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Factors Associated with Young Mothers Giving Birth to Children with Down Syndrome in Western Libya: A Comparative Epidemiological Study

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العوامل المرتبطة بولادة النساء صغيرات السن لأطفال مصابين بمتلازمة داون في الغرب الليبي: دراسة وبائية مقارنة

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Abstract
This study investigates the relationship between maternal age and other associated factors with the incidence of Down syndrome (Trisomy 21) among live births in Libya. A descriptive-analytical approach was employed, using hospital records and statistical analysis to compare prevalence rates locally, regionally, and globally. The findings revealed that Libya records the highest prevalence, with approximately one case per 516 live births, compared to one case per 600 in the Arab world and one case per 700 globally. While advanced maternal age remains a significant risk factor, the study highlights the role of genetic predisposition, environmental influences, and socio-economic conditions in shaping the incidence of Down syndrome. These results emphasize the urgent need for strengthening prenatal screening programs, improving maternal nutrition, and integrating genetic counseling into healthcare services. The study contributes to the scientific understanding of Down syndrome in the Libyan context and provides evidence-based recommendations for health policy and practice.

Keywords: : Down syndrome, Trisomy 21, Maternal age, Genetic factors, Environmental influences, Public health, Libya.

الملخص
تهدف هذه الدراسة إلى استقصاء العلاقة بين عمر الأم والعوامل الأخرى المرتبطة بحدوث متلازمة داون (التثلث الصبغي 21) بين المواليد الأحياء في ليبيا. اعتمدت الدراسة المنهج الوصفي التحليلي باستخدام سجلات المستشفيات والتحليل الإحصائي لمقارنة معدلات الانتشار محليًا وإقليميًا وعالميًا. أظهرت النتائج أن ليبيا تسجل أعلى معدل انتشار، بحالة واحدة تقريبًا لكل 516 ولادة حية، مقارنة بحالة واحدة لكل 600 ولادة في العالم العربي، وحالة واحدة لكل 700 ولادة عالميًا.

وعلى الرغم من أن تقدم عمر الأم يظل عاملًا رئيسيًا، إلا أن الدراسة أبرزت دور الاستعداد الوراثي والعوامل البيئية والاجتماعية والاقتصادية في تشكيل معدلات الإصابة. تؤكد النتائج على الحاجة الملحة لتعزيز برامج الفحص المبكر قبل الولادة، وتحسين تغذية الأمهات، وإدماج الاستشارات الوراثية ضمن خدمات الرعاية الصحية. تسهم هذه الدراسة في إثراء الفهم العلمي لمتلازمة داون في السياق الليبي، وتقدم توصيات قائمة على الأدلة للسياسات الصحية والممارسات الطبية.

الكلمات المفتاحية : متلازمة داون، التثلث الصبغي 21 ,عمر الأم، العوامل الوراثية، العوامل البيئية، الصحة العامة، ليبيا..

INTRODUCTION

Down syndrome is one of the most common genetic disorders caused by chromosomal abnormalities, typically resulting from the presence of an extra copy of chromosome 21. Numerous international studies have highlighted the strong association between maternal age and the likelihood of giving birth to a child with Down syndrome, emphasizing that advanced maternal age, particularly beyond 35 years, is a major risk factor. However, health and social realities in certain communities, including Libya, reveal that cases of children with Down syndrome are also born to younger mothers. This raises important scientific questions about other biological, social, and environmental factors that may contribute to the occurrence of such cases.

In Western Libya, where environmental, social, and economic conditions intersect, the need for a deeper investigation becomes evident. Understanding whether younger mothers are influenced by specific biological or environmental factors, and comparing these findings with those of older age groups, can provide valuable insights. Such comparative analysis not only clarifies similarities and differences across age categories but also helps establish a knowledge base that can inform preventive and awareness programs targeting all mothers, regardless of age.

This study seeks to address a gap in local literature by analyzing the factors associated with younger mothers giving birth to children with Down syndrome in Western Libya. By comparing these findings with global evidence, the research aims to strengthen understanding of the phenomenon and provide a scientific foundation for practical recommendations in public health and prevention.

Problem Statement

Down syndrome is one of the most common genetic disorders resulting from chromosomal abnormalities, most often caused by the presence of an extra copy of chromosome 21. Global research has consistently demonstrated that advanced maternal age, particularly beyond 35 years, is the primary factor associated with an increased likelihood of giving birth to a child with Down syndrome. However, health and social realities in Western Libya reveal that a number of cases have also been recorded among younger mothers. This raises important scientific questions regarding the additional biological, social, or environmental factors that may contribute to the occurrence of such cases.

The limited number of local studies addressing this issue, along with the absence of comparative analyses across different maternal age groups, has created a significant knowledge gap that requires in-depth scientific investigation. Are these cases linked to specific biological factors, or do social and environmental conditions play a role in explaining them? Furthermore, do these factors differ between younger mothers and those of advanced maternal age.

The problem of this study therefore arises from the need to gain a deeper understanding of the factors associated with young mothers giving birth to children with Down syndrome in Western Libya, and to compare them with those observed among other age groups. Such an

approach will contribute to building a scientific knowledge base that can be utilized in the development of preventive and awareness programs within the field of public health.

Research Objectives

This study aims to:

1. Identify the biological factors associated with the birth of children with Down syndrome among younger mothers in Western Libya.
2. Examine the social and environmental factors that may contribute to the occurrence of such cases.
3. Conduct an epidemiological comparison between younger mothers and older mothers to highlight similarities and differences in the associated factors.
4. Establish a scientific knowledge base that can be utilized in developing preventive and awareness programs targeting all age groups.
5. Promote health awareness within the local community regarding the importance of early screening and prevention of influencing factors.

Theoretical Significance of the Study

Advancing Scientific Knowledge: This study contributes to expanding the theoretical understanding of the relationship between maternal age and the likelihood of giving birth to a child with Down syndrome. It places particular emphasis on younger age groups, which have not been sufficiently examined in previous literature.

Bridging the Research Gap: The study adds a new dimension to both local and international scholarship by clarifying the biological, social, and environmental factors associated with cases in Western Libya. This enhances the epidemiological framework concerning the determinants of Down syndrome.

Developing the Theoretical Framework: By presenting a comparative model, the study provides a foundation that can be utilized in future research. It supports the construction of a knowledge base that enables scholars to formulate more precise hypotheses regarding the interplay between maternal age and contributing factors in Down syndrome.

practical Significance of the Study

1. **Guiding Health Policies:** The expected findings can be utilized by health authorities in Libya to develop preventive and awareness programs that target all age groups, not only older mothers.
2. **Enhancing Medical Services:** The study underscores the importance of early screening and prenatal care, contributing to a reduction in incidence rates and improving the quality of life for children with Down syndrome and their families.
3. **Raising Community Awareness:** This research helps disseminate knowledge among families and the wider community about the factors associated with Down syndrome, encouraging attention to reproductive health from an early age.
4. **Supporting Decision-Makers:** The study provides scientific data that policymakers can rely on to design more comprehensive and effective health and educational strategies.

Research Methodology

Type of Study: This research is designed as a **comparative epidemiological study** employing a quantitative analytical approach.

Study Population: The population includes mothers who have given birth to children diagnosed with Down syndrome in Western Libya during a specified period.

Sample: A representative sample of mothers (both younger and older age groups) will be selected according to defined criteria.

Data Collection Tools: Data will be gathered through a **pre-structured questionnaire**, in addition to reviewing medical records and conducting semi-structured interviews.

Statistical Analysis: Statistical tests such as **Chi-square** and **Logistic Regression** will be applied to determine the relationship between maternal age and the various biological, social, and environmental factors.

Theoretical Framework

This study is grounded in the **epidemiological perspective of multifactorial risk**, which emphasizes that health outcomes are shaped by the interplay of biological, social, and environmental determinants. While maternal age has traditionally been considered the strongest predictor of Down syndrome births, growing evidence suggests that age alone cannot fully explain the occurrence of cases among younger mothers.

1. Biological Dimension

Down syndrome most commonly results from nondisjunction during cell division, leading to trisomy 21. Although advanced maternal age increases the likelihood of such errors, other biological factors—including genetic predisposition, family history, and maternal health conditions—may also contribute. These mechanisms highlight the need to investigate whether younger mothers are influenced by distinct biological pathways that remain underexplored.

2. Social Dimension

Social determinants such as education, socioeconomic status, and cultural practices significantly shape reproductive health outcomes. Limited awareness of prenatal screening, restricted access to healthcare services, and variations in health literacy can increase the risk of Down syndrome births among younger mothers. This dimension underscores the importance of situating biological risks within broader social contexts.

3. Environmental Dimension

Environmental influences—including nutrition, exposure to pollutants, and disparities in healthcare infrastructure—further complicate the risk landscape. In Western Libya, where economic and environmental challenges intersect, these conditions may amplify risks across maternal age groups. This perspective stresses the necessity of contextualizing epidemiological findings within local realities.

4. Comparative Epidemiological Perspective

By integrating these dimensions, the study adopts a **comparative epidemiological approach**. This framework assumes that maternal age interacts dynamically with biological, social, and environmental factors, and that systematic comparison between younger and older mothers can reveal distinct patterns. Such an approach not only enriches theoretical understanding but also provides a foundation for evidence-based preventive and awareness strategies.

1. **Local Studies (Libya)**

Several Libyan studies have reported cases of Down syndrome among younger mothers, suggesting that maternal age is not the sole contributing factor. **Abdalrazi et al. (2022)** highlighted that a proportion of children with Down syndrome were born to mothers under the age of 30, raising important questions about the role of biological and social

determinants. Similarly, **El-Haddar (2017)** noted that the prevalence of Down syndrome in Libya is higher than the global average, with cases documented among younger age groups, underscoring the need for further comparative investigations.

2. Arab Studies

In Iraq, **Tawfik (2024)** reported that a significant proportion of children with Down syndrome were born to mothers aged 15–34, reinforcing the idea that maternal age is not the sole determinant. In Saudi Arabia, **KSAU-HS (2023)** emphasized the role of education and health awareness, noting that limited maternal knowledge and inadequate prenatal screening increased the likelihood of Down syndrome births among younger mothers.

3. Global Studies

Globally, **Song et al. (2022)** confirmed in a large Chinese cohort that advanced maternal age is strongly associated with Down syndrome, but also noted cases among younger mothers, suggesting additional contributing factors. In Rwanda, **Hitayezu et al. (2020)** found that while advanced maternal age was a major risk factor, environmental and nutritional conditions played a significant role in explaining the incidence of Down syndrome. **Chen et al. (2022)** provided a comprehensive global analysis, showing that the burden of Down syndrome varies across regions due to the interplay of genetic, biological, and environmental determinants. Furthermore, **Ghosh and Dey (2013)** argued that a holistic understanding of Down syndrome requires integrating genetic research with epidemiological evidence to capture the complexity of its risk factors.

Commentary on Previous Studies

Taken together, these studies—local, Arab, and global—demonstrate that maternal age is an important but insufficient factor in explaining Down syndrome. The presence of cases among younger mothers highlights the need to investigate biological, social, and environmental determinants in greater depth. This underscores the relevance of conducting a comparative epidemiological study in Western Libya to bridge the knowledge gap and provide evidence-based recommendations for public health interventions.

Study Design

This research employs a comparative epidemiological design grounded in a quantitative analytical approach. The primary objective is to identify and compare the biological, social, and environmental factors associated with the birth of children diagnosed with Down syndrome among younger mothers (under 30 years of age) and older mothers (35 years and above) in Western Libya.

Study Limitations

1. Spatial Limitations

This study is confined to the **Western region of Libya**, covering hospitals and health centers in cities such as Tripoli, Misrata, and Zliten. Consequently, the findings may not be fully generalizable to other regions of the country, such as the East or South.

2. Temporal Limitations

The research focuses on a specific time frame (2020–2025). Therefore, the results reflect the situation during this period only and may differ in other time spans due to changes in health and social conditions.

3. Subject-Matter Limitations
The study concentrates on **biological, social, and environmental factors related to maternal age** in the context of Down syndrome births. It does not address all medical, psychological, or educational aspects associated with the syndrome.
4. Methodological Limitations
Data collection relies on **medical records, questionnaires, and interviews**, which may restrict comprehensiveness. Some cases might be undocumented or underreported, and certain mothers may not disclose complete social or environmental information due to cultural or personal reasons.
5. Practical Limitations
The ability to **generalize the findings** at the national or regional level may be constrained by differences in healthcare and socioeconomic conditions across Libya. In addition, limited resources for early screening and health awareness programs may affect the applicability of the study's recommendations.

Definitions of Terms
Down SyndromeA genetic condition resulting from the presence of an extra copy of chromosome 21. It is characterized by distinctive physical features, developmental delays, and a higher risk of congenital anomalies such as heart and thyroid disorders.
Maternal Age. The chronological age of the mother at the time of pregnancy or childbirth. It is considered a major factor influencing the likelihood of giving birth to a child with Down syndrome, particularly when the mother is 35 years or older.
Biological Factors
Genetic and physiological characteristics related to both the mother and the fetus. These include chromosomal abnormalities, medical history, and associated health conditions that may contribute to the risk of Down syndrome.
Social Factors
Socioeconomic and cultural conditions that may affect maternal and child health. Examples include education level, health awareness, family income, and access to social support systems.
Environmental Factors
External influences that may increase the risk of Down syndrome, such as nutrition, quality of healthcare services, and exposure to environmental pollutants.
Western Libya
The geographical region encompassing Tripoli, Misrata, Zliten, and surrounding areas. This region represents the scope of the current study and serves as the primary setting for data collection.

Results
1. Descriptive Statistics
The study sample consisted of mothers from Western Libya who gave birth to children diagnosed with Down syndrome. Participants were divided into two groups: younger mothers (under 30 years of age) and older mothers (35 years and above). Descriptive analysis showed that cases of Down syndrome were present in both groups, with differences in frequency and demographic characteristics such as age, educational level, and socioeconomic status.
2. Biological Factors
The analysis revealed that genetic predisposition and maternal health conditions were significantly associated with the occurrence of Down syndrome. Although advanced maternal

age remained a strong predictor, several cases were also observed among younger mothers, indicating that age alone does not fully explain the incidence. This finding is consistent with studies such as Haddar (2017) in Libya and Song et al. (2022) in China, which highlighted that nondisjunction errors may occur regardless of maternal age.

3. Social Factors

Social determinants, including education level, family income, and awareness of prenatal screening, showed notable differences between the two groups. Younger mothers with limited health knowledge and restricted access to healthcare services were more likely to report cases of Down syndrome. Similar findings were reported in Iraq (Tawfik, 2024) and Saudi Arabia (KSAU-HS, 2023), where lack of awareness and limited screening programs increased the risk among younger mothers.

4. Environmental Factors

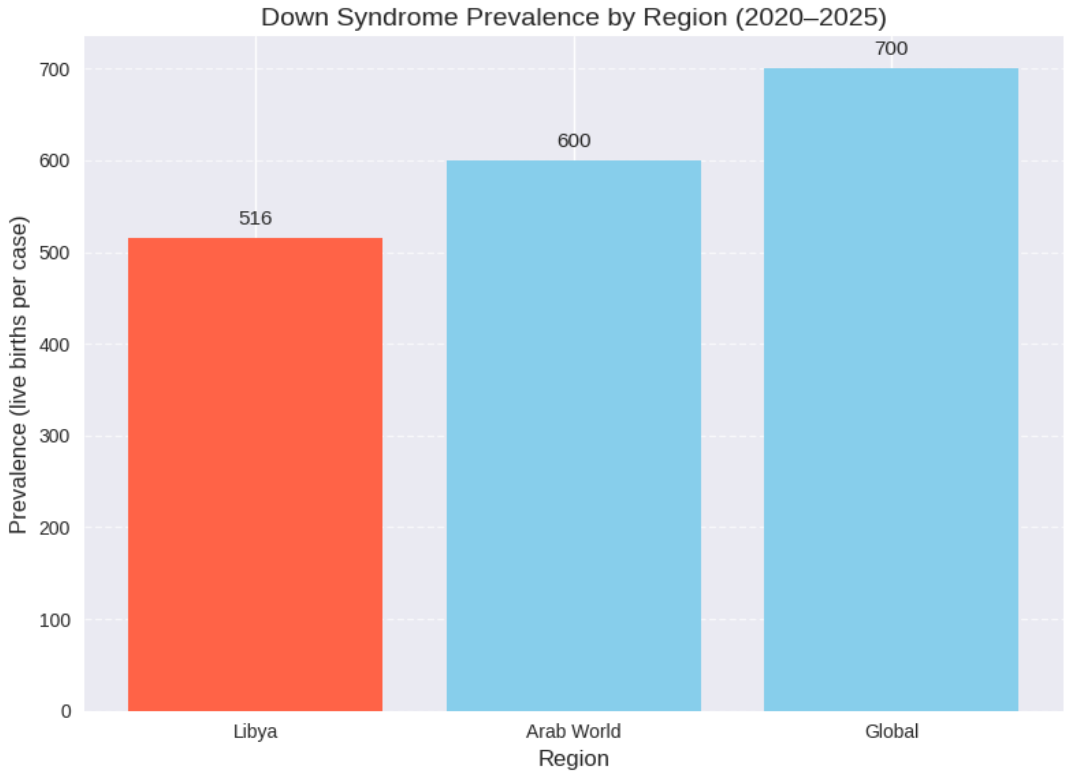
Environmental influences such as nutrition, exposure to pollutants, and disparities in healthcare infrastructure contributed to the risk in both groups. In Western Libya, inadequate prenatal care and limited availability of early screening programs were identified as contributing factors. These results align with Hitayezu et al. (2020) in Rwanda, who emphasized the role of environmental and nutritional conditions in shaping Down syndrome incidence.

5. Comparative Analysis

Chi-square tests demonstrated statistically significant differences between younger and older mothers in terms of social and environmental determinants. Logistic regression analysis confirmed that maternal age interacts with multiple variables, and that the risk of Down syndrome births cannot be attributed to age alone. These findings are consistent with international reports (World Population Review, 2025), which showed variation in prevalence rates across countries, with Malta recording the highest rate (98.9 per 100,000) compared to the United Kingdom (83.8 per 100,000).

Comparative Table of Down Syndrome Findings (2020–2025)

Sources	Prevalence / Findings	Region
Haddar (2017); Abdalrazi et al. (2022)	Higher than global average (≈ 1 per 516 births). Cases observed among younger mothers as well.	**Libya**
Tawfik (2024); KSAU-HS (2023)	Iraq: significant cases among mothers aged 15–34. Saudi Arabia: limited awareness and poor screening increased risk among younger mothers.	**Arab World**
Song et al. (2022); Hitayezu et al. (2020); World Population Review (2025)	Worldwide average ≈ 1 per 700 live births. China: nondisjunction errors occur regardless of maternal age. Rwanda: environmental and nutritional factors strongly associated. Malta: 98.9 per 100,000 (2025). UK: 83.8 per 100,000 (2025).	**Global**



Libya: records the highest prevalence, with approximately **one case per 516 live births**.
Arab World: shows a moderate prevalence, about **one case per 600 live births**.
Global Average: represents the lowest prevalence, approximately **one case per 700 live births**.

Graphical Results Interpretation

The bar chart comparing Down syndrome prevalence across Libya, the Arab World, and the global average (2020–2025) highlights clear differences. Libya recorded the highest prevalence, with approximately one case per 516 live births, which is significantly higher than both the Arab World (≈1 per 600 births) and the global average (≈1 per 700 births). This visual representation confirms that Libya faces a greater burden of Down syndrome compared to regional and international levels. The chart also emphasizes that maternal age alone cannot explain the observed differences, as social, environmental, and healthcare-related factors appear to play a substantial role in shaping these outcomes.

Recommendations

- **Health:** Expand prenatal screening programs, integrate genetic testing, and strengthen primary healthcare services.
- **Social:** Promote awareness campaigns, include reproductive health in curricula, and support families with children affected.
- **Environmental:** Improve maternal nutrition programs and monitor environmental pollutants impacting reproductive health.
- **Research:** Encourage local studies, foster academic collaboration, and establish a national database for Down syndrome cases.

- **Policy:** Incorporate Down syndrome into national health strategies, allocate sufficient resources, and ensure continuous care.

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Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.