Sectoral Growth, Exports, and Energy Consumption: A Case of Pakistan

Komal Urooj1, Muhammad Ali Zafar2

1 MPhil Scholar, Department of Economics, The Islamia University of Bahawalpur, Pakistan. Email: komalurooj03@gmail.com
2 MPhil Scholar, Department of Economics, The Islamia University of Bahawalpur, Pakistan. Email: alizaffaar@gmail.com

ABSTRACT

Economic Growth is a prominent factor to affect the energy consumption of Pakistan. This study tends to explore the influence of GDP growth of sectoral growth, agricultural, industrial, and service sector on the level of energy consumption fossil fuel in Pakistan from 1990 to 2019 long period of time. The data was obtained from WDI (World Development Indicators). ARDL (Auto Regressive Distributive Lag Model) econometric model was designed to look into the impacts of fossil fuel or energy consumption on Pakistan’s economic growth in both the short and long run. Results revealed the negative effect of energy consumption or fossil fuel use on the industry, personal expenditures, and exports of goods and the positive impact on agriculture and services, and the model is significant. These results showed that economic expansion plays an important role in increasing energy consumption in Pakistan.

KEYWORDS: Sectoral growth, Energy consumption, Fossil fuel, Economic growth, Pakistan

JEL Classification Codes: O47, Q41, R11

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1. Introduction

The agriculture sector has significantly contributed to Pakistan’s economy as it is the main and dominant sector in Pakistan. The energy demand is much higher, so traditional sources of energy production are used for the growing energy demand. Such things become critical for the growth and development of the country. A suitable stock of energy is inevitable for the fulfillment of the needs of the country. Energy is necessary to reduce poverty. Energy is necessary for the services sector and agriculture services. Sectoral growth will raise the energy demand. In agriculture, we need the energy to run tube wells and tractors. In the industrial sector, energy is used in production activities. Services sectors use energy in different forms. Energy is essential as an engine in the economic expansion of a country in the long run. Energy conservation might hinder economic expansion. Energy production and use are crucial for a nation's economic development.

Abundant use of energy resources is essential for a country's economic growth. The investor's return can be increased by maximizing the utilization of energy resources. Due to the rise in sectorial growth, per capita income increases, increasing energy demand. Coal is
the cheapest resource of energy all over the world (Satti, Hassan, Mahmood, & Shahbaz, 2014). According to estimations, the depletion time for the world’s coal resources is 14 decades. Pakistan has trillion tonnes of coal reserves that are enough to produce a surplus of electricity for many decades. Electricity produced by coal is the cheapest way in Pakistan (Government of Pakistan, 2014; SDPI, 2014). According to Shahbaz and Dube (2012), economic growth and coal consumption share a two-way relationship in Pakistan.

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Figure 1: Commercial Energy Consumption in Pakistan

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Figure 1 shows that in the case of Pakistan, the coal consumption in the Cement industry is 47.54 thousand metric tons. In contrast, in the Power sector and Brick Kilns, this consumption is 27.41 thousand metric tons and 25.04 thousand metric tons, respectively. The petroleum or oil consumption by industrial, transport, and power sectors is 6.76 thousand metric tons, 76.36 thousand metric tons, and 14.36 thousand metric tons, respectively. The agriculture and household sector use 0.08 thousand metric tons and 0.32 thousand metric tons, respectively, while the energy consumed by other government sectors use 2.13 thousand metric tons (Ahmad, Bashir, & Zafar, 2021).

The developing countries fear that low energy consumption can hinder their economic growth. Developed countries also face energy shortfalls due to increasing oil prices from the 2000s. This study seeks to establish the recently popular association between economic development and energy use. Identifying the substantial correlation between energy consumption and economic growth is necessary since energy is crucial for economic growth (Jamil & Ahmad, 2010).

Many researchers explored the relationship between these two vital factors. The results exposed two contrary arguments, and one concluded that energy impacts economic growth significantly (Abbasi, Lv, Nadeem, Khan, & Shaheen, 2020; Hondroyiannis, 2004; Lin & Liu, 2016; Shahbaz & Feridun, 2012; Tang & Shahbaz, 2013). However, according to some researchers, electricity has little impact on a nation’s economic development (Hirsh & Koomey, 2015; Soytas & Sari, 2003; Stern, Burke, & Bruns, 2019).

Concerning the policy, knowing the precise ratio and direction of the relationship between energy use and economic development is essential, which can be helpful to make the economic growth of a country strengthen (Tang & Shahbaz, 2013). This study aimed to examine the effects of sectoral expansion, agricultural, industrial, and services sector’s GDP growth of energy consumption in Pakistan.
2. Literature Review

Komal and Abbas (2015) conducted research on Pakistan's energy usage and economic growth. The outputs revealed a healthy relationship between economic growth with urbanization in Pakistan's capacity for energy consumption. On the other side, Pakistan's energy usage is significantly and highly negatively impacted by energy expenditures. In addition, Nasreen and Anwar (2014) examined how economic development in fifteen Asian nations affected energy use. In Asian countries, there was a clear inverse link between energy use and trade possibilities, economic progress, and casualties. Kourtzidis, Tzeremes, and Tzeremes (2018) examined how economic growth affected energy consumption in the United States and found that it had a favorable effect on economic development in the United States. Rafindadi (2016) conducted research to examine how economic development affects energy use in developing nations. His research showed a positive correlation between economic development and energy use in developing nations throughout the world.

Asafu-Adjaye (2000) also determined the correlation between economic development, energy prices, and energy usage at the level of developed and developing nations. The study verifies the long- and short-term relationships between the variables in the case of industrialized and emerging countries. M. K. Khan, Khan, and Rehan (2020) examined how Pakistan's economic development affected energy use. The findings showed that economic expansion had a favorable effect on energy use. Still, an increase in energy usage in the industry can become the reason for environmental degradation, which can cause health issues in the long run. Studies conducted in all GCC countries showed a bidirectional relation between energy usage and economic development both in the long and short terms (Osman, Gachino, & Hoque, 2016; Ozturk, Aslan, & Kalyoncu, 2010). A study carried out in 17 Arab nations using data from 1980 to 2011 revealed a two-way or bidirectional association between these two factors (Shahateet, 2014).

A study conducted in 11 selected oil exporting but developing countries showed that in Qatar, Nigeria, Iran, Saudi Arabia, and UAE, economic growth is influencing energy consumption as a direct relationship exists between them, while in Qatar and Saudi Arabia, a short run relationship was observed between these two variables (Mehrara, 2007). Damette and Seghir (2013) conducted a study of 5 non-OPEC (Russia, Canada, Norway, Mexico) and 7 OPEC (Angola, Algeria, Venezuela, Nigeria, Iran, UAE, Saudi Arabia) oil-exporting countries, which showed that economic development is affecting the energy usage in the long run.

Narayan and Smyth (2009) also conducted a study in six countries in the Middle East: Israel, Oman, Kuwait, Saudi Arabia, Syria, and Iran. The findings of this study showed a bidirectional relationship showing long-term and short-term relationship between economic growth and energy consumption. A study conducted in Turkish states Kazakhstan and Azerbaijan showed a panel analysis showing a bidirectional relationship between economic development and energy use over the long and short terms (Sentürk & Sataf, 2015). Rahman, Nepal, and Alam (2021) explored the impact of energy usage and economic development on the environment at the level of newly developed industrial countries from 1979–2017. The researcher used MOLS (Modified Ordinary Least Squares) to analyze data. Results revealed improvement of economic expansion in a long-run relationship, although exports have a long-term detrimental impact on energy usage. Results of Doğanlar, Mike, Kizilkaya, and Karlılar (2021) also showed a positive relationship between economic expansion on energy usage, while the research of Wang, Zhang, and Zhang (2021) revealed a negative relationship between economic consumption in long-run.

Z. A. Khan, Koondhar, Khan, Ali, and Tianjun (2021) determined the relationship between agriculture exports and energy consumption. Pakistan time series data from 1976 to 2017 was used. For the examination of partnerships in the short- and long-term, ARDL was utilized. Both in the short and long terms, exports have a positive and considerable impact on energy consumption. The study of Rehman, Ma, Irfan, and Ahmad (2020)
confirmed that exports have a significant long-term impact on energy use. The study of Ahmed and Zeshan (2014); Nazia and Normaz (2019) confirmed an important and optimistic relationship between exports on energy consumption. Liu et al. (2018) investigated the impact of sectoral expansion on energy consumption in China. Granger causality tests were applied for analysis. This study revealed a long-term but unidirectional correlation between sectoral development and energy usage. Results confirmed with research of Zhang et al. (2012) that revealed an unidirectional relationship among sectoral expansion and energy utilization.

Energy use and economic growth have been the subject of extensive investigation in the past. Environment Kuznets Curve (EKC) proposes an inverted U-shaped curve when Per Capita Income works in the opposite direction to pollution. Dasgupