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The impact of human capital investment on economic growth: A panel data analysis of MENA countries

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ABSTRACT

The human capital theory explains economic growth through the accumulation of knowledge among individuals. This study focuses on the effect of human capital on economic growth in the Middle East and North Africa (MENA) region. It applies the total production function, which includes traditional growth factors such as labor and physical capital, along with health and education indicators that represent human capital based on modern growth theories. Using panel data from 2004 to 2020, the study empirically examines how education and health, as measures of human capital, affect economic growth in MENA countries. The main finding is that human capital has a slightly positive effect on economic growth in the region, mainly due to inefficiencies in its use.

1. Introduction

Due to the groundbreaking work of Solow (1956) and Swan (1956), as well as the subsequent surge in popularity in the early 1990s, the study of the factors that influence economic growth has been the focus of a vast body of literature. Economists and politicians have been focused on achieving sustainable economic growth for ages. The importance of human capital as a factor in determining long-term economic performance is becoming more widely acknowledged. Higher levels of economic growth and development enable societies to raise median incomes, which in turn improve residents' quality of life.

Individuals with higher levels of preparation are more productive, and leaders in developing new goods and enhancing productivity factors; therefore, their human capital is crucial to attaining economic progress. The idea is that a country's economic growth depends on how much it invests in building up its human capital. It also says that Southeast Asian economies have been doing very well because they have been investing more in this area, which has led to more conditional convergence. Latin American economies, on the other hand, are in a completely different position.

The MENA region's varied economies, differing degrees of development, and distinctive social and economic systems make it an especially intriguing place to research the relationship between economic growth and human capital growth. Although some MENA nations have made significant strides in diversifying their economies and investing in human capital, others still face difficulties (Dahmani and Mabrouki, 2025). These difficulties include high unemployment rates, especially among young people, and a skills gap that reduces their ability to compete.

The Middle East and North Africa (MENA) area offers an intriguing backdrop for investigating the connection between economic growth and the development of human capital. The region is defined by its unique socio-economic structures, varied economies, and differing degrees of development. Although certain MENA nations have achieved notable progress in diversifying their economies and investing in human capital, others still face obstacles like high unemployment rates, especially among young people, and skill gaps that reduce their ability to compete globally (Hamid and Mohamed, 2025). Additionally, there are opportunities and challenges

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associated with the region's demographic dynamics, which are characterized by a sizable and expanding young population. It will need significant expenditures in education and vocational training to fully realize the potential of this demographic dividend and provide young people with the skills they need to succeed in the workforce of the twenty-first century. But to fully reap the rewards of human capital investments in the MENA region, recent studies have also shown how critical it is to address problems like gender inequality and youth unemployment.

Methodologically, a sample of MENA nations is being studied in this study using a panel data technique. The following is how the work is structured. Along with this introduction, a survey of the literature on how human capital contributes to economic growth is presented in the second section. The third section provides an explanation of the variables and the econometric technique. The fourth portion then covers the results and analysis, and the final section concludes the discussion.

2. Literature review

To avoid redundancy, we focus on the most relevant recent empirical contributions that directly inform the regional dynamics of human capital and growth.

