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Comparison of EPI in the field of climate changes indexes in Iran and other countries in 2020 and the relationship between GDP and EPI

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Abstract

Background: This study aimed to evaluate the Environmental Performance Index (EPI) in the field of climate changes in Iran in 2020, to compare these indexes in the Middle East countries and developed countries, and to evaluate the relationship between these indexes and gross domestic product (GDP) in Iran and some of the Middle East countries, as well as 10 developed countries in the world.

Methods: Data related to the EPI in the field of climate changes and GDP were extracted from the database of the Yale University (https://epi.yale.edu) and the World Bank. The relationship between them was investigated using linear regression analysis.

Results: The results showed that in 2020, Iran was ranked fourteenth and sixth among the studied countries, in terms of carbon dioxide growth rate and black carbon growth rate, respectively. It has also been ranked first in terms of carbon dioxide from land cover. Also, Iran was ranked eleventh among the Middle East countries and developed countries in terms of methane (CH_4) growth rate and was ranked sixth among the Middle East countries in terms of greenhouse gas (GHG) per capita and 13th among all studied countries. However, a significant relationship was observed between changes in GDP with GHG emissions of EPI ($R^2 = 0.82$).

Conclusion: Based on the Iran's ranking in the field of climate change performance index, planning to reduce CHGs generation is necessary. Also, education of citizens in the field of methods to reduce greenhouse effects should be done by environmental policy makers.

Keywords: Environmental performance index, Gross domestic product, Iran, Middle East countries, Developed countries

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Introduction

Today, the issue of environmental protection and prevention of its destruction has been raised as one of the most important challenges of the international community, for which various meetings and conventions have been held (1,2). After the earth summit in Rio, various countries made great efforts to improve the performance of the environment using quantitative criteria such as pollution control and management challenges in the field of natural resources, and various investments were made in this field (3). One of these important indicators is the Environmental Performance Index (EPI). This index was published experimentally in 2006 and contains important information about the approach of different countries in the field of environmental issues and has the greatest emphasis on environmental performance. This index highlights applied policies and identifies priorities (4), and it ranks how each country manages environmental issues (5). The EPI is a key factor in increasing the world's ability to assess global movement toward environmental policy goals. It also ranks countries' performance on environmental issues in the areas of human health protection and ecosystem protection (6). The value of the EPI ranges from 0 to 100, which the value of 100 is the best and zero is the worst case (7).

The last report was published in June 2020, in which the two main areas of waste management and climate change were addressed for the first time. In this report, 32 indicators have been measured in 11 fields in 180 countries and the Islamic Republic of Iran is ranked 67th category (8). This index provides practical guidance for countries wishing to move forward by identifying

problems, objectives, pursuing trends and identifying the best policy practices to maximize environmental efficiency, and supporting efforts to achieve the United Nations Sustainable Development Goals (UN-SDGs) (7). Shamsipour et al reported that according to the EPI report in 2018, Iran was ranked sixth in the field of environmental health among 23 countries in the Islamic Republic of Iran's Vision Plan for 2023 (9). Sustainable development is the ability to meet the needs of the current generation without limiting or jeopardizing the ability of future generations to meet their own needs (10). The EPI is compared with criteria such as gross domestic product (GDP), population, area of the country, etc., the increased growth of which has caused more pressure on the environment and its destruction (3,11). According to the 2016 EPI report, almost all countries have improved their EPI score in the past decade, but countries like North America and Europe, which are currently at higher levels of performance, have not progressed as much as developing countries over the past decade (6). Tamim and Sheesh examined the relationship between economic growth and environmental performance in South Asia, Bangladesh, India, Nepal, Sri Lanka, and Pakistan, and reported that increasing the GDP growth rate has a positive effect on the EPI measures (12). The results of Hasani Sadrabadi et al showed that energy consumption and employment in the studied periods in Iran have been the stimulus for GDP, at the same time, the role of employment precedes energy consumption (13). Jafari Samimi and Ahmadpour evaluated the relationship between EPI and economic growth in the selected developed countries between 2002 and 2003 and reported that in developed countries, economic growth has a negative impact on environmental performance. Increasing economic growth in these countries leads to environmental degradation or reduced environmental quality (1). Mozayani and Morad Hasel also reported that despite the positive impact of economic growth on health promotion, if countries cannot reduce the environmental consequences of their economic growth process, a part of the positive effects of economic growth on health (approximately 4.5%) will be neutralized. This argument also applies to Iran and can have political implications (14). Babaei et al in their study of the impact of foreign investment on EPI in 2002-2012 reported that foreign direct investment has a negative and significant relationship with EPI (15). Therefore, the aim of this study was to investigate the EPIs for climate change in the country in 2020 and compare these indexes with some countries in the Middle East and developed countries. In addition, the relationship between these indexes and GDP in Iran and some countries of the Middle East, as well as 10 developed countries were studied.

Materials and Methods

The EPI is a biennial index developed by Yale University and Columbia University in collaboration with the World Economic Forum (7). Information on the EPI and GDP in the field of climate change was extracted from the epi.yale.edu database, which is one of the reference indexes in the world (16). In this descriptive-analytical study, the indexes of climate change in 2020 (including carbon dioxide growth rate, carbon dioxide from land cover, Black Carbon growth rate, CH_4 growth rate, fluorinated gas growth rate, N_2O growth rate, greenhouse gas (GHG) intensity trend and GHG per capita in Iran were studied and compared with the Middle East countries (Iran, Egypt, Iraq, Saudi Arabia, Jordan, The *United Arab Emirates* [UAE], Lebanon, Oman, Kuwait, Qatar, Bahrain, and Turkey, and no information was available on Yemen, Syria, and Palestine) as well as the 10 developed countries according to the ranking of the world's top countries in the World Bank database (https://worldbank.org), respectively in 2020 (The *United States*, China, Japan, Germany, the United Kingdom, India, France, Italy, Canada, South Korea). The studied countries in the Middle East were selected based on the economical index (GDP) and population, and also, tried to select countries based on the ratio of population to an area similar to Iran and developed countries were selected as the world bank report. Finally, the relationship between EPI and GDP was investigated using the linear regression analysis with Excel (17).

Results

According to the EPI score for each country and according to Figure 1, Iran was ranked sixth among the Middle East countries and fourteenth among all studied countries in terms of carbon dioxide production. Also, in the Middle East, Iraq and Bahrain had the lowest and highest EPI scores, respectively, and among the developed countries, India and the UK had the lowest and highest EPI scores, respectively. On the other hand, Iran has the first rank in producing carbon dioxide from land cover according to Figure 2. Figure 3 also shows that Iran in 2020 in terms of black carbon production in the Middle East after Bahrain and the UAE was ranked third and among all the Middle East countries and developed countries in this study, was ranked sixth.

According to Figure 4, Iran was ranked sixth among the Middle East countries and eleventh among all studied countries in terms of methane (CH_4) production. Also, in the Middle East, Bahrain and Turkey had the lowest and highest EPI scores, respectively, and among developed countries, China had the lowest, and Japan, Germany, the United Kingdom, France, and South Korea had the highest EPI scores. Figure 5 also shows that among the studied countries, Iran, Iraq, and South Korea are the largest producers of fluorinated gases and were ranked first. Also, Turkey among the Middle East countries, and Japan among the developed countries, had the lowest EPI

