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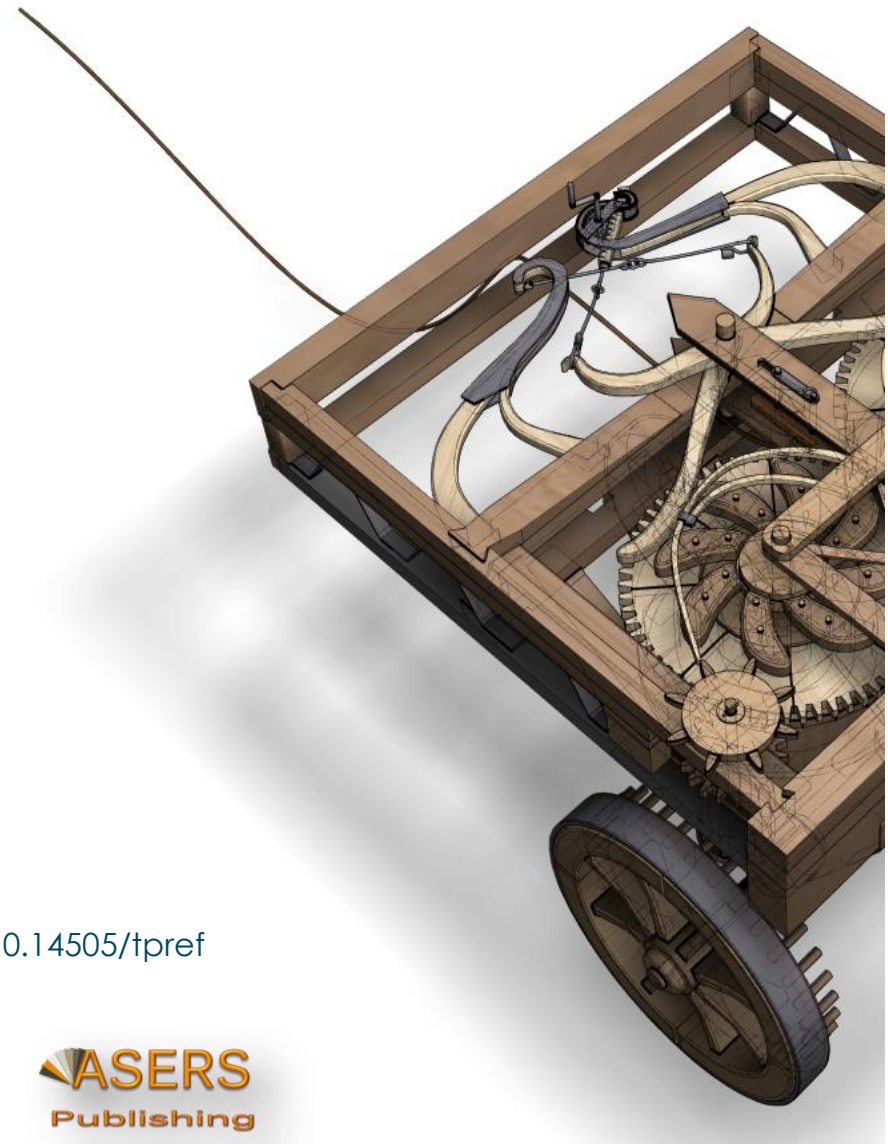

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Impact of Remittances on Women's Longevity in North African Countries

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Abstract: This article aims to explore the impact of migrants' remittances on life expectancy and mortality rate of adult women left behind in north African countries. The study contributes to the literature by highlighting how remittances can support the achievement of sustainable development goals. At the same time, it investigates the extent to which remittances may challenge social policies in these countries. The empirical findings suggest that remittances significantly increase life expectancy of women in north Africa countries. Furthermore, migrants' remittances are negatively and significatively associated with the mortality rate for adult women. Assessing the impact of remittances by country, highlights the existence of significant differences between the countries in the sub-region. The results suggest that, although remittances have positive aspects on the conditions of women, in the absence of specific public policies, the situation of elderly women in these countries is likely to deteriorate due to the risks social isolation and economic precarity.

Keywords: North Africa; dynamic ordinary least squares; life expectancy; gender; mortality rate; remittances; demographic transformation; demographic transition.

JEL Classification: J14; J16; I15; I14; C10; R11.

Introduction

Between 1990 and 2022, the North African countries have made significant progress in terms of both economic development[1] and human development[2]. However, this economic and human growth has not been accompanied by a reduction in gender inequalities.[3] Despite this situation, certain aspects reflecting living conditions in these countries remain favourable to women, such as life expectancy[4] and adult mortality rates[5]. During the same

[1] The average GDP per capita in this sub-region increased by 2.5 times between 1990 and 2021, rising from $1,464 in 1990 to $3,790 in 2021 (World Bank).
[2] Between 1990 and 2021, the average Human Development Index (HDI) in the sub-region rose from 0.5465 to 0.7225. This average increased by 32% while the world average increased by 22% (UNDP).
[3] According to the UNDP in 2022, Algeria, Morocco, Egypt and Tunisia were ranked, respectively, in 114th, 110th, 93rd and 59th place in terms of gender inequality.
[4] According to the United Nations Population Division, life expectancy at birth indicates the number of years a newborn baby should live if the general rules of mortality at the time of its birth were to remain the same throughout its life. In 2021, female life expectancy at birth was 76 years, while male life expectancy was 71.5 years.
[5] According to the United Nations Population Division, the adult mortality rate is the probability of death for a person aged 15 before reaching age 60, if subject to age-specific mortality rates current during this period. In 2021, the adult female mortality rate was 90 (deaths per 1000) compared to an adult male mortality rate of 143.5 (deaths per 1000).

period, countries in this sub-region received significant amounts of remittances[6] from their emigrants. Some research shows that remittances enable households in home countries to overcome budgetary constraints that hinder their access to healthcare services. They conclude that remittances lead to an increase in household health budgets (Amuedo-Dorantes and Pozo, 2011; Gerber and Torosyan, 2013). Others have concluded that remittances represent informal social protection that allows household members to access health care (Petreski *et al.* 2018).