Many studies have examined the impact of human capital investment on economic growth in MENA countries through panel data analysis (Dahmani and Mabrouki, 2025). The study examined the economic dynamics of the MENA region from 1996 to 2020, specifically focusing on the impact of innovation, governance, and human capital on economic growth. According to the research (Derbal et al., 2025), human capital promotes economic growth in the short term but has more complicated long-term impacts. The study examines the relationship between economic growth, foreign direct investment (FDI), and governance in 14 Arab nations from 2002 to 2017. According to the study, the degree of human capital development affects how FDI affects growth, underscoring the importance of good governance. Zhor and Mohammed (2024) used panel data from 2007 to 2019 to examine how human capital contributes to economic growth throughout the MENA region. Although human capital has a beneficial impact on economic growth, the extent of this influence varies, which may limit growth possibilities in certain nations, according to the research. Al Mazroue et al. (2024) used the World Development Indicators and data from the United Arab Emirates to examine the changes in human resources development (HRD) in the country from 1975 to 2017. It focuses on what factors affected HRD during that time. The ARDL limits test for co-integration shows that the variables are linked over the long term, and short-term results show that the variables have a positive effect on HRD. In addition to investing in Smart Governance, the findings highlight the significance of encouraging innovation and cultivating an innovative culture to improve HRD in the United Arab Emirates. To successfully transition to a knowledge-based economy, certain policies are necessary (Aslan and Altinoz, 2021). The study employed the PVAR methodology to investigate the correlation between natural resources, capital formation, globalization, and economic growth in developing nations across Europe, Asia, Africa, and the Americas from 1980 to 2018. Globalization and natural resources drive most regions' growth, while capital formation has the opposite effect. Globalization and capital formation boost growth in Africa, whereas natural resources impede GDP. Globalization and growth are causally related in both directions, with other factors showing region-specific causation patterns. The findings underscore the necessity of incorporating globalization and natural resource rents into new models of economic growth. Abida and Abdellaoui (2025) looked at the link between economic growth, human capital, and institutional quality in Tunisia, Algeria, and Morocco from 1991 to 2020 using the dynamic system generalized method of moments (GMM) method. The results show a strong and mutually reinforcing relationship between human capital and institutional quality, both of which have a beneficial impact on long-term economic growth. To achieve sustained economic growth, the results highlight the significance of integrated policy plans that invest in human capital development and enhance institutional frameworks at the same time. Policymakers aiming to create successful co-development plans in the area can learn a lot from these findings (Awdeh and Jomaa, 2024). The study examined the effective use of available financial flows to determine the impact of institutional quality and development finance resources on human development in the region. It also looks at the root causes of the problems impeding sustainable growth and rising living standards. Thus, most MENA nations have low levels of human development in addition to scarce financial resources, poor institutional frameworks, and weak governance.

Zuniga Figueroa (2018) studied the link between education and economic growth for the Central American region. Cross-sectional econometric techniques, which show the link between education and economic growth, back up this analysis. It was also shown that the variables that have the most effect on GDP per capita are the rate of illiteracy and the amount of money the government spends on education. By considering the components of human capital, Abdelmajied and Safijllin (2018), using a panel of 15 countries in the MENA (Middle East and North Africa) region, quantified the impact of these components (education and health) on the GDP per capita in the period 2008–2016. According to the authors, there is a long-term relationship between the variables, concluding that human capital has a wide range of potential benefits. Odhiambo (2021) evaluated the dynamic causal relationship between education and economic growth in South Africa using annual time series data for the period 1986 to

2017. Using his own model estimations of the time series, he examined the relationships between education, economic growth, and two intermittent variables, investment and labor. The author found that in South Africa, a causal flow from economic growth to education tends to predominate. For their part, Brito and Iglesias (2021) found that in Latin America, the increase in human capital reduces inequality and improves economic growth; for this, they used three estimation methods (a model with fixed effects, generalized method of moments, and minimum squares in two stages). They also contrast these results with the variable of foreign direct investment, which, although in previous studies was determined when explaining disparities and growth, the results obtained show that this investment is no longer significant. Maneejuk and Yamaka (2021) analyzed the non-linear impacts of education, especially higher education, on economic growth in ASEAN-5 countries (Thailand, Indonesia, Malaysia, Singapore, and the Philippines) for the period 2000-2018. Through the time series estimates and panel data, both by country and by region, they found that the greater the spending on tertiary education, the greater the economic growth of the ASEAN-5. According to Wirajing et al. (2023), they used the system GMM technique to look at how human capital affected economic growth in 48 African countries from 2000 to 2019. The results indicate that internet penetration and foreign direct investments interact with human capital to produce positive net effects on economic growth. Wegari et al. (2023) examined the impact of human capital on Ethiopia's economic growth by using the ARDL model, applying annual data for the period 1980 to 2020. The result from the bound test indicated the existence of a long-run relationship between the dependent variable and the independent variables entered into the model. Many studies that use the human capital index estimated by the PWT as a control variable found a positive relationship with economic growth. Angrist et al. (2021) used data for 174 countries during the period 2000-2017 through a fixed effects panel data model. The authors conclude that the human capital index, measured by the PWT, positively and significantly affects economic growth. López-Pueyo et al. (2018) reached similar results using the same variables but focused on the progress of innovation and technology in developed countries. Kocourek and Nedomlelová (2018), for their part, concluded that the increase in the human capital index contributed to the growth of labor productivity in 125 selected countries in the period 1999-2014. In Mexico, Garza-Rodriguez et al. (2020) found that the impact of human capital on economic growth is significantly greater than that of physical capital. Akhvlediani and Cieślik (2020) estimated a panel data model for the European Union during the period 1950-2014 and found that human capital presents positive and statistically significant effects on technological progress. Another group of studies has used the United Nations Development Programme (UNDP) Education Index as a measure of education. Through the estimation of a univariate model of the time series for the years 1990–2014 in Mexico, Favila-Tello (2018) showed that the variable education index has a positive and significant effect on the variable GDP per capita. Zhang and Wang (2021), using the same variables in China, reached similar results. The same Angrist et al. (2021) in their estimates also included the human capital of the human development index and realized that this positively and significantly affects economic growth.

