e o Quociente Locacional. Os resultados revelam uma concentração geográfica, com os 10 principais países respondendo por 72,5% de todos os laureados, e uma mudança histórica na hegemonia da Europa para a América do Norte. A análise também quantifica uma persistente desigualdade de gênero, com as mulheres representando menos de 7% dos laureados e sendo severamente sub-representadas nas ciências (por exemplo, QL em Física = 0,32). Além disso, são identificadas variações significativas na idade dos laureados por disciplina, sendo os laureados em Economia os mais velhos, em média. O estudo fornece um retrato baseado em dados do sistema Nobel, oferecendo uma base para discussões sobre equidade e diversidade no reconhecimento global da excelência.

Palavras-chave: prêmio nobel, análise quantitativa, cientometria, distribuição geográfica, desigualdades de gênero.

1. Introduction

The Nobel Prize (NP) stands as the preeminent global honor awarded across the fields of science, literature, and peace, symbolizing pinnacle achievement and recognition of exceptional contributions to humanity. Established in 1901, these prizes reflect both individual excellence and serve as cultural and scientific markers of global prestige (von Zedtwitz, Gutmann & Engelmann, 2025). Over more than a century, the NP has become deeply embedded in academic and societal understandings of advancement, innovation, and influence, making it a critical subject for scientometric and sociological analysis.

Despite extensive historical documentation on laureates and their achievements, comprehensive quantitative studies that concurrently examine the geographic, gender, and age distributions of Nobel Prize recipients remain limited. Prior research frequently relies on simple counts or qualitative assessments, lacking the application of nuanced metrics capable of capturing inequalities in concentration and distribution across these dimensions (Bornmann & Daniel, 2005; Chowdhury, 2024). Studies employing advanced statistical techniques, such as multiple correspondence analysis and concentration indices like the Herfindahl-Hirschman Index and Gini coefficient (Djolov, 2013), which can reveal systemic inequalities and demographic patterns, are comparatively rare (Yang et al., 2024; Freeman et al., 2024). Moreover, recent bibliometric analyses highlight persistent gender disparities and geographic concentration among laureates, underscoring the need for integrative quantitative approaches to unravel structural patterns that simple frequency counts cannot address (Neikirk et al., 2024; Li et al., 2020; King, 2004; Rossiter, 1993). Quantitative indices such as the Herfindahl-Hirschman Index (HHI) offer robust tools to dissect the structural patterns and disparities embedded in laureate demographics, revealing not just who wins, but also how equitably or concentrated these honors are distributed globally and socially (Bornmann & Daniel, 2005).

This study aims to fill that gap by utilizing a comprehensive dataset spanning from 1901 to 2025, analyzing Nobel laureates' distribution by country

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and region, gender disparities across prize categories and over time, and the age demographics at the moment of award. The key research questions that guide this work are: (1) How are Nobel Prizes geographically distributed, and what levels of concentration exist across prize categories? (2) What is the nature and extent of gender disparities among laureates, and how have these evolved historically? (3) What are the age patterns of laureates by category and gender at the time of recognition?

The paper is structured as follows. Section 2 details the methodology, including data sources, cleaning, and statistical measures used for analysis. Section 3 presents objective results with descriptive statistics and graphical visualization of geographic, gender, and age distributions. Section 4 discusses implications of these findings, including patterns of geographic dominance, persistent gender gaps, and age-related trends. Finally, Section 5 concludes with a summary of contributions and directions for future research.

2. Research approach

The primary data source for this study is the publicly available Nobel Prize dataset curated by Chowdhury (2024) and hosted on the Harvard Dataverse. This dataset contains comprehensive information on Nobel Prize laureates and their awards, covering the period from 1901 to 2019. It includes 950 entries with rich metadata across 52 columns such as award year, category, laureate names, birth and death details, prize amounts, motivations, and affiliations. The dataset is provided in CSV format, facilitating efficient quantitative analysis. For the period from 2020 through 2025, data was supplemented and updated using the generative artificial intelligence platform Perplexity Pro (Roy, 2025). This involved targeted academic and web searches combined with manual review to ensure accuracy and completeness, given the unavailability of fully integrated official datasets for these years.

Data cleaning and preparation processes included standardizing country names according to current geopolitical standards, aligning laureate birthplaces with World Bank regional classifications to facilitate geographic analysis, and

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distinguishing between individual laureates and organizations to accurately reflect awardee types. Shared prizes were handled by recording portions of the prize and multiple laureates linked to a single award where applicable. Missing values in non-essential fields (like death place or affiliated institution) were noted but did not affect core analyses.

The geographic distribution of laureates was analyzed using several quantitative measures to assess concentration, diversity, and specialization.To measure the overall concentration of laureates by country, the Normalized Herfindahl-Hirschman Index (HHI) was employed. First, the standard HHI is calculated as the sum of the squared shares (s_i) of each country (i) in the total number of laureates (N):

$$HHI = \sum_{i=1}^{N} s_i^2$$

Then, to ensure comparability across categories with different numbers of participating countries, this index is normalized (H^*) to a scale ranging from 0 (minimum concentration) to 1 (maximum concentration) using the formula:

$$H^* = \frac{H - 1/N}{1 - 1/N}$$

Higher values of H^* indicate greater concentration of laureates within fewer countries (Freeman, 2024). Complementing the concentration analysis, the Shannon Index (H), derived from information theory, was used to assess the diversity of the laureate distribution. It quantifies the uncertainty associated with selecting a laureate's nationality at random and is calculated as:

$$H = -\sum_{i=1}^{N} s_i \, ln(s_i)$$

Where s_i is the share of country i. A higher Shannon index reflects both a greater number of participating countries and a more even distribution of prizes among them (Jost, 2006).To facilitate the interpretation of diversity, Pielou's Evenness Index (J) was calculated. This index normalizes the Shannon index relative to its maximum possible value ($H_{max} = ln(N)$), providing a measure of

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how evenly the laureates are distributed across the participating countries on a scale from 0 to 1:

$$J = \frac{H}{H_{max}} = \frac{H}{ln(N)}$$

A value of $J = 1$ indicates perfect evenness, where all countries have an equal share of laureates (Tuomisto, 2010).To assess the relative specialization of countries within specific prize categories, the Location Quotient (LQ) was applied. For a given country i and prize category j, the LQ is calculated as the ratio of the category's share within the country to the category's share globally:

$$LQ = \frac{(x_{ij}/\sum_j \quad x_{ij})}{(\sum_i \quad x_{ij}/\sum_i \quad \sum_j \quad x_{ij})}$$

Where x_{ij} represents the number of laureates from country i in category j. An LQ > 1 indicates that the country is over-represented (specialized) in that category compared to the global distribution, while an LQ < 1 indicates under-representation (Miller, Gibson & Wright, 1991). Finally, the Concentration Ratio (CR10) was used to provide a straightforward metric of elite dominance. It is calculated as the sum of the shares (s_i) of the top 10 countries with the most laureates, after sorting the shares in descending order:

$$CR_{10} = \sum_{i=1}^{10} \quad s_i$$

This metric directly captures the combined share held by the leading nations.

Gender distribution among Nobel laureates was examined using descriptive statistics to calculate total counts and percentages of male and female recipients, both overall and by category. This was complemented by temporal analysis evaluating the percentage of female laureates per decade, providing insight into historic trends and gender representation dynamics over time (Sá et al., 2023). Meanwhile, age-related characteristics at the time of award receipt were summarized through descriptive statistics including mean, median, standard deviation, and range (minimum and maximum), computed overall and segmented by prize category and gender to identify differences and patterns.

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3. Results and discussion

3.1. Geographic Distribution of Nobel Laureates

The analysis of laureate affiliation by country reveals a significant and persistent concentration of Nobel Prizes in a small number of nations. Table 1 lists the top 10 countries with the highest number of Nobel laureates in the period under study. The United States leads substantially with 299 laureates, more than three times the number of the second-ranked country, the United Kingdom (94). Germany (85) and France (64) follow, solidifying the dominance of a few Western nations. These top four countries alone account for 542 prizes, representing approximately 56% of all laureates in the dataset. The list also highlights the emergence of non-Western scientific powers, such as Japan, which ranks alongside Sweden with 30 laureates.

**Table 1:** Top 10 countries with respect to Nobel Laureate count.

Rank	Country	Laureate Count
1	USA	299
2	United Kingdom	94
3	Germany	85
4	France	64
5	Sweden	30
6	Japan	30
7	Poland	28
8	Russia	28
9	Canada	22
10	Netherlands	20

Source: own elaboration, based on Chowdhury (2024).

This geographic disparity is visually represented in the global choropleth map in Figure 1. The map utilizes a color scale where greener shades indicate a higher concentration of laureates (based on a logarithmic scale to accommodate the wide range of data). It illustrates that the vast majority of NP have been

awarded to individuals and organizations in North America and Western Europe. Conversely, most countries in South America, Africa, and large parts of Asia are represented by reddish shades, indicating a significantly lower number of laureates and highlighting the profound global imbalance in prize distribution.

Figure 1: Global Choropleth Map of Nobel Prize Distribution
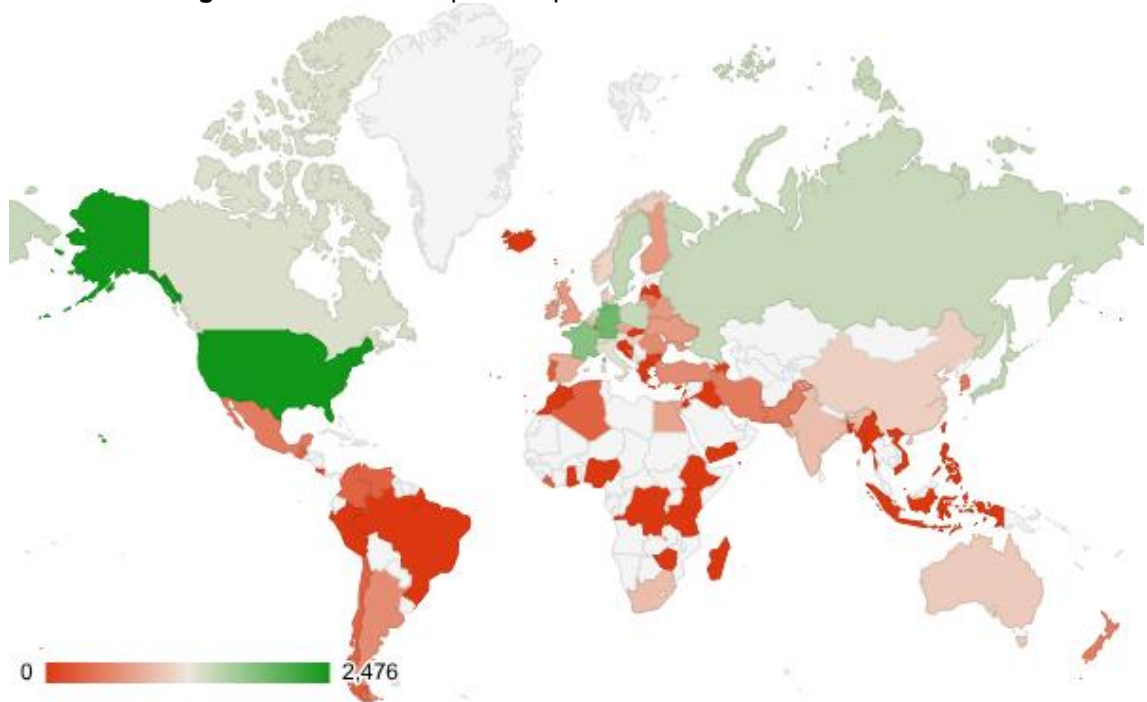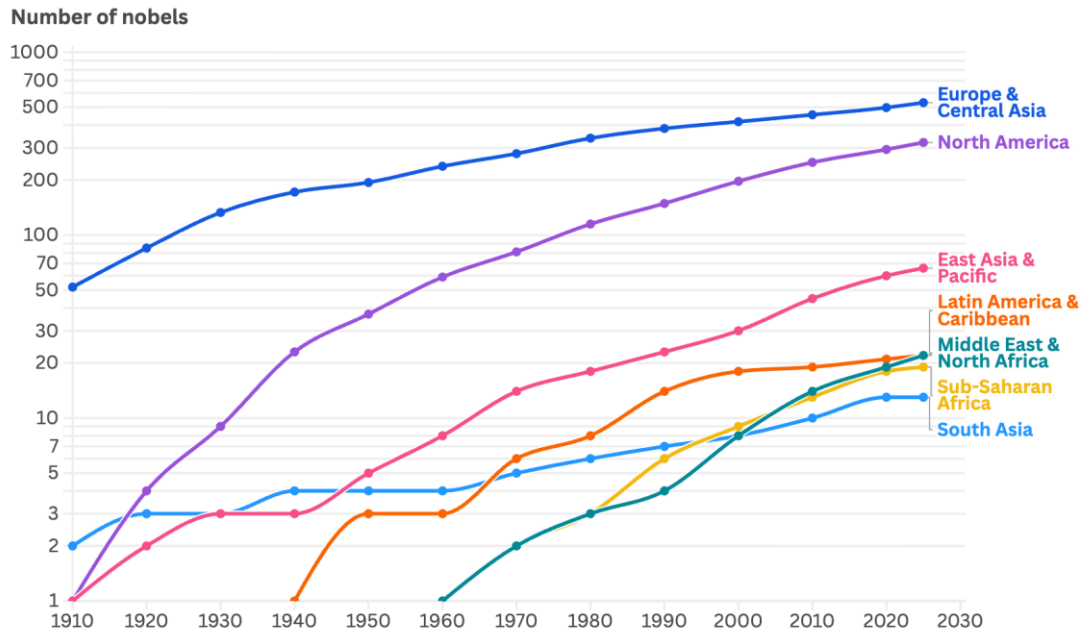

Source: own elaboration (2025)

While the map provides a static snapshot, Figure 2 presents the temporal dynamic of this distribution, showing the cumulative number of Nobel laureates by World Bank region since 1910. The logarithmic scale on the y-axis is particularly effective at highlighting the different growth rates over time. It is evident that Europe & Central Asia and North America have dominated throughout the entire period. While North America exhibits a steeper growth trajectory, particularly in the post-World War II era, Europe & Central Asia has maintained the highest cumulative total. There is a significant, albeit later, rise of the East Asia & Pacific region, which began its accelerated growth around the 1940s. In contrast, other regions such as Latin America & Caribbean, the Middle East & North Africa, Sub-Saharan Africa, and South Asia show much slower,

flatter growth curves, indicating a persistent gap in the cumulative number of laureates.

Figure 2: Cumulative Number of Nobel Laureates by Geographic Region (1910-2025)

Source: own elaboration (2025)

To quantify the degree of concentration, several indices were calculated. The analysis of CR10 shows that the top 10 nations alone account for 700 of the total laureates, resulting in a CR10 of approximately 72.5%. This provides an intuitive measure of the market's oligopolistic structure, where a small minority of countries holds a vast majority of the total prizes awarded.

Finally, Table 2 summarizes a broader set of calculated indices for concentration and diversity, both at the country level and when aggregated by geographic region.

Table 2: Concentration and Diversity Indices for Geographic Distribution

Level of Analysis	HHI	HHI normalized	Shannon entropy	Pielou evenness
By Country (N=87)	11.81%	0.108	3.035	0.681
By Region (N=7)	39.53%	0.295	1.182	0.607

Source: own elaboration, based on Chowdhury (2024).

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At the country level (N=87), the normalized HHI is 0.108, indicating moderate concentration. The Pielou evenness index of 0.681 suggests that the distribution of prizes has achieved 68.1% of its maximum possible diversity. When the data is aggregated into the seven World Bank regions, the concentration becomes significantly more pronounced. The normalized HHI more than doubles to 0.295, and the Pielou evenness drops to 0.607, confirming that while many countries have won prizes, these prizes are heavily concentrated within a few geographic regions.

3.2. Gender Distribution of Nobel Laureates

The analysis of Nobel laureates by gender reveals a persistent disparity over the history of the prizes. The overall distribution from 1901 to 2025 shows a majority of male recipients. Of the 995 individual laureates, 928 (93.27%) are men, while only 67 (6.73%) are women. This initial finding establishes a significant gender imbalance as a baseline characteristic of the Nobel Prizes across their entire history.

When disaggregated by prize category, the data reveals that this gender disparity is not uniform across all fields. Table 3 presents the distribution of male and female laureates within each of the six Nobel categories, along with the location quotient for each group. The LQ measures the degree of over- or under-representation of a gender in a specific category relative to their overall share of Nobel Prizes. A LQ greater than 1 indicates over-representation, while a LQ less than 1 indicates under-representation.

The results show that the highest absolute number of female laureates is in the Peace (20) and Literature (17) categories. Conversely, the science categories show the lowest counts, with only 5 female laureates in Physics and 3 in Economic Sciences. The LQ analysis quantifies this pattern, revealing a significant over-representation of women in the Nobel Peace Prize (LQ = 2.65) and Literature (LQ = 2.07). In contrast, women are substantially under-represented in the science-focused fields, most notably in Physics (LQ = 0.32), Economic Sciences (LQ = 0.45), and Chemistry (LQ = 0.59). For male laureates,

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the pattern is reversed, with a slight over-representation across all three science categories and Economic Sciences, and a relative under-representation in Peace and Literature.

Table 3: Gender Distribution and Location Quotient (LQ) by Prize Category

Gender	Category	Laureate Count	LQ
Female	Peace	20	2.65
	Literature	17	2.07
	Physiology or Medicine	14	0.90
	Chemistry	8	0.59
	Physics	5	0.32
	Economic Sciences	3	0.45
Male	Physics	225	1.05
	Economic Sciences	96	1.04
	Chemistry	192	1.03
	Physiology or Medicine	218	1.01
	Literature	105	0.92
	Peace	92	0.88

Source: own elaboration, based on Chowdhury (2024).

The historical evolution of this gender gap is visualized in Figure 4, which plots the cumulative number of male and female laureates over time. The use of a logarithmic scale on the y-axis effectively highlights the differences in growth rates between the two groups. The curve for male laureates shows a steep and consistent accumulation throughout the entire period, reaching 928 by the end of the timeline. In stark contrast, the curve for female laureates remains nearly flat for the first several decades, with only 4 women awarded a prize by 1920 and just 12 by 1960. There is an acceleration in the rate of female laureates beginning in the latter part of the 20th century. The number of female laureates grows from 15 in 1970 to 41 by 2010, and further to 67 by the 2020s, which indicates a positive, albeit slow, trend towards increased recognition. Despite this recent

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acceleration, the absolute gap between the number of male and female laureates remains immense, as represented by the vast space between the two curves.

Figure 4: Cumulative Number of Male vs. Female Laureates (1910-2030)
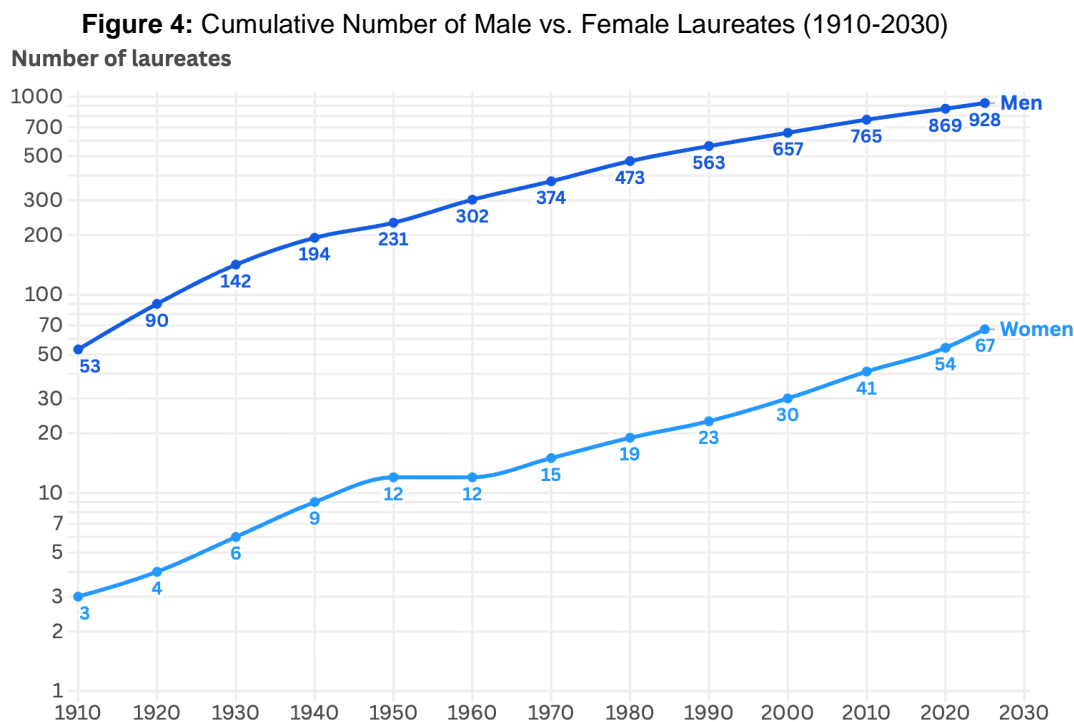
Source: own elaboration (2025)

3.3. Age Distribution of Nobel Laureates

The overall descriptive statistics, presented in Table 4, reveal key demographic characteristics of Nobel laureates. Male laureates, with a mean age of 60.6 years and a median of 61, are on average slightly older than female laureates, who have a mean age of 58.4 years and a median of 57. The age range for laureates is substantial, spanning 80 years from the youngest recipient at 17 years old (Malala Yousafzai) to the oldest at 97 (John B. Goodenough). Furthermore, the standard deviation suggests that the age distribution for female laureates (15.24 years) is more dispersed around the mean compared to that of male laureates (12.46 years).

**Table 4:** Overall Descriptive Statistics for Laureate Age by Gender (1901-2025)

Gender	Mean Age	Median Age	Minimum Age	Maximum Age	Std. Dev.

Male	60.60	61	25	97	12.46
Female	58.36	57	17	88	15.24

Source: own elaboration, based on Chowdhury (2024).

In terms of age distribution, the age pyramid (Figure 5) shows the number of male (blue) and female (purple) laureates in five-year age intervals. For male laureates, the distribution is heavily concentrated in the middle to late career stages, peaking in the 60-65 age bracket with 147 laureates. There are substantial numbers of laureates in all brackets from 45 to 80. For female laureates, the absolute numbers are much smaller, but there is a peak in the 55-60 age bracket (13 laureates), followed by the 50-55 bracket (9 laureates). It is possible to note, also, the rarity of laureates at the extremes of the age spectrum, particularly under the age of 30.

Figure 5: Age Pyramid of Nobel Laureates by Gender
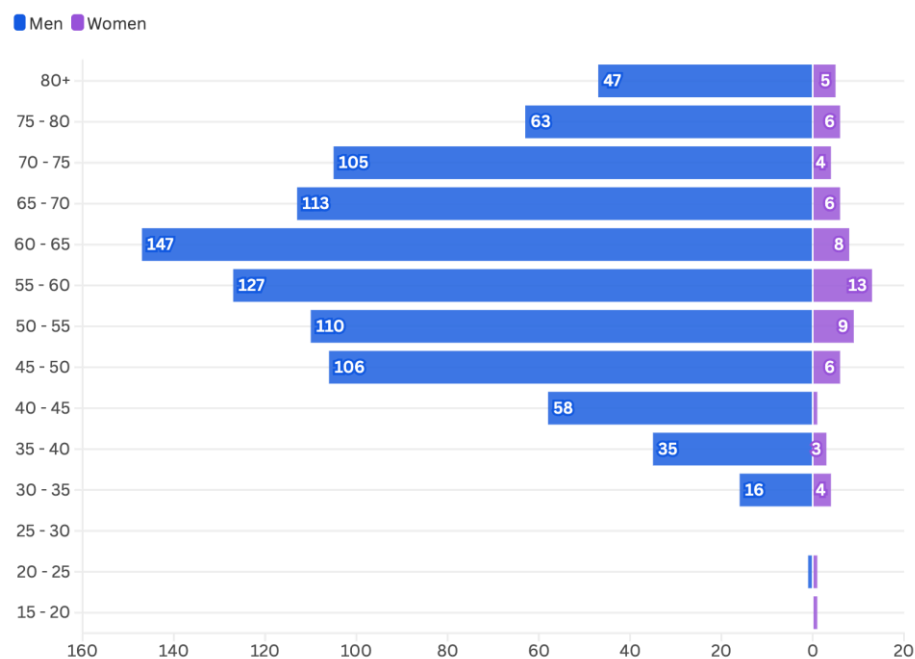
Source: own elaboration (2025)

A more granular analysis, breaking down the mean and median ages by both prize category and gender, is presented in Table 5. This disaggregation reveals significant variations that are not apparent in the overall statistics. For both male and female laureates, the average age is highest in the Economic

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Sciences category (67.0 for men, 66.7 for women). Conversely, the Peace Prize tends to be awarded to younger individuals, particularly women, whose average age in this category (51.3) is substantially lower than that of their male counterparts (62.8) and is the lowest average age across all categories for either gender.

Table 5: Overall Descriptive Statistics for Laureate Age by Gender (1901-2025)

Category	Gender	Mean Age	Median Age
Physiology or Medicine	Male	58.7	58.0
	Female	63.1	63.5
Peace	Male	62.8	63.0
	Female	51.3	52.5
Chemistry	Male	59.4	59.0
	Female	54.0	54.5
Literature	Male	65.0	65.0
	Female	64.6	65.0
Physics	Male	57.8	57.0
	Female	54.4	55.0
Economic Sciences	Male	67.0	67.0
	Female	66.7	69.0

Source: own elaboration, based on Chowdhury (2024).

Within the science fields, notable differences emerge. For men, the average age is lowest in Physics (57.8), while for women, the average age is lowest in Chemistry (54.0). An interesting inversion occurs in Physiology or Medicine, where the average age of female laureates (63.1) is higher than that of male laureates (58.7). In Literature, the average ages are more closely aligned between genders (65.0 for men, 64.6 for women). These results indicate that the demographic profile of a "typical" Nobel laureate is highly dependent not only on gender but also on the specific field of achievement.

4. Synthesis and concluding remarks

The quantitative analysis of Nobel laureates from 1901 to 2025 reveals three structural patterns of inequality. Geographically, the distribution is

profoundly concentrated, with a normalized HHI of 0.108 and a CR10 showing that just ten countries account for 72.5% of all laureates, a reality visually affirmed by the dominance of the "Global North" on the choropleth map (Collyer, 2018). The temporal analysis depicts a clear shift in hegemony from an early European dominance to a post-war consolidation of North American leadership, which is now being gradually challenged by the emergence of new scientific poles, particularly in the East Asia & Pacific region, reflecting what is analyzed in the literature (Freeman, 2024; Robinson-Garcia et al., 2017).

A second, persistent disparity is the gender gap, with women constituting less than 7% of all laureates. A Location Quotient (LQ) analysis shows women are significantly over-represented in Peace (LQ=2.65) and Literature (LQ=2.07) but severely under-represented in Physics (LQ=0.32) and Economic Sciences (LQ=0.45), suggesting different recognition pipelines (Kennelly & Spalter-Roth, 2021; Huang et al., 2020; Rossiter, 1993). Although the rate of female laureates has accelerated in recent decades, the absolute gap remains immense (Su et al., 2019).

Thirdly, the age of laureates varies significantly by discipline, with recipients in Economics (mean age approximately 67) being the oldest and in Peace the youngest (female mean age 51.3), reflecting different cycles of achievement and recognition (Dufaud, Lémonon-Waxin & Greece, 2025).

The study's main contribution is this portrait of the Nobel system, which provides a data-driven baseline for discussions on global equity in science and culture, reinforcing previous studies (von Zedtwitz, Gutmann & Engelmann, 2025; Neikirk et al., 2024). Key limitations include the quantitative focused approach and simplification of laureates' complex international trajectories. Future research could include a qualitative analysis of nomination archives and a network analysis of laureate collaborations.

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Authors Contribution

Author 1: Conceptualization/Methodology/Data Collection/Formal Analysis/Writing Original Version/Curatorship

Author 2 – Review and Editing/Supervision

Conflict of Interest

The authors declare that there is no conflict of interest with the article.

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