This article enriches the discourse on demographic transformation in North African countries through an innovative analysis of how remittances affect the mortality rate and life expectancy of women. While several studies have investigated determinants explaining the increase in life expectancy and decrease in adult mortality (see, for example: Akoto, 1994; Daoudi, 2001; Hajjem and Achour, 2001; Gaimard, 2008; Sajoux and Nowik, 2010; Tabutin and Masquelier, 2017; Jafrin *et al.* 2021), few articles have explored the impact of remittances on adult longevity in home countries (including: Zhunio *et al.* 2012; Amakom and Iheoma, 2014; Amega, 2018; Azizi, 2018; Ullah *et al.* 2019). Existing studies either cover a large panel of developing countries without regional differentiation in political and economic integration[7], or concentrate on specific areas[8] unrelated to the countries in this sub-region. This situation highlights the significance of this study in addressing this gap within the context of North African countries. Therefore, this research aims to fulfil this gap by examining the impacts of remittances on the life expectancy and mortality adult women in North African countries.

Concentrating this research on women in North African countries is interesting on several levels. First, it allows us to empirically explore the consequences of receiving remittances on a segment of the population that has been largely absent from the debate on the impact of migration on home countries (Moujoud, 2008; Cortes, 2016). Secondly, although North African women have made inroads into fields traditionally reserved for men[9], they still face various forms of gender-based discrimination.[10] This study investigates how remittances can improve longevity of North African women, while also paving the way for new research on migration and gender in this sub-region.

Focusing on the life expectancy and mortality rates of adult women helps inform policymakers in these countries about the challenges they may face in the coming years. In fact, women in these countries have been largely excluded from the labour market[11], depriving them of social protection in their advanced years. In addition, North African societies are experiencing profound social transformations that have reshaped the traditional pattern of family relationships. For years, these countries have witnessed a shift from extended households to nuclear households.[12] This shift in social organization reduces the intergenerational solidarity that previously served as a social safety net and alternative welfare system, protecting elderly individuals, especially women, from social isolation and economic precariousness. This article offers political and economic decision-makers a set of proposals to anticipate these changes.

The two main obstacles to estimating the impact of remittances on female life expectancy and mortality in North African countries are the size of the panel and the endogeneity of remittances. To overcome these obstacles, the Dynamic Ordinary Least Squares (DOLS) method, proposed by Stock and Watson (1993), was used. Our results indicate that remittances significantly increase life expectancy and significantly reduce the mortality rate for women. A more detailed analysis, which consists of assessing the impact of remittances by country, reveals the existence of significant differences between the countries in the sub-region, highlighting the specific local characteristics of each country.

This paper contributes to the existing literature on gender and migration in several ways. First, the paper uses data from North African countries for the period 1990 to 2021. To the best of our knowledge, we are not

[6] Between 1990 and 2021, these four countries received an average of just over $18 billion USD in remittances. This amount corresponds to an annual average of 4.5% of their GDP (World Bank).
[7] Among others: Zhunio *et al.* (2012); Azizi (2018).
[8] For example: (Amakom and Iheoma, 2014; Bare *et al.* 2021and Hao *et al.* 2023) on sub-Saharan African countries and Ullah et al., 2019 on Asian countries.
[9] For example, the gender parity rate for higher education enrolment in 2022 was 1.01 in Egypt, 1.12 in Morocco and 1.42 in Algeria and Tunisia (World Bank).
[10] Particularly in terms of employment and participation in the labour market. For example, in 2022, the female labor force participation rate in these four countries was only 19.5% (ILO estimate).
[11] Between 1991 and 2022, the participation rate of women in the labour force in these four countries was on average 22.4% (ILO estimate).
[12] In 2001, nuclear households represented three-quarters of Tunisian households. In 2002, 75% of Algerian households are nuclear. In 1998-1999, more than half of Moroccan households (58%) are nuclear.

aware of any papers estimating the impact of remittances on female life expectancy and mortality in the countries of this sub-region. Secondly, this study surpasses the limitations of previous research that estimated the impact of remittances on women's healthcare access by directly measuring its effects on women's longevity.

The rest of the article is organised as follows: after the introduction, the second section presents a review of the literature on the impact of remittances on access to the healthcare system and on adult life expectancy and mortality. The third section is dedicated to presenting the data and empirical models, while the fourth section outlines the methodological approach. The fifth section presents empirical results, while the sixth section is dedicated to the conclusion and policy recommendations.

1. Literature Review

International migration and its corollary remittances have attracted the interest of academic researchers. They have concluded that migrant remittances have an impact on several aspects of the economic and social development of home countries (see, among others: Adams and Page, 2003; Faini, 2007; Gupta *et al.* 2009; Adams and Cuecuecha, 2013; Bouoiyour, 2013; Bouoiyour *et al.* 2016, Zennati *et al.* 2025). In this context, especially since the late 2000s, research on migration and remittances has increasingly focused on the impact of human mobility on the health of individuals left behind in their home countries. The studies conducted have focused on various aspects related to the healthcare sector. The first trend reveals that emigrants interact with the healthcare systems of their host countries. Interactions with various stakeholders in this ecosystem enable emigrants to internalize new knowledge and practices. These new behaviours and information are then transferred to communities of origin through social remittances (Levitt, 1998). This dissemination contributes to an enhanced understanding of the benefits of modern preventive care (see, for example, Ponce *et al.* 2011). Other studies demonstrate that remittances enable households in home countries to overcome budgetary constraints that previously limited their access to healthcare service. They conclude that remittances imply an increase in household health budgets. This result has been observed in several countries of origin: Abraham and Tao (2021) in 130 developing countries, Valdero-Gil (2009) and Amuedo-Dorantes and Pozo (2011) in Mexico, Gerber and Torosyan (2013) in Georgia, Petreski *et al.* (2018) in Macedonia, Paul and Omeje (2022) in Nigeria, Basu and Biswas (2024) in Kenya and Li *et al.* (2024) in China. Moreover, it has been found that migrant remittances increase government health expenditures in developing countries (Williams, 2024).

Other researchers consider remittances as a form of informal social protection that enables household members to access healthcare (Petreski *et al.* 2018). Another line of research has highlighted that the impact of remittances on health includes improvements in the nutrition of populations in the countries of origin (for example: Combes *et al.* 2014; Sangwan and Tasciotti, 2023). They argue that remittances help stabilize food prices in countries of origin, enabling households to maintain their usual consumption levels and thereby improving nutritional status. In a study covering 122 developing countries between 1990 and 2015, Azizi (2018) argues that remittances reduce the prevalence of malnutrition. In a representative World Health Organization survey, Antón (2010) studies the impact of remittances on nutritional status in Ecuador in 2006. He concludes that remittances have a positive and significant effect in the short and medium term on nutritional status.