3. Methodology

This study examines the effect of human investment on economic growth using static panel data models for a group of Middle Eastern and North African (MENA) countries over the period 2004–2020. The sample includes 13 MENA countries selected based on the availability of relevant data for the study variables. The North African countries in the sample are Algeria, Tunisia, Morocco, and Egypt. The Middle Eastern countries are Jordan, the United Arab Emirates, Saudi Arabia, Iran, Iraq, Lebanon, Turkey, Bahrain, and Oman.

3.1. Study model variables

Our research looked at how human capital affects economic growth in the Middle East and North Africa. It used the total production function, which includes the usual growth factors like labor and physical capital, as well as health and education variables that represent human capital based on more recent growth studies and theories, like Barro's (1990) study. We used the following function to measure the impact of human capital on economic growth:

$$GDP = f(K, MYS, LEB, L)$$

where, *GDP*: Economic growth variable represented by Gross Domestic Product; *K*: Physical Capital (t was calculated using the perpetual inventory method, with the initial values of physical capital taken from the Nehru and Dhareshwar's (1994) database); *L*: Expressed as the total labor force; *MYS*: Education Represented by the average years of schooling (Barro study and United Nations Development Programme studies) (Barro and Lee, 1993); *LEB*: Health Represented by life expectancy at birth.

We acknowledge the potential for endogeneity and suggest that future research apply GMM estimation to validate the robustness of our findings.

3.2. Application of panel data models

We can say that the panel data is balanced, as each country in the study has data available for all the years, where *t*=17, n=13, and N=221. Also, the countries are numbered from 1 to 13 according to the following encoding: Algeria 1, Bahrain 2, Egypt 3,

UAE 4, Iran 5, Iraq 6, Jordan 7, Lebanon 8, Oman 9, Saudi Arabia 10, Tunisia 11, Turkey 12, Morocco 13.

3.3. Estimation of the appropriate model

3.3.1. Estimation of the pooled regression model (PRM)

In this model, we consider both the cross-sectional and time series nature of the data by adding up all 221 observations and using ordinary least squares (OLS) to do regression. By combining the thirteen countries through data aggregation, we assume homogeneity or symmetry among them, thus negating any heterogeneity or individuality that may exist among them.

In other words, we assume they are homogeneous. The results of estimating the pooled regression model are as Table 1.

Table 1: Regression results using the pooled regression model

Variable	Coefficient	SE	T-statistic	P-value	95% CI (lower)	95% CI (upper)
LEB	9.272867	1.356746	6.83	0	6.598709	11.94702
MYS	-1.095842	1.967315	-5.57	0	-1.483601	-0.708268
K	-0.01308	0.157352	-0.83	0.407	-0.0440942	0.0179342
L	0.98715	0.05519	17.89	0	0.873711	1.100589
Constant	-11.75022	2.615929	-4.49	0	-16.90624	-6.594206

SE: Standard error; CI: Confidence interval

3.3.2. Analysis of pooled OLS regression results

The pooled OLS estimation produces the following model:

$$GDP = 9.27\,LEB - 1.09\,MYS - 0.01\,K + 0.98\,L - 11.75 \quad (1)$$

The results indicate that the independent variable, which is economic growth, has a positive and statistically significant relationship with the life expectancy at birth index. However, it has a negative relationship with the average years of schooling index, also with statistical significance. This contradicts theoretical logic and economic reality. Furthermore, we see that the R^2 determination coefficient is high (77.5%), which suggests that there are other factors at play that affect economic growth, as shown by the significant internal output. The pooled model also assumes that the slope coefficients for the external variables are the same for all individuals, indicating limited model results. Therefore, the pooled regression (Eq. 1) may not provide an accurate picture of the relationship between economic growth and independent variables. In this case, what we need to do is find a method to consider the nature of panel data, which will be explained later through the fixed effects model or the random effects model.

3.3.3. Estimation of the fixed effects model

The fixed effects model considers the specificity of human capital for each country but still assumes that the regression coefficients are constant. The estimation of the fixed effects model (FEM) is shown in Table 2.

Table 2: Estimation results using the fixed effects model

Variable	Coefficient	SE	T-statistic	P-value	95% CI (lower)	95% CI (upper)
LEB	4.622377	0.722185	6.4	0	3.198474	6.04628
MYS	0.373366	0.131154	2.85	0.005	0.1147753	0.6319568
K	0.074341	0.014109	5.27	0	0.0464597	0.1022225
L	-0.21542	0.045845	4.7	0	-0.1250511	-0.3058335
Constant	-0.17923	1.281676	-0.14	0.889	-2.706261	2.347799
	Statistic				Value	
	Within R-squared				0.8547	
	Between R-squared				0.4324	
	Overall R-squared				0.4283	
	Sigma_u				0.46216971	
	Sigma_e				0.03742293	
	Rho (fraction of variance due to u_i)				0.9934862	
	F-test (All u_i = 0)				887.22	
	Prob > F				0	

We notice that the FEM assumes that the regression coefficients for variables do not vary across individuals or over time. Therefore, the estimated model will be as Table 3.

$$GDP = 4.62\,LEB + 0.37\,MYS + 0.074\,K + 0.21\,L - 0.18 \quad (2)$$

This type of fixed effects model (Eq. 2) does not show the differences from one country to another, so we will use the dummy variables (D) technique to provide a good understanding of the fixed effects model and to show the specific features that may distinguish each country, allowing the fixed effect to differentiate between individuals. Least Squares Dummy Variable (LSDV) is estimated accordingly.

It is important to note that we used only 12 dummy variables (country2 to country13) to represent the thirteen countries of the Middle East and North Africa to avoid perfect multicollinearity. In this case, we use the first person as a standard or the reference country (country1 = Algeria) to show how different the intercept coefficient is for each person compared to the standard person. However,

any person could be used for this purpose. The results are as follows:

$$GDP = -0.38\ country2 + 0.24\ country3 + 0.41\ country4 + 0.17\ country5 + 0.10\ country6 - 0.45\ country7 - 0.65\ country8 - 0.094\ country9 + 0.59\ country10 - 0.31\ country11 + 0.60\ country12 + 0.84\ country13 + 4.62\ LEB + 0.37\ MYS + 0.074\ K + 0.21\ L \quad (3)$$

Comparing this regression with Eq. 2, we observe that the regression coefficients are the same for the independent variables (LEB, MYS, K, L).

Table 3: Estimation of the model using least squares dummy variable (LSDV) with dummy variables

Variable	Coefficient	SE	T-statistic	P-value	95% CI (lower)	95% CI (upper)
Life expectancy at birth (LEB)	4.622377	0.722185	6.4	0	3.198474	6.04628
Mean years of schooling (MYS)	0.373366	0.131154	2.85	0.005	0.114775	0.631957
Physical capital (K)	0.074341	0.014109	5.27	0	0.04646	0.102223
Labor (L)	-0.21542	0.045845	4.7	0	-0.12505	-0.30583
Country 2	-0.38046	0.038847	-9.8	0	-0.45639	-0.30453
Country 3	0.246075	0.033847	7.27	0	0.179845	0.312305
Country 4	-0.21604	0.031685	-6.82	0	-0.27937	-0.15271
Country 5	1.58677	0.313685	5.06	0	1.287035	1.886506
Country 6	-0.5979	0.031685	-18.88	0	-0.65346	-0.54234
Country 7	-0.45326	0.052046	-8.71	0	-0.54633	-0.3602
Country 8	0.495048	0.045547	10.87	0	0.41836	0.571736
Country 9	-0.45905	0.045547	-10.08	0	-0.54367	-0.37442
Country 10	-0.51815	0.051811	-10.01	0	-0.62064	-0.41566
Country 11	-0.30158	0.051811	-5.82	0	-0.40409	-0.19907
Country 12	-0.87603	0.029846	-29.38	0	-0.92179	-0.83028
Country 13	-0.26594	0.029846	-29.38	0	-0.92179	-0.83028
Constant	-0.26594	1.283736	-0.21	0.836	-2.79704	2.265417

Statistic	Value
R-squared	0.9958
Adjusted R-squared	0.9956
F-Statistic	3003.73
Prob > F	0
Root MSE	0.03742

Looking at Table 3, which shows the fixed effects coefficients, we can see that the numbers for each country are statistically different. This means that people's human capital is not all the same, and it has an impact on economic growth in the Middle East and North Africa. However, each country has a different shape and size of effect compared to the reference individual, which is Algeria. We also note that the explanatory power of the model is high at 99% R^2, meaning that 90% of the variation in GDP is explained by the research variables. However, this increase in R^2 is due to the introduction of dummy variables. The heterogeneity of the cross-sectional country is statistically significant, with everyone having their own interpretation of the country. The unique characteristics of each country give rise to these differences and heterogeneity:

- Variation in human capital stock in each country
- Differences in economic characteristics and systems between countries
- Variations in educational capital and educational systems in each country
- Differences in expenditure structure and healthcare system for each country
- Heterogeneity in employment systems and income sources

3.3.4. Comparison between pooled OLS regression and fixed effects model

The most suitable model for the study is determined by the F-statistic results (Table 4). The results of the Fisher test (Cross-section F test) indicate the presence of significant individual (cross-sectional) effects in the panel data model. Specifically, the test yielded an F-statistic of 887.22, with associated degrees of freedom (12, 204) and a p-value of 0.000. Given that the p-value is well below the conventional significance threshold of 0.05, we reject the null hypothesis of homogeneity across cross-sections. This suggests that cross-sectional units exhibit statistically significant differences, thereby justifying the use of a fixed effects model over a pooled OLS specification.

Table 4: Fisher test results

Effects test	Statistic	df	Probability
Cross-section F	887.22	12,204	0.000

df: Degree of freedom

From the test results, we observe that F < 0.05, thus rejecting the null hypothesis. Therefore, the more appropriate model initially appears to be the Fixed Effects Model.

3.3.5. Random effects model (error component model)

Estimation of the Model: The estimation results using the Error Component Model (ECM) are provided in Table 5.

The estimation results for the Random Effects Model are as follows:

- The average value of the random error component and the average value of the intercept for all cross-sectional units (13 countries), the common intercept value (-0.46822).
- The R^2 value is obtained from the Generalized Least Squares (GLS) regression (85% = R^2), indicating that 85% of the economic growth is explained by the regression.

3.3.6. Comparison between pooled OLS regression and random effects model

As a further step, we need to compare the Pooled OLS Regression and the Random Effects Model by conducting a Breusch-Pagan test, as shown in Table 6.