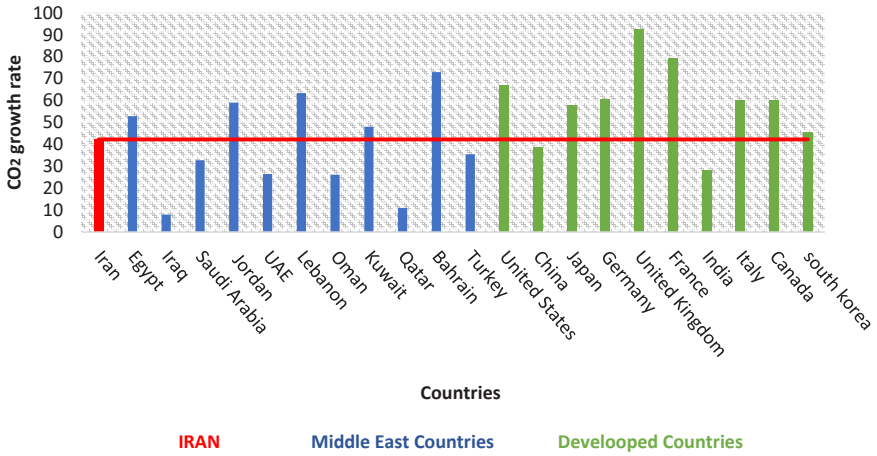

Figure 1. The EPI score of carbon dioxide growth rate in 2020 in Iran (red), compared with Middle East countries (blue) and developed countries (green)

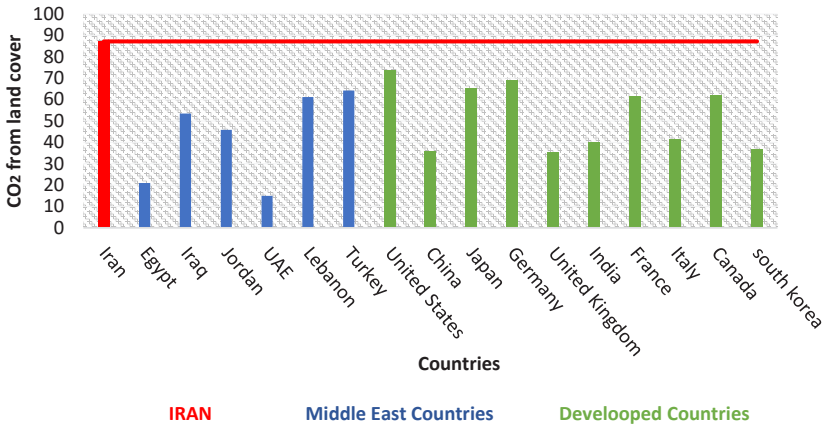

Figure 2. The EPI score of carbon dioxide from land cover in 2020 in Iran (red), compared with some Middle East countries (blue) and developed countries (green)

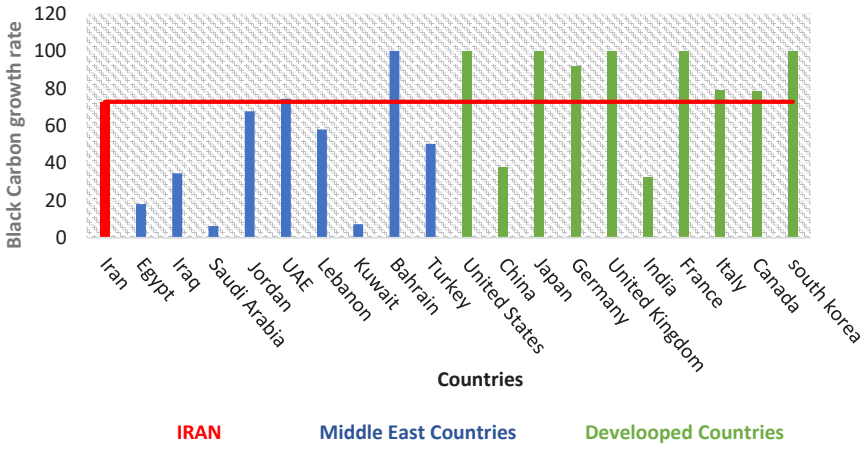

Figure 3. The EPI score of black carbon growth rate in 2020 in Iran (red), compared with some Middle East countries (blue) and developed countries (green)

score in fluorinated gases production.

Figure 6 also shows that based on the EPI score, Iran was ranked first among the Middle East countries and eighth among all studied countries in terms of nitrous oxide production. Also, in the Middle East, Oman and Iran had the lowest and highest EPI scores, respectively, and among developed countries, India had the lowest and Japan had the highest EPI scores.

According to Figure 7, Iran was ranked second among the Middle East countries after Qatar in GHG emissions. Figure 8 also shows that in terms of GHG emissions per capita among the Middle East countries, Iran was ranked

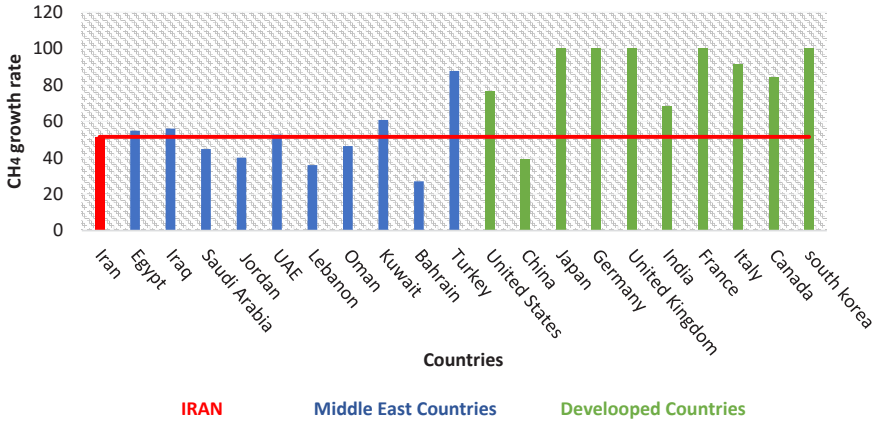

Figure 4. The EPI score of CH_4 growth rate in 2020 in Iran (red), compared with some Middle East countries (blue) and developed countries (green)

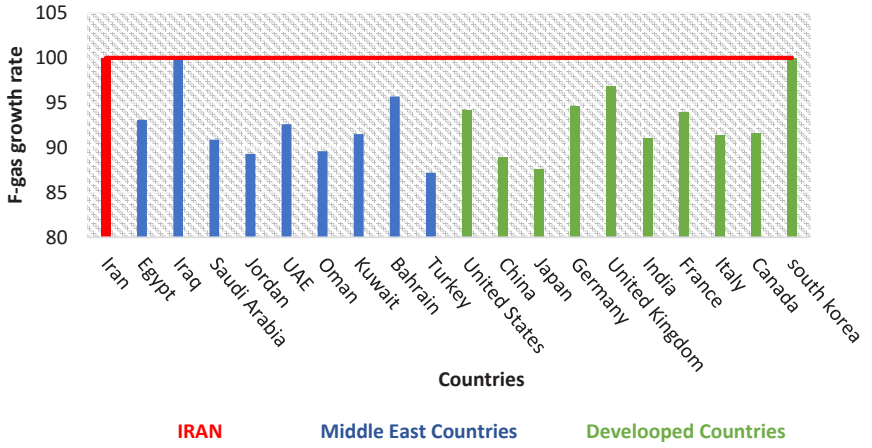

Figure 5. The EPI score of F-gas (Fluorinated GHG) growth rate in 2020 in Iran (red), compared with some Middle East countries (blue) and developed countries (green)

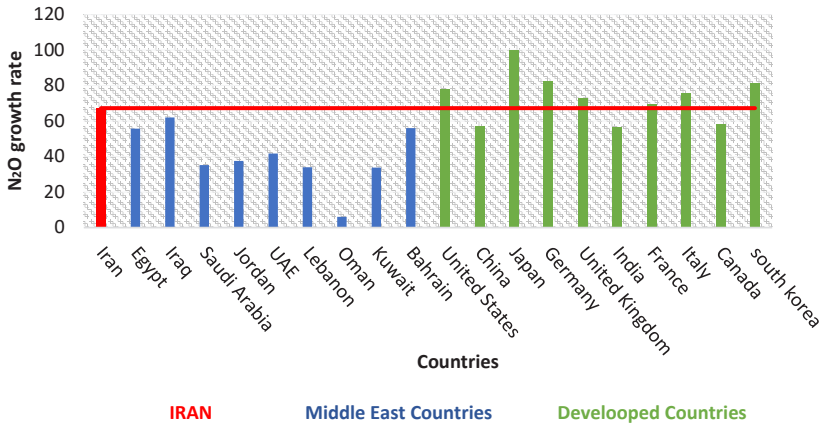

Figure 6. The EPI score of nitrous oxide growth rate in 2020 in Iran (red), compared with some Middle East countries (blue) and developed countries (green)

sixth and 13th among all studied countries.

Figure 9 shows the changes in GDP compared to the global ranking and EPI score of the studied countries in the field of climate change. Although the global ranking of these countries increased with the increase of EPI score in the studied countries, as can be seen, there was no significant relationship between changes in GDP with EPI score and global ranking.

The percentage of carbon dioxide emissions on five continents by 2020 in the 20 major carbon dioxide producing countries, shows that China and the United States are the main producers of carbon dioxide. In 2016, China and the United States were responsible for 43.3 percent of global carbon emissions, and also, controlled

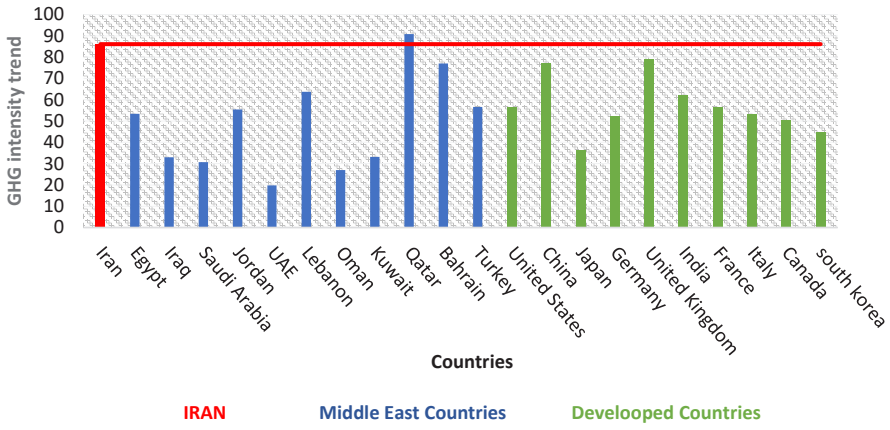

Figure 7. The EPI score of GHG intensity trend in 2020 in Iran (red), compared with the Middle East countries (blue) and developed countries (green)

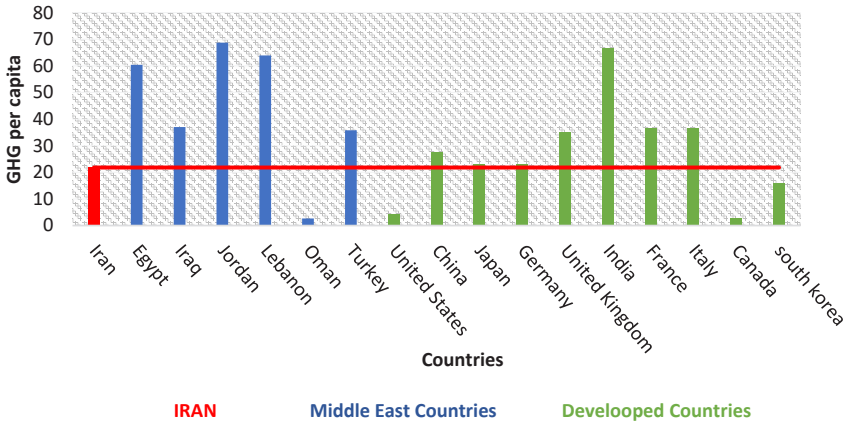

Figure 8. The EPI score of GHG per capita in 2020 in Iran (red), compared with some Middle East countries (blue) and developed countries (green)

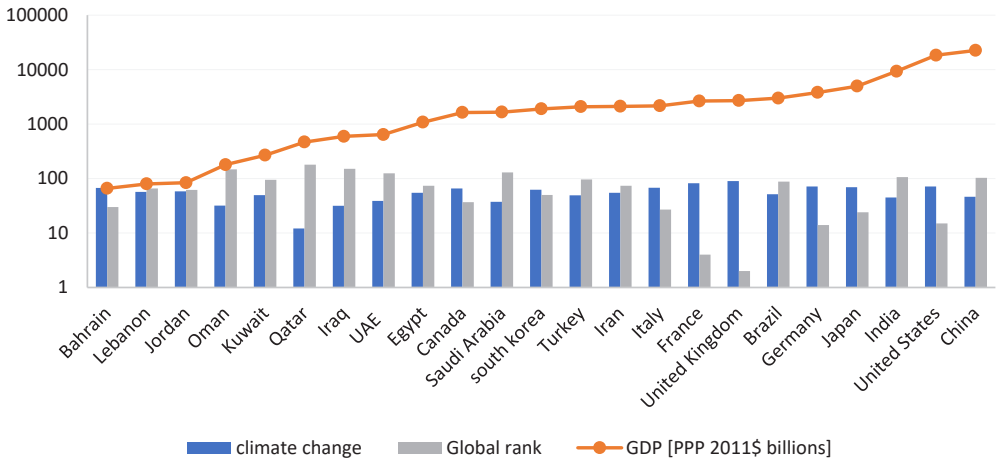

Figure 9. Global rank changes, the EPI score of Climate Change and GDP in 2020 in Iran, compared with Middle East countries and developed countries

34 percent of the global economy (18). In response to the Paris Agreement, China pledged to reduce its carbon dioxide emissions by 60 to 65 percent per unit of GDP by 2030, at a cost of 6 percent less per year (19). As shown in Figure 10, there is a significant relationship between GDP and GHG emissions ($R^2 = 0.82$). Countries with higher GDPs, such as China and the US, have higher GHG emissions, and countries with lower GDPs have lower GHG emissions.

Discussion

The relationship between economic development and environmental protection has long been considered, whether economic development creates problems for

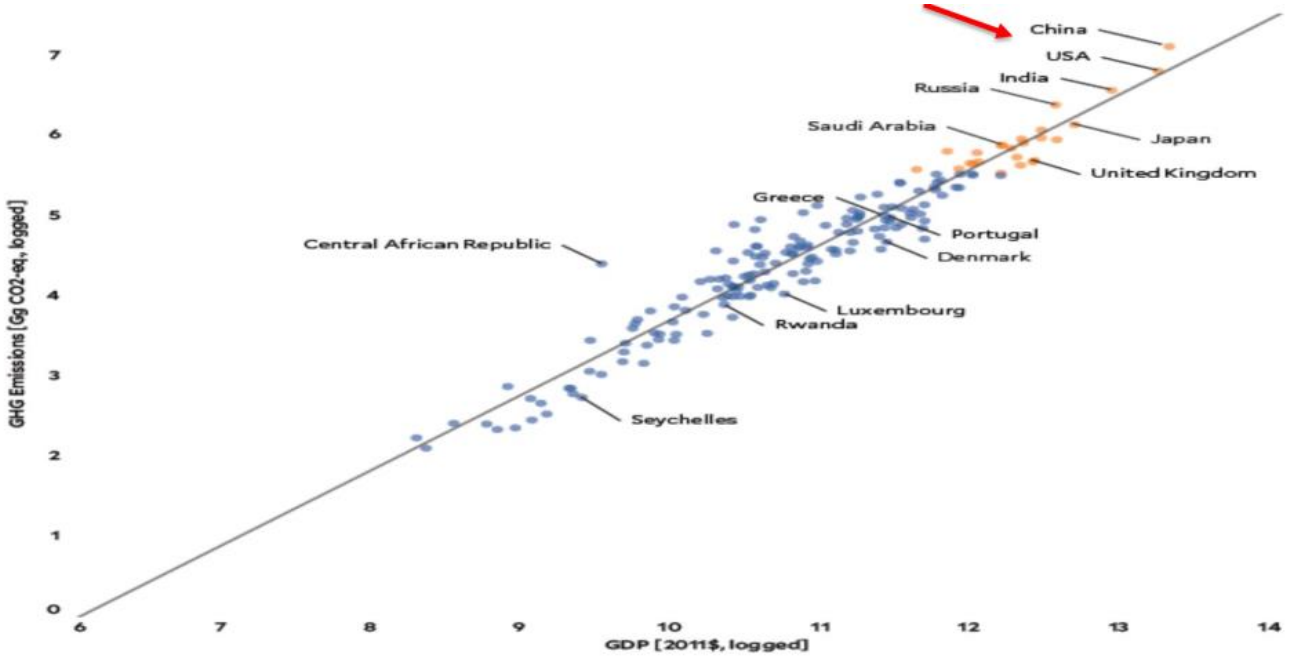

Figure 10. The relationship between countries' GHG emissions and GDP (R2 = 0.82)

environmental protection or improves the quality of the environment (20). In 1992, the World Bank report stated that some indicators, such as carbon dioxide emissions and municipal waste generation, were deteriorating as economic development progressed (21). According to the scenarios presented by the Intergovernmental Panel on Climate Change (IPCC), economic factors and the energy sector play an important role in carbon dioxide emissions. Therefore, it is important to study the impact of energy systems and economic factors on carbon dioxide emissions (22). Increasing carbon dioxide emissions as GHG have significantly contributed to global warming, especially over the past decade, as carbon dioxide accounts for 58.8 percent of total GHG emissions. Because a part of the increase in carbon dioxide emissions is attributed to economic growth, climate problems associated with increased pollution accumulation affecting the world economy have been assessed by researchers since the 1990s. Between 1967 and 2007, the final consumption of fossil fuels in Iran increased about 617 percent and carbon dioxide emissions about 610 percent (23). Iran also ranks seventh among the countries with the most carbon dioxide emissions and after Venezuela, Saudi Arabia, and Canada have the largest oil resources, and after that Russia has the largest natural gas reserves in the world (24). On the other hand, the Middle East is one of the largest suppliers of energy resources in the world, and this has led to an increase in per capita carbon dioxide emissions in the region (25). In this regard, Arfanuzzaman reported an integrated relationship between carbon dioxide emissions and per capita income in Bangladesh (26). Al-Mulali and Che Sab also studied the impact of energy consumption and carbon dioxide emissions on the GDP growth and financial development in 30 South African countries and reported that energy consumption plays an important role in increasing economic growth and financial development in the studied countries (27). In another study, they stated that carbon dioxide emissions have a long-term relationship with economic growth (28). On the other hand, Kasman and Duman considered GDP to reduce carbon emissions (29). Interestingly, studies by Salahuddin and Gow (30), Acheampong (31), Soytas et al (32) as well as Gorus and Aydin (33) provided evidence showing that GDP has no significant effect on no carbon emissions.

Yusuf et al stated that GDP has a significant positive effect on CH_4 emissions and a small positive effect on nitrous oxide emissions. This indicates that the higher the economic activity, the higher the CH_4 emissions, and consequently, the degradation of the environment (34). However, Adeel-Farooq et al analyzed the relationship between CH_4 emissions and economic growth among the six countries of the Association of Southeast Asian Nations (ASEAN) between 1985 and 2012 showed that economic growth reduced CH_4 emissions (35). The results of the study of Liobikienė et al showed that as economic conditions improve, GHG emissions will gradually increase (36). Gupta also analyzed the relationship between environmental indicators and GDP in the Organization for Economic Co-operation and Development (OECD) countries and reported that GDP grew 4 percent faster than GHG emissions and despite the significant growth in GDP, GHGs remained largely stable (37). Conte Grand also reported that GDP grew by 1.9% per year faster than GHG emissions (38). Kumar and Muhuri also stated that the concentration of carbon dioxide in