Since the mid-2010s, research has focused on the results and changes produced by the allocation of migrants' remittances in access to healthcare. In this regard, two areas have attracted the attention of researchers. The first area explores the relationship between remittance receipts and life expectancy in the home countries. Existing research indicates that remittances contribute to increasing life expectancy in home countries. Analysing the impact of remittances on human capital in 122 developing countries, Azizi (2018) finds that remittances improve life expectancy in home countries. In the same line, Kuziboev *et al.* (2024) finds that life expectancy is positively correlated with remittances in 11 CIS countries.[13] Additionally, Zhunio *et al.* (2012) explores the effect of remittances on the health of people staying in 69 developing countries. They find that remittances significantly increase life expectancy in the countries studied. Similarly, Amakom and Iheoma (2014) investigate the impact of remittances on health outcomes in 18 sub-Saharan African countries, concluding that remittances significantly enhance life expectancy in these countries of origin. Also, Amega (2018) focuses its research on 46 countries in sub-Saharan Africa. He concludes that remittances are positively associated with life expectancy in these countries. In the same vein, Bare *et al.* (2021) conclude that remittances contribute to higher life expectancy in 39 sub-Saharan African countries. In South Asian countries, Ullah et al (2019) analyse the effect of remittances on health indicators. They conclude that remittances are positively and statistically

[13] The CIS countries covered by this study are: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Ukraine, and Uzbekistan.

significantly associated with increased life expectancy in these countries. Another area attempts to analyse the impact of husband emigration on the health of wives left behind in the countries of origin and to identify the mechanisms by which these effects are transmitted. Lei and Desai (2021) show that wives who left behind had worse health compared to the wives of non-migrants. They attribute this effect to the limited number of remittances sent by migrant husbands and the additional responsibilities placed on women, such as caring for animals and managing household finances. Zhang *et al.* (2022) study the impact of adult children's migration on their parents' health in rural China. They find that, thanks to remittances, the migration of adult children leads to an improvement in the physical health of the parents. They add that this income effect is attenuated by the parental time allocation effect which has a negative effect on parents' health due to lack of care and increased working hours.

The second area of research interest relates to the adult mortality rate in the home countries. Although rare, existing studies highlight that remittances are positively associated with reducing adult mortality rates in countries of origin. In a study that estimates the impact of remittances on health outcomes in 46 sub-Saharan African countries, Amega (2018) concludes that remittances are negatively associated with adult mortality in sub-Saharan African countries.

The mechanism by which remittances reduce adult mortality and extend life expectancy lies in the impact of these funds on health outcomes. By studying the effect of remittances on health outcomes in 107 developing countries over the period from 1990 to2018 and using a panel vector autoregression (PVAR) model, Djeunankan and Tekam (2022) conclude that that remittances improve health outcomes in developing countries. Furthermore, by analysing the impact of remittances on Human Development Index (HDI) rankings. Ali *et al.* (2024) find that remittances significantly improve the well-being of populations in countries of origin through improved health outcomes. Kan (2021) shows that remittances have a positive and significant effect on the likelihood that household members seek direct medical care in tadjikistan. Moreover, he confirms the positive role of remittances in improving the well-being of left behind. On the other hand, remittances increase the healthy social and physical functioning of elderly adults Ojijieme *et al.* (2022).

2. Data and Empirical Model

2.1 Data

This study examines four developing countries in North Africa.[14] The data used in this study is annual and spans from 1990 to 2021. Living conditions are assessed using two indicators: life expectancy at birth (LE) and the adult female mortality rate (Mortality). The main variable of interest in this paper is per capita remittances (REM-CAPI), which is calculated as the total remittance inflows for a given year divided by the population size of that year. This measure was chosen over the remittance-to-GDP ratio because fluctuations in the latter could be attributed to both changes in GDP and the volume of remittances received. As noted by Escribà-Folch *et al.* (2015), this dual dependency complicates isolating the effect of remittances on the outcomes under study. To strengthen the robustness of our findings, we also introduce a second proxy of interest - annual total remittances received by the country (REMIT) - into our models.

Economic development is measured by gross domestic product (GDP) per capita, expressed in current U.S. dollars adjusted for purchasing power parity (GDP-CAPI). To assess the effect of public policies, two proxies are introduced: the ratio of government spending on education to GDP (EDUC-EXPE) and the percentage of current health expenditure as a share of GDP (HEAL-EXPE). Finally, urbanization is quantified by the urban population rate (URBA-POPU). [15]To account for the demographic characteristics of the countries in our panel, two variables have been introduced into our models. The first corresponds to the total fertility rate (**TFR**).[16] The second proxy measures the proportion of individuals aged 65 and over within the total population (**OVER-65**). All variables are sourced from the World Bank's World Development Indicators (WDI) database. To reduce variance, the variables REM_CAPI, REMIT, GDP_CAPI, HEAL_EXPE, EDUC_EXPE, and URBA_POPU were transformed by applying the natural logarithm

[14] This paper covers: Algeria, Egypt, Morocco and Tunisia. Libya was excluded for lack of data.
[15] This rate corresponds to the share of people living in urban areas compared to the total population.
[16] This rate represents the number of children that would be born to a woman if she lived to the end of her childbearing years.

2.2 Empirical Model

The baseline model used to estimate the impact of remittances on the longevity of women in North African countries is specified as follows:

$$\boldsymbol{log(Y)_{it} = \beta_0 + \beta_1 log(Rem - capi_{it}) + \gamma_i X_{it} + \epsilon_{it}} \quad (1)$$

Where:

i corresponds to the country (ranging from 1 to N, where N represents the number of countries in our panel). t refers to the time (ranging from 1 to T), covering the period from 1990 to 2021. β_0 is a constant, $Rem - capi_{it}$ is the amount of per capita remittances and X_{it} is the vector of variables that potentially affect Y_{it} and ϵ_{it} is the error term.

In this paper, women's longevity is measured by two proxies, life expectancy at birth[17] (LE) and the mortality rate of adult women[18] (Mortality).

Estimating the effect of remittances on women's longevity involves two empirical models, which build upon existing models (*e.g.*, Amakom and Iheoma, 2014; Azizi, 2018; Ullah *et al.* 2019).

$$\textbf{Model 1: } \boldsymbol{log(LE)_{it} = \beta_0 + \beta_1 log(Rem - capi_{it}) + \gamma_i X_{it} + \epsilon_{it}} \quad (2)$$

The vector of control variables X_{it} is composed of GDP per capita, the rate of government spending on health in GDP, the rate of population over 65, the rate of education spending in GDP and the total fertility rate.

$$\textbf{Model 2: } \boldsymbol{log(Mortality)_{it} = \beta_0 + \beta_1 log(Rem - capi_{it}) + \gamma_i X_{it} + \epsilon_{it}} \quad (3)$$

The vector of control variables X_{it} is composed of GDP per capita, the rate of government spending on health to GDP, the share of the population over 65 years of age among the overall population, the share of the urban population and the total fertility rate.

2.3 Empirical Methodology

Estimating the impact of remittances on women's longevity in North African countries involves several stages. Before applying cointegration techniques, we first need to verify the stationarity of all variables included in our model. To do this, we employ panel unit root tests based on the methodology of Im *et al.* (2003). Additionally, we apply the Fisher-type augmented Dickey-Fuller (ADF) panel unit root test, as proposed by Dickey and Fuller (1979)

When certain variables are integrated of order one, the issue of spurious correlations may arise. To address this, we analyze the cointegration between the dependent and independent variables in the panel dataset. The presence of cointegration rules out the bias from spurious correlations and confirms the existence of a long-term relationship between the variables in the model. The most commonly used test in the context of panel data models is that proposed by Pedroni (1999, 2001b). This test includes seven distinct statistical tests: four intra-dimensional statistics (Panel v-Statistic, Panel Rho-Statistic, Panel PP-Statistic, Panel ADF-Statistic) and three cross-sectional statistics (Group rho-Statistic, Group PP-Statistic, Group ADF-Statistic). When at least four of these statistics are significant, the null hypothesis is rejected, indicating the presence of a long-term relationship between the variables. To further assess the robustness of the cointegration results, we also apply the cointegration test proposed by Kao (1999), which is based on the DF (Dickey-Fuller) and ADF (Generalized Dickey-Fuller) tests. The null hypothesis is "H0: no cointegration," while the alternative hypothesis is "H1: cointegration exists." If the ADF test statistic is significant, the null hypothesis is rejected, implying that the series are cointegrated.

According to the existing literature, three methods have been commonly used to estimate long-term relationships in the presence of panel data: Panel Ordinary Least Squares (POLS) (*e.g.*, Azizi, 2018), Fully Modified Ordinary Least Squares (FMOLS), and Dynamic Ordinary Least Squares (DOLS) (*e.g.*, Hooy *et al.* 2015; Shahbaz *et al.* 2021). Several studies have highlighted that estimates obtained using the POLS method may be biased due to issues such as endogeneity (*e.g.*, Kao and Chiang, 2000; Pedroni, 2001a; Pedroni, 2001b; Narayan and Narayan, 2005; Shahbaz *et al.* 2021; Hooy *et al.* 2015; Latif, 2015; Ahmad *et al.* 2023). In this paper, the primary method for estimating long-term relationships is the Dynamic Ordinary Least Squares (DOLS) method, introduced by Stock and Watson (1993). This method was chosen for its effectiveness with small panel datasets and its ability to address endogeneity bias among regressors (Kao and Chiang, 2000; Hooy *et al.* 2015;

[17] Life expectancy at birth indicates the number of years a newborn would live if the prevailing mortality patterns at the time of birth remained the same throughout their life.

[18] The mortality rate among adult women corresponds to the probability that a young woman aged 15 will die before reaching the age of 60.

Álvarez-Ayuso *et al.* 2018). To ensure the robustness of the results, the Fully Modified OLS (FMOLS) method, developed by Phillips and Hansen (1990), is used as an alternative.

3. Results

3.1 Descriptive Statistics

Table 1 presents the descriptive statistics for the series included in our model. The average remittances per capita received in the North African countries is 120 USD. This figure fluctuated between 38 and 288 USD during the period, highlighting the disparities among the four countries. Additionally, the average annual remittance inflow for these countries is 10.9 billion USD, with Egypt being the primary contributor. This table also highlights the results achieved through public health policies. In this context, the average life expectancy at birth for women in these countries is 70.89 years, showing an increase of over thirty years, rising from 65.9 years to nearly 74 years. The improvement in life expectancy has been accompanied by a notable reduction in the adult female mortality rate, which averaged 116 deaths per 1,000 women annually. North African countries have invested a significant portion of their GDP in education and health. Between 1990 and 2021, these countries allocated nearly 5% of their GDP annually to the health sector and 4% to the education sector. Additionally, these countries have undergone a moderate demographic transition. During the period studied, the total fertility rate averaged 2.99 births per woman. This decline in fertility, along with other factors, has led to an increase in the proportion of the population aged over 65, which averaged 4.66% during this period. North African countries have also experienced a significant wave of urbanization, with just over half of the population living in cities between 1990 and 2021.

Table 1. Description and Descriptive Statistics of Variables

Variable	Description	N	Mean	Std. Dev.	Min	Max	Source
REM-CAPI	Remittances per capita	128	120.18	80.83	38.89	288.18	Calculated
REMIT	Annual amount of remittances received	128	1.09E+10	9.12E+09	2.85E+09	3.15E+10	WDI
GDP-CAPI	*GDP per capita expressed in current international dollars converted by the purchasing power parity*	128	7523.31	2849.87	3639.37	12706.40	WDI
EDUC-EXPE	The share of government expenditure on education in GDP (as % of GDP)	80	3.98	0.66	2.48	4.95	WDI
HEAL-EXPE	*The share of health expenditure in GDP (as % of GDP)*	*80*	*4.91*	*0.41*	*4.15*	*5.63*	*WDI*
LE	*Life expectancy at birth for females*	*128*	*70.89*	*2.33*	*65.97*	*73.97*	*WDI*
MORTALITÉ	*Adult female mortality rate (per 1000 deaths)*	*128*	*116.15*	*38.75*	*61.94*	*214.70*	*WDI*
URBAN-POPU	*Rate of urban population in total population*	*91*	*54.79*	*8.50*	*42.66*	*68.35*	*WDI*
TFR	*Total fertility rate*	*91*	*2.99*	*0.66*	*1.96*	*4.56*	*WDI*
OVER-65	*The share of people over 65 in the total population*	*91*	*4.66*	*0.96*	*3.03*	*7.68*	*WDI*
WDI : World Development Indicator							

Source: developed by the authors

3.2 Unit Root Tests

To analyze the impact of migrants' remittances on women's empowerment in North African countries, we first assess the stationarity properties using the Im *et al.* (2003) and Augmented Dickey-Fuller (ADF) panel unit root tests. Table 2 presents the results of the unit root tests for all the variables included in our models. The table shows that all variables are integrated of order I(1), and none display I(2) characteristics.

Table 2. Unit root test

		At level		1st difference		
Variable	Test	Statistic	Prob.	Statistic	Prob.	Conclusion
REM_CAPI	Im, Pesaran and Shin W-stat	2.341	0.9904	-3.815	0.0001	I(1)
	ADF - Fisher Chi-square	4.581	0.8013	31.484	0.0001	I(1)
REMIT	Im, Pesaran and Shin W-stat	3.577	0.9998	-3.216	0.0007	I(1)
	ADF - Fisher Chi-square	3.133	0.9258	27.344	0.0006	I(1)
GDP-CAPI	Im, Pesaran and Shin W-stat	3.025	0.9988	-3.623	0.0001	I(1)
	ADF - Fisher Chi-square	1.855	0.9851	28.878	0.0003	I(1)
HEAL_EXPE	Im, Pesaran and Shin W-stat	0.491	0.6882	-4.168	0.0000	I(1)
	ADF - Fisher Chi-square	5.648	0.6866	30.739	0.0002	I(1)
EDUC_EXPE	Im, Pesaran and Shin W-stat	1.018	0.8457	-2.578	0.0050	I(1)
	ADF - Fisher Chi-square	6.989	0.5378	26.458	0.0002	I(1)
LE	Im, Pesaran and Shin W-stat	0.106	0.5422	-3.463	0.0003	I(1)
	ADF - Fisher Chi-square	5.574	0.6948	38.179	0.0000	I(1)
OVER_65	Im, Pesaran and Shin W-stat	2.824	0.9976	-2.17783	0.0147	I(1)
	ADF - Fisher Chi-square	12.012	0.1507	18.1287	0.0203	I(1)
Individual intercept included in unit root test equation Lag length on automatic selection and Swartz info criterion (SIC)						

Source: developed by the authors

3.3 Panel Cointegration Test

Before estimating equations (eq.1) and (eq.2), it is essential to conduct panel cointegration tests to examine the presence of long-term relationships and avoid the risk of spurious results. As mentioned earlier, we employ the Pedroni and Kao cointegration tests. Table 3 shows that both the Pedroni and Kao cointegration tests confirm the existence of cointegration among the variables in both models.

Table 3. Cointegration tests

Test	Variable	Model 1	Model 2
Pederoni	Panel v-Statistic	5.479***	-1.657
	Panel rho-Statistic	1.599	2.789
	Panel PP-Statistic	-4.623***	-5.829***
	Panel ADF-Statistic	-3.245***	-3.304***
	Group rho-Statistic	2.619	3.372
	Group PP-Statistic	-3.613***	-8.920***
	Group ADF-Statistic	-2.609***	-3.279***
Kao	ADF	-3.640***	-1.782**
***** significance at 1%, ** significance at 5%, * significance at 10% Note: The results of the Pedroni test for both models are with constant and trend.**			

Source: developed by the authors

3.4 Results of the Cointegrated Panel Estimator

In this paper, we estimate the impact of remittances on women's living conditions in North African countries. As mentioned earlier, living conditions are measured using two proxies: the first is women's life expectancy at birth, and the second is the women's mortality rate. To this end, we estimate the two models using the Dynamic OLS method. As noted above, the main variable of interest is the number of remittances per capita (Rem-capi). To test the robustness of the results, we use the annual amount of remittances received by each country (Remit) as an alternative variable of interest, and the Fully Modified OLS method as an alternative estimator

Evaluating the impact of remittances on women's life expectancy in North African countries requires estimating equation (eq.1). The results of this estimation are presented in Table 4.

Table 4. Estimated impact of remittances on female life expectancy at birth

Model 1				
Dependent variable: LE				
	DOLS	**FMOLS**	**DOLS**	**FMOLS**
LREM_CAPI	0.010*** (0.003)	0.013*** (0.002)		
LREMIT			0.010*** (0.002)	0.013*** (0.002)
LGDP_CAPI	0.034*** (0.012)	0.038*** (0.009)	0.032*** (0.011)	0.036*** (0.009)
LHEAL_EXPE	0.014 (0.022)	-0.0001 (0.024)	0.011 (0.022)	-0.002 (0.023)
LEDUC_EXPE	0.014 (0.015)	0.0166 (0.014)	0.016 (0.015)	0.018 (0.013)
OVER_65	0.012*** (0.004)	0.009*** (0.003)	0.012*** (0.004)	0.009*** (0.003)
TFR	-0.032* (0.018)	-0.038** (0.018)	-0.032* (0.017)	-0.039** (0.017)
Values in brackets denote standard error. * significance at 1%, ** significance at 5%, * significance at 10%. Dols made for a constant trend.**				

Source: developed by the authors

Table 4 shows that remittances are positively and significantly associated with an increase in life expectancy in North African countries. The DOLS method reveals that a 10% increase in remittances per capita results in a 0.10% increase in women's life expectancy in these countries. This finding suggests that migrant remittances have a positive impact on life expectancy at birth in the home countries. This result aligns with the findings of Azizi (2018) in his study of 122 developing countries, Omon (2021) in the West African Monetary Zone (WAMZ) countries, Zhunio *et al.* (2012) in their survey of 69 low- and middle-income countries, and Naatus (2013) in El Salvador. For robustness, the same results are obtained using the alternative variable of interest and alternative estimator.

Table 5. Estimated impact of remittances on adult female mortality

Model 2				
Dependent variable: Mortality				
	DOLS	**FMOLS**	**DOLS**	**FMOLS**
LREM_CAPI	-0.030** (0.014)	-0.029*** (0.009)		
LREMIT			-0.032** (0.013)	-0.031*** (0.009)
LGDP_CAPI	-0.243*** (0.062)	-0.298*** (0.045)	-0.231*** (0.061)	-0.286*** (0.045)
LHEAL_EXPE	-0.109 (0.115)	-0.090 (0.085)	-0.101 (0.113)	-0.083 (0.084)
OVER_65	0.150 (0.182)	0.402*** (0.135)	0.149 (0.178)	0.397*** (0.133)
TFR	0.109 (0.089)	0.173** (0.068)	0.109 (0.087)	0.174** (0.067)
LURBA_POPU	-2.611*** (0.526)	-3.086*** (0.383)	-2.615*** (0.515)	-3.097*** (0.377)
Values in brackets denote standard error. * significance at 1%, ** significance at 5%, * significance at 10%. Dols made for a constant trend.**				

Source: developed by the authors

The country-specific results are shown in Table 6 in the appendix. We observe that, with the exception of Tunisia, remittances have a positive effect on female life expectancy. A 10% increase in remittances per capita

corresponds to a 0.02% increase in female life expectancy in Algeria, 0.17% in Egypt, and 0.007% in Morocco.[10] This finding aligns with the studies by Naatus (2013), Zhunio *et al.* (2012), Amakom and Iheoma (2014), Azizi (2018), Amega (2018), and Bare *et al.* (2021). Some researchers suggest that this positive impact is due to remittances improving recipients' access to healthcare and increasing their healthcare spending (Nathaniel, 2019; Omon, 2021). For robustness, the same results were obtained using an alternative interest variable and estimator.

Model 2 is estimated to assess the impact of remittances on the mortality rate of adult women. The results in Table 5 indicate that remittances are negatively and significantly correlated with adult female mortality in North African countries. A 10% increase in per capita remittances would lead to an approximate 0.3% reduction in female mortality in these countries. Previous research has shown that remittances not only alleviate economic hardship but also increase the share of household income allocated to health expenditures. Furthermore, remittances enhance household food security and encourage greater use of healthcare services (Kuhn, 2006; Valdero-Gil, 2009; Ponce *et al.* 2011; Adams and Cuecuecha, 2013; Azizi, 2018; Agadjanian *et al.* 2021). These improvements in living conditions positively affect the health of women left behind, thereby contributing to a decrease in their mortality rate. This result aligns with previous findings that remittances contribute to an increase in female life expectancy in these countries. In fact, it has been demonstrated that the reduction in adult mortality is linked to an increase in life expectancy at birth (among others: Vaupel, 1986; Crimmins and Zhang, 2019; Marshall *et al.* 2019; Woolf and Schoomaker, 2019).

Our findings further suggest that an increase in income, as measured by GDP per capita, significantly reduces mortality rates among adult women. Specifically, higher income improves individuals' access to healthcare services, which in turn has a positive effect on lowering mortality during adulthood. Additionally, higher income may contribute to a decrease in the fertility rate, resulting in better overall health conditions. As a result, the mortality rate among adult women decreases. In line with our expectations, the increase in the proportion of individuals over 65 and the total fertility rate positively affects the mortality rate of adult women in North African countries. Moreover, urbanization plays a key role in reducing female mortality in these countries. Urban women are more likely to benefit from healthcare services, medical monitoring of pregnancies, improved housing conditions, and other factors. It is important to note, however, that the proportion of health expenditure in GDP does not have a significant impact on female mortality in North African countries.

This broad analysis seems to overlook certain nuances. As a result, a country-specific analysis was carried out. The findings, presented in Table 7 of the appendix, show a negative and significant relationship between remittances and adult female mortality in Egypt and Morocco. Specifically, a 10% increase in per capita remittances would lead to a reduction in the mortality rate for adult women by 0.8% in Egypt and 0.24% in Morocco. In contrast, remittances are positively correlated with an increase in female mortality in Algeria and Tunisia. For robustness, the same results were obtained using an alternative interest variable and estimator

The positive impact of remittances on life expectancy and the reduction in mortality among adult women in Morocco and Egypt can be attributed to the significant portion of remittances spent on healthcare and medicines. This expenditure represents the third-largest allocation of remittances, accounting for 18% in Morocco and 11.8% in Egypt, respectively (Jureidini *et al.* 2010; Farid *et al.* 2013; HCP, 2022). Although Tunisian households receiving remittances allocate more than 15% of these funds to medical expenses and medicines (Kriaa and Ben Youssef, 2022), our findings indicate that these transfers have a negative effect on life expectancy and mortality among adult women.

Several researchers have highlighted significant challenges in financing Tunisia's healthcare system (Abu-Zaineh *et al.* 2013; Abdelaziz *et al.* 2018; Ismaïl, 2021). Abu-Zaineh *et al.* (2013) note that the system remains heavily dependent on direct out-of-pocket payments, which can constitute up to 40.5% of healthcare expenses, despite the availability of medical coverage. While remittances could provide a financial solution to this issue, the amounts sent by households appear insufficient to meet the growing demand. A second explanation is that male migration may have a negative impact on the health of women left behind in Tunisia. This decline in health could be partly attributed to the limited funds remitted, the increased responsibilities placed on women, feelings of loneliness and abandonment, and greater experiences of oppression and control (McEvoy, 2008; Kadi, 2020; Lei and Desai, 2021). The situation in Algeria is linked to the lack of public policies aimed at better utilizing remittances (Mohamed, 2024) and the relatively low volume of remittances compared to the substantial influx of oil revenues (Johansson, 2012)

Conclusion

This paper aims to estimate the impact of remittances on female life expectancy and mortality in North African countries from 1990 to 2021. Considering the size of our panel and to address potential endogeneity bias of remittances, we have employed the Dynamic Ordinary Least Squares (DOLS) method as proposed by Stock and Watson (1993). To verify the robustness of the findings, we employ the Fully Modified Ordinary Least Squares (FMOLS) method, developed by Phillips and Hansen (1990), as an alternative estimator method. our findings indicate that remittances exert a positive and statistically significant impact on the living conditions of women in North African countries. A 10% rise in remittance inflows would lead to a 0.3% reduction in the morality rate of adult women and a 0.1% increase in life expectancy. This result can be attributed to the fact that remittances enhance access to health care and preventive health measures for those left behind, particularly women and girls. Remittances also alleviate the budgetary constraints of households in home countries, thereby improving their access to quality food.

Although the countries in this subregion share certain similarities, they also exhibit points of divergence. In this regard, a more detailed country-by-country analysis reveals disparities in the effects of remittances on longevity of North African women. Indeed, while remittances benefit of Egyptian and Moroccan women, they exacerbate the living conditions of Tunisian women. It appears that in Algeria, which differs structurally from other countries in the sub-region, remittances have a limited impact on the situation of women. These differences can be attributed to several factors. Such as the volume of remittances received and the share that these remittances represent in each country's GDP. In addition, these differences can be attributed to the public policies of these countries towards their diasporas. The economic choices of each country and the allocation of remittances. However, more in-depth analyses are needed to better interpret the existing differences. These results indicate that remittances have significant potential to enhance human development indicators for women in North African countries. Remittances could also serve as an effective strategy for reducing gender inequalities in these nations and advancing their progress towards achieving the Sustainable Development Goals (SDGs). This study, on the other hand, highlights that remittances may pose a risk to the sustainability of social protection systems in these countries.

This study makes several contributions to existing literature. Firstly, it utilizes data from North African countries spanning the period from 1990 to 2021. To our knowledge, no prior papers have explored the impact of remittances on women's living conditions in the countries of this sub-region, which are geographically situated near Europe and therefore possess strategic significance. Secondly, this study surpasses the limitations of previous work that estimated the impact of remittances on women's access to fundamental rights. However, this work allows for the measurement of the effects induced and changes brought by the receipt of remittances on women's situation.

While previous studies have focused on analysing the impact of remittances on women's access to healthcare, this article examines the broader societal changes brought about by these remittances. This approach will provide a deeper understanding of the demographic transition in these countries. Additionally, it will help inform policymakers and international cooperation organizations, enabling them to anticipate potential societal challenges that could worsen the economic and social situation of this segment of the population.

In terms of policy recommendations, the countries in the sub-region are encouraged to maximize and sustain the positive effects of remittances. They are also invited to set up appropriate pension plans for women to prevent them from falling into poverty at retirement age. These countries will also benefit from directing a part of remittances towards health insurance, ensuring that older women can access healthcare services. These countries should enhance the gender dimension in the expansion of their national social protection programs. Additionally, health studies should evolve to include considerations for women's geriatric health. These countries also need to promote research in gerontology and gender-specific health issues.

Credit Authorship Contribution Statement

Aomar Ibourk: Conceptualization, Methodology, Formal analysis, Writing – original draft, Supervision, Validation, review.

Oussama Zennati: Investigation, Formal analysis, Writing – original draft, Data curation, Visualization, Writing – review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies during the preparation of this work.

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Appendix

Table 6. Impact of remittances on women's life expectancy in North African countries

	Algeria				Egypt				Morocco		Tunisia			
Dependent variable: LE														
	DOLS	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**DOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**
LREM_CAPI	0.002** (0.0006)	0.002** (0.0005)			0.017* (0.007)	0.017*** (0.003)			0.0007 (0.027)		-0.016* (0.008)	-0.016** (0.006)		
LREMIT			0.002** (0.0006)	0.002** (0.0006)			0.019** (0.006)	0.018*** (0.003)		0.006 (0.027)			-0.015 (0.008)	-0.015** (0.006)
LGDP_CAPI	0.024 (0.012)	0.029* (0.011)	0.024 (0.012)	0.028* (0.010)	0.023 (0.023)	0.023 (0.011)	0.008 (0.022)	0.011 (0.011)	0.169 (0.093)	0.179 (0.087)	0.068*** (0.018)	0.067*** (0.013)	0.066*** (0.018)	0.064*** (0.013)
LHEAL_EXPE	0.039*** (0.009)	0.034** (0.008)	0.040*** (0.009)	0.034** (0.008)	0.015 (0.019)	-0.019 (0.015)	0.018 (0.017)	-0.015 (0.014)	-0.001 (0.059)	0.008 (0.059)	0.057** (0.024)	0.067*** (0.019)	0.056** (0.025)	0.065*** (0.019)
LEDUC_EXPE	0.006 (0.005)	0.009 (0.005)	0.006 (0.005)	0.009 (0.005)	0.012 (0.010)	0.0004 (0.006)	0.010 (0.009)	-0.0002 (0.005)	0.017 (0.014)	0.015 (0.015)	0.002 (0.005)	0.001 (0.004)	0.002 (0.005)	0.001 (0.004)
OVER_65	0.027*** (0.002)	0.028*** (0.002)	0.027*** (0.002)	0.028*** (0.002)	0.007 (0.008)	0.051** (0.011)	0.003 (0.007)	0.043*** (0.011)	0.0006 (0.024)	-0.002 (0.024)	1.94E-05 (0.004)	0.0002 (0.003)	0.002 (0.003)	0.002 (0.003)
TFR	-0.013 (0.013)	-0.009 (0.011)	-0.014 (0.013)	-0.011 (0.011)	-0.018** (0.007)	-0.023*** (0.004)	-0.017** (0.006)	-0.021*** (0.004)	0.004) (0.081)	-0.007 (0.082)	-0.035** (0.014)	-0.042*** (0.013)	-0.035** (0.014)	-0.042** (0.014)
C	3.916*** (0.123)	3.861*** (0.109)	3.883*** (0.13)	3.827*** (0.110)	3.982*** (0.162)	3.871*** (0.084)	3.775*** (0.067)	3.659*** (0.049)	2.763* (0.696)	2.569 (1.038)	3.79*** (0.114)	3.796*** (0.083)	4.040*** (0.058)	4.049*** (0.043)

Values in brackets denote standard error.
***** significance at 1%, ** significance at 5%, * significance at 10%.**
Dols made for a constant trend.
Results for Morocco using the FMOLS model are not available

Source: developed by the authors

Table 7. Impact of remittances on female mortality in North African countries

	Algeria				Egypt				Morocco				Tunisia			
Dependent variable: Mortality																
	DOLS	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**
LREM-CAPI	0.0003 (0.006)	0.00027 (0.006)			-0.080*** (0.017)	-0.079*** (0.015)			-0.024** (0.011)	-0.027** (0.009)			0.099** (0.040)	0.104** (0.039)		
LREMIT			0.00027 (0.006)	0.0012 (0.0099)			-0.083*** (0.016)	-0.082*** (0.014)			-0.024** (0.010)	-0.028** (0.009)			0.098** (0.039)	0.103** (0.039)
LGDP_CAPI	-0.031 (0.130)	-0.001 (0.128)	-0.031 (0.131)	0.026 (0.192)	-0.142** (0.047)	-0.141*** (0.045)	-0.097* (0.049)	-0.095* (0.046)	0.141** (0.053)	0.147*** (0.047)	0.142** (0.052)	0.149*** (0.047)	-0.034 (0.096)	-0.047 (0.095)	-0.026 (0.093)	-0.039 (0.092)
LHEAL_EXPE	-0.203*** (0.064)	-0.188** (0.066)	-0.203*** (0.064)	-0.182 (0.084*	-0.118** (0.042)	-0.113** (0.047)	-0.111** (0.039)	-0.100** (0.044)	0.050** (0.018)	0.052*** (0.016)	0.051** (0.018)	0.052*** (0.016)	0.013 (0.108)	0.00068 (0.106)	0.017 (0.107)	0.005 (0.105)
OVER_65	-0.798 (0.461)	-0.704 (0.495)	-0.799 (0.461)	-0.647 (0.592)	0.208 (0.187)	0.241 (0.169)	0.218 (0.176)	0.256 (0.158)	-0.314*** (0.088)	-0.303*** (0.077)	-0.317*** (0.087)	-0.306*** (0.077)	-0.158 (0.278)	-0.045 (0.279)	-0.182 (0.270)	-0.069 (0.272)
TFR	-0.122 (0.125)	-0.106 (0.199)	-0.122 (0.125)	-0.083 (0.171)	0.183*** (0.021)	0.177*** (0.019)	0.172*** (0.019)	0.167*** (0.018)	0.009 (0.033)	0.022 (0.0299)	0.008 (0.032)	0.020 (0.029)	0.012 (0.046)	0.016 (0.048)	0.008 (0.045)	0.012 (0.048)
LURBA_POPU	-0.789 (1.236)	-1.067 (1.446)	-0.787 (1.239)	-1.297 (1.612)	16.446*** (2.334)	16.838*** (2.468)	15.913 (2.206)	16.544*** (2.329)	-3.844*** (0.337)	-3.878** (0.295)	-3.809*** (0.329)	-3.841*** (0.291)	-2.415* (1.123)	-2.913** (1.167)	-2.578** (1.146)	-3.089** (1.188)
C	10.046*** (3.071)	10.715** (3.832)	10.037*** (3.046)	11.246** (3.721)	-56.030*** (9.111)	-57.556*** (9.651)	-52.89 (8.651)	-55.367*** (9.124)	19.718*** (0.838)	19.769*** (0.731)	19.998*** (0.845)	20.095*** (0.747)	14.453*** (4.397)	16.426*** (4.536)	13.529*** (4.216)	15.469*** (4.401)
Values in brackets denote standard error. ***** significance at 1%, ** significance at 5%, * significance at 10%.** **Dols made for a constant trend.**																

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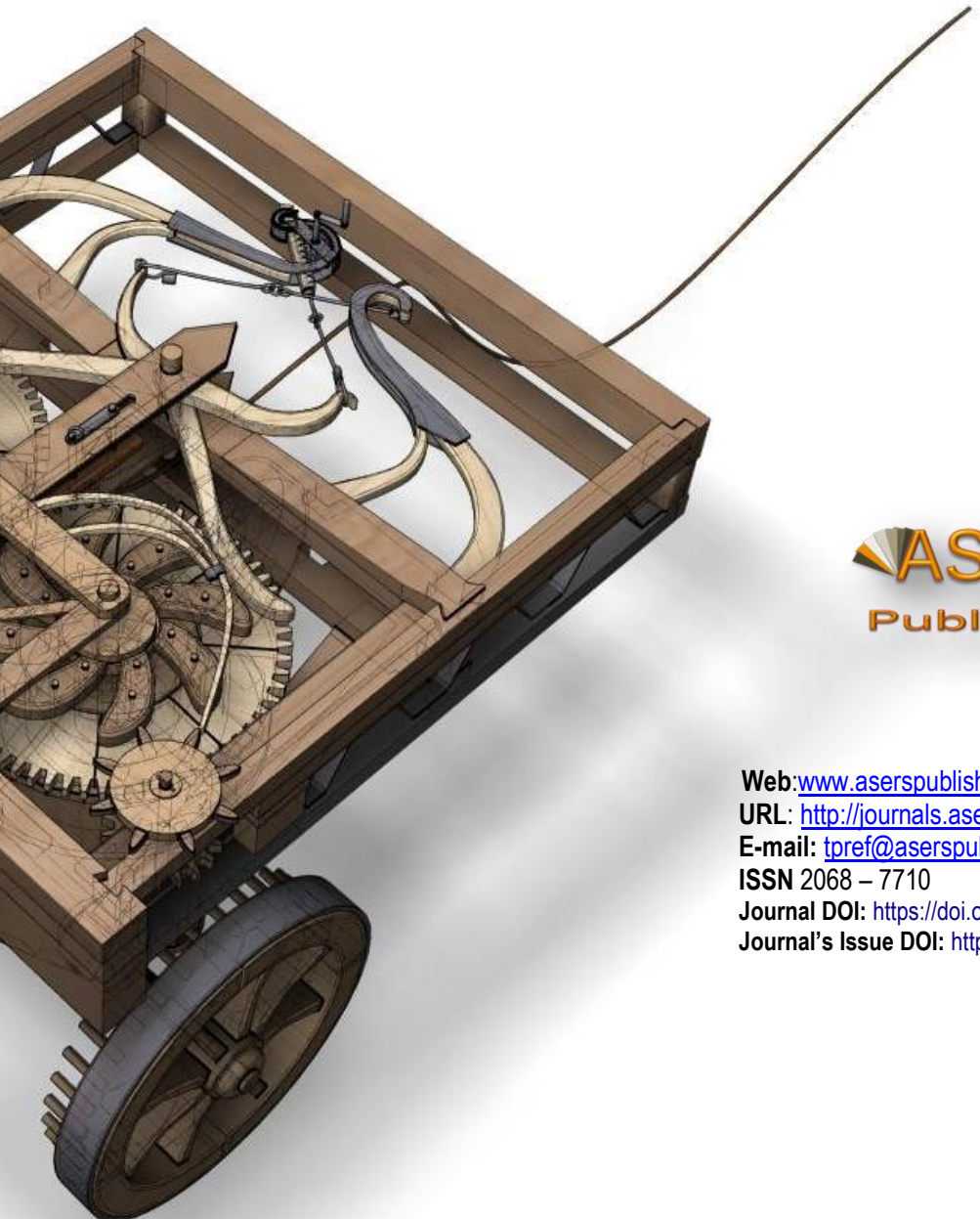

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