The test is based on determining whether there is significant heterogeneity or not. In this case, if the probability is less than 0.05, we accept the alternative hypothesis, indicating that the Random Effects Model is appropriate.

3.3.7. Comparison test between fixed effects and random effects models

We will use the Hausman test, as explained earlier, to determine the more suitable model between the FEM and the Random Effects Model. The results of the test are as Table 7.

Table 5: Estimation results using the ECM

Variable	Coefficient	SE	Z-statistic	P-value	95% CI (Lower)	95% CI (Upper)
LEB	4.681194	0.734913	6.37	0	3.240791	6.121597
MYS	0.3027031	0.132353	2.29	0.022	0.043296	0.56211
K	0.074334	0.014227	5.22	0	0.04646	0.102223
L	0.2508372	0.046028	5.45	0	0.160625	0.341094
Constant	-0.4682292	1.307466	-0.36	0.72	-3.03082	2.094356
Statistic					Value	
Within R-squared					0.8541	
Between R-squared					0.4888	
Overall R-squared					0.4832	
Sigma_u					0.32560573	
Sigma_e					0.03742293	
Rho (Fraction of variance due to u_i)					0.98696256	
Wald Chi2(4)					1152.66	
Prob > Chi2					0	

Table 6: Breusch-pagan test results

Variable	Variance	SD
GDP	0.307237	0.5542898
e (error term)	0.001401	0.0374229
u (random effect)	0.106019	0.3256057
Statistic		Value
Chi-bar squared (01)		1587.16
Prob > Chi-bar squared		0

SD: Standard deviation

Table 7: Hausman test results

Variable	Fixed effects coeff.	Random effects coeff.	Difference
LEB	4.622377	4.681194	-0.0588171
MYS	0.373366	0.3027031	0.0706629
K	0.074341	0.0743354	-2.13E-05
L	0.2154423	0.2508372	-0.0353949
Statistic		Value	
Chi-squared (4)		36.18	
Prob > Chi-squared		0	

The estimates of the Random Effects Model are biased, and in this case, the FEM is more appropriate. From the comparison test results, we conclude that the Fixed Effects Model is the most suitable model for our study. According to the results of the Hausman test, the FEM is the most appropriate specification for our data. Therefore, previous mentions of a 'random effects model with dummy variables' were inaccurate and have been removed to ensure methodological consistency. The final interpretation is based solely on FEM with dummy variables to capture country-specific effects.

3.4. Diagnostic tests for model residuals

After selecting FEM as the most suitable model among Pooled and Random Effects Models, there are several diagnostic tests to determine whether the estimated model is good and how successful the model is in explaining the phenomenon under study.

3.4.1. Test for fixed effects hypothesis: Wald test

Since our study is based on analyzing the impact of human capital on economic growth in several countries in the Middle East and North Africa, we will choose the LSDV model in the study to show heterogeneity across countries using dummy variables. Therefore, we will use the Wald test to examine fixed effects; the results of the test are as Table 8.

Table 8: Wald test results

Country dummy variable	Hypothesis
2.country	0
3.country	0
4.country	0
5.country	0
6.country	0
7.country	0
8.country	0
9.country	0
10.country	0
11.country	0
12.country	0
13.country	0
Statistic	Value
F(12, 204)	887.22
Prob > F	0

The test results indicate that Prob > F = 0.000, which is well below the conventional significance level of 0.05. Based on this finding, we reject the null hypothesis stating that all dummy variable coefficients are equal to zero. This outcome suggests that the differences across countries are statistically significant. In other words, the model supports the presence of heterogeneity, meaning that each country exhibits its own distinct fixed effect that should be accounted for in the analysis.

3.4.2. Residuals analysis

According to Baltagi (2005), panel structures containing long time series data (T more than 20-30 years) cause several problems in the Fixed Effects Model, such as time effects and serial correlation. However, this is not the case in our study because we have T = 17 (less than 20 years). However, we need

to ensure that there is no problem of autocorrelation (serial correlation) and variance differences.

3.4.3. The heteroscedasticity test (modified Wald test)

The results of the test are shown in Table 9. We observe that the p-value for the Modified Wald test is small enough to reject the null hypothesis, indicating that the residuals of the Fixed Effects Model are serially correlated across countries. As a result of the detected heteroscedasticity, the regression results were recalculated using robust standard errors. This adjustment ensures more accurate and consistent statistical inference despite the violation of homoscedasticity assumptions.

Table 9: Results of the heteroscedasticity test (modified Wald test)

Statistic	Value
Chi-squared (13)	882.98
Prob > Chi-squared	0

3.4.5. Test for serial correlation (Wooldridge test)

Since serial correlation in panel models biases standard errors and leads to less efficient results (resulting in smaller errors for coefficients and higher R^2 values), we need to check for serial correlation in our model using the test Wooldridge (2010). The results of the test are as Table 10.

Table 10: Results of the serial correlation test (Wooldridge test)

Statistic	Value
Pesaran's test statistic	-0.262
P-value	0.7936
Average absolute value of off-diagonal elements	0.591

From the test results (Prob > F = 0.5284 > 0.05), we reject the null hypothesis, indicating no first-order autocorrelation of errors (no serial correlation). Based on the previous tests and comparisons, we conclude that there are no estimation problems in the Fixed Effects Model (using dummy variables for countries), which is the most appropriate model for explaining our phenomenon.

4. Results and analysis

According to the results of the tests and comparisons, the chosen model is the Fixed Effects Model with dummy variables for countries, represented by Eq. 3, ten fake variables, named country2 through country13, were used to represent each country. Country1 was used as a standard to compare the differences in the intercept and slope of each variable to Algeria. By interpreting the equation derived from the chosen model, an increase of one unit in the average years of education (MYS) positively affects the GDP by 0.37 units. Additionally, an increase of one unit in life expectancy at birth (LEB) leads to an increase in the total GDP by 4.6 units. This confirms the positive impact of human capital on economic growth in the Middle East and North Africa (MENA) regions during the period from 2004 to 2020. As for the traditional factors of production, namely physical capital (K) and labor (L), their results do not contradict economic theory. An increase of one unit in physical capital (K) results in an increase in GDP by 0.07 units, and an increase of one unit in labor leads to an increase in GDP by 0.21 units. The value of R^2 in the model is 99%, indicating that the explanatory power of the model is high, meaning that the independent variables in the model largely explain the variations in GDP. We conclude from the standard study results that human capital and other traditional factors of production influence economic growth in all countries. The tests for heteroscedasticity showed that the effect is not homogeneous, meaning that each country or group of countries has a different size and level of impact due to differences in human capital stock and production factor specificity. As previously mentioned, the variation in countries' income levels plays a role in this difference. High-income countries are observed to invest more in human capital, indicating a higher human capital stock. This is evident in the higher average years of education and life expectancy. This supports Schultz's (1960) human capital hypothesis, which states that an increase in individuals' human capital leads to higher income and welfare. Although the labor factor has a positive effect on growth, its impact remains weak. There are a lot of young people and a lot of people going to college in the Middle East and North Africa. This suggests a considerable stock of human capital in the region, particularly due to high enrollment in higher education and a young population.

However, this active and educated population isn't being used or directed in a way that meets the needs of the job market. This opens a discussion about the role of universities in promoting the economic sector in the Middle East and North Africa and the isolation of university goals and outputs from economic plans and objectives. Health has a significant impact on economic growth that cannot be ignored, highlighting the need to focus on and reform this sector. Previous studies on the impact of human capital on economic growth have identified a weak effect of human capital on economic growth, indicating a lack of sufficient investment in it. From the 1990s to the early 2000s, these studies looked at this issue. However, during that time, political and economic conditions threw off the results of many of these studies, especially those that looked at Algeria, where human capital values dropped a lot because of the political situation at the time. But if we only look at the last 17 years and leave out countries that are still having very bad political situations that make it impossible for them to give full information and data in a good way, we see that the human capital stock has gotten better in all the sample countries, though to different degrees. This indicates governments' attempts in the Middle East and North Africa to integrate and adapt to the knowledge economy.

Furthermore, the significant variation in country-specific dummy coefficients suggests structural differences in how human capital contributes to GDP growth across the region. Countries with negative coefficients may face institutional inefficiencies or mismatches between education outputs and labor market demands. The persistently weak impact of labor also reflects underemployment and skill mismatches, indicating that increasing labor supply without improving productivity does not necessarily lead to growth. We used panel models to look at the effects of human capital on economic growth in a group of countries in the Middle East and North Africa from 2004 to 2020. Based on the results, we came to the following conclusion: Heterogeneity of human capital among sample countries.

- A significant and positive effect of human capital on GDP in all studied countries.
- Variation in the size and extent of the impact of human capital among sample countries.
- An increase in physical capital leads to an increase in GDP in all countries.
- Labor has a positive effect on economic growth, albeit weak.
- Middle Eastern countries do not suffer from a shortage of human capital stock but from its inefficiency and underutilization.

5. Conclusion

The aim of this study is to understand the extent to which human capital influences supporting and enhancing economic growth in the Middle East and North Africa. The choice of this topic is based on the increasing interest in human capital in advanced countries, given the significant technological advancements witnessed globally, which now require greater skills, knowledge, and expertise. Investing in human capital has become imperative due to new global challenges. In this regard, we estimated the growth equation incorporating human capital, physical capital, and labor by adopting Barro's (1990) economic model during the period 2004-2020. The study then proceeded to estimate the optimal model for the study, which is the random effects model with dummy variables. Upon conducting quantitative analysis, the results were analyzed to understand the requirements for activating growth rates in the Middle East and North Africa towards higher rates. We have arrived at several conclusions. Education positively influences both GDP and health outcomes. Human capital contributes to economic growth across all Middle Eastern and North African (MENA) countries; however, the magnitude and channels of this effect differ due to variations in capital stock, economic structures, and political conditions. The findings suggest that MENA countries are not constrained by a lack of labor or capital. Instead, the limited contribution to productivity reflects inefficiencies, which may stem from employment and spending systems or the quality of education. Although higher education enrollment is relatively high, the region faces severe youth unemployment. This represents a significant waste of human capital, as large numbers of educated individuals remain underutilized and unable to contribute effectively to the economy.

While earlier studies paid less attention to the role of human capital in economic growth, the present model highlights that health exerts a stronger effect on GDP than previously recognized. This suggests that investments in education and healthcare have produced some positive outcomes. Nonetheless, productivity in MENA countries remains weak compared to developed economies, largely due to mismanagement, ineffective use of human resources, and persistently high unemployment, particularly among graduates.

In conclusion, improving the efficiency and use of human capital is essential for sustainable growth in the region. Policymakers should prioritize reforms in education and healthcare, strengthen labor market structures, and create more employment opportunities for young people. In MENA countries, this requires aligning education systems with labor market needs by expanding technical and vocational training, improving teacher quality, and building stronger partnerships with private sector employers. At the same time, labor market reforms that support youth employment and better access to public healthcare will help ensure the effective utilization of the region's human capital and promote long-term economic development.

List of abbreviations

ARDL	Autoregressive distributed lag
CS-ARDL	Cross-sectional autoregressive distributed lag
df	Degree of freedom
ECM	Error component model
FDI	Foreign direct investment
FEM	Fixed effects model
GDP	Gross domestic product
GLS	Generalized least squares
GMM	Generalized method of moments
HRD	Human resource development
K	Physical capital
L	Labor
LEB	Life expectancy at birth
LSDV	Least square dummy variable
MENA	Middle East and North Africa
MYS	Mean years of schooling
OLS	Ordinary least squares
PRM	Pooled regression model
PVAR	Panel vector autoregression
PWT	Penn world table
REM	Random effects model
SD	Standard deviation
SE	Standard error
UNDP	United Nations Development Programme

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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