the atmosphere has increased from 280 ppm to 400 ppm, and this has increased the average global temperature by approximately 0.7°C due to the greenhouse effect. Also, the most prosperous countries are the most emitters of GHGs especially carbon dioxide, which indicates a strong relationship between GHG emissions and GDP (39). The results of the study by Zambrano-Monserrate and Fernandez showed that exports have a negative impact on nitrous oxide emissions in Germany, which shows that the production of goods for export increases GDP without environmental consequences (40). The results of the study by Haider et al also showed that increasing agricultural land use, per capita energy consumption, and economic growth will increase the level of nitrous oxide emissions (41).

Conclusion

The aim of this study was to describe the situation, the latest ranking of Iran in the field of EPIs in the category of climate change and the relationship between economic growth and climate change performance indexes in the top 10 developed countries and Middle East countries with emphasis on the position of Iran. This study, using the latest biennial data from the EPI, focused on comparing climate change patterns with the Middle East countries and developed countries, which can provide valuable information to the authorities to formulate climate change policies in the country. The results showed that in 2020, Iran was ranked fourteenth and sixth among the studied countries in terms of carbon dioxide and black carbon production, respectively. It has also been ranked first in the process of carbon dioxide from land cover. On the other hand, Iran was ranked eleventh among the Middle East countries and developed countries in CH_4 production. Also, Iran was ranked sixth among the Middle East countries in terms of per capita GHG emissions and 13th among all countries studied. In the studied countries, there was a significant relationship between GDP and climate change performance indicators. According to studies, economic growth that is generally measured by GDP and its increasing trend leads to increased energy demand and the exploitation of natural energy resources in recent decades. The widespread use of energy has degraded the environment and increased GHG emissions. Although natural levels of GHGs are essential for the normal functioning of the atmosphere and life on earth, the recent increase in population and human activities through industrialization, agricultural development, deforestation, and fuel-burning fossils have increased energy consumption and GHG emissions. On the other hand, there are also several ways to reduce GHG emissions, such as switching to renewable energy, considering solar panels, getting energy efficient-appliances, reducing, reusing, recycling, and etc. As a developing country, Iran is facing many environmental problems, as it is ranked Sixty-seventh among countries in the world in environmental indexes. Considering the position of Iran in comparison with the studied countries in the studied indicators, it can be concluded that Iran should design production and economic methods to improve climate parameters in order to improve environmental performance in the field of climate change. In this regard, it is proposed to establish strict laws to protect the environment and continuous assessment of the environmental situation in Iran.

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Ethical issues

The present study was approved by the Ethics Committee of the Vice Chancellor for Research and Technology of Mazandaran University of Medical Sciences (Ethical code: IR.MAZUMS.REC.1400.113).

Competing interests

The authors declare that they have no conflict of interests.

Authors' contribution

Conceptualization: Fathollah Gholami-Borujeni.
Data curation: Fatemeh Mortezazadeh.
Formal analysis: Fatemeh Mortezazadeh.
Funding acquisition: Soheila Amiri-Hossein.
Investigation: Fatemeh Mortezazadeh, Soheila Amiri-Hossein.
Methodology: Fatemeh Mortezazadeh, Soheila Amiri-Hossein.
Project administration: Fathollah Gholami-Borujeni.
Resources: Soheila Amiri-Hossein.
Software: Fatemeh Mortezazadeh.
Supervision: Fathollah Gholami-Borujeni.
Validation: Fatemeh Mortezazadeh.
Visualization: Fatemeh Mortezazadeh.
Writing–original draft: Fatemeh Mortezazadeh, Soheila Amiri-Hossein.
Writing–review & editing: Fatemeh Mortezazadeh, Soheila Amiri-Hossein, Fathollah Gholami-Borujeni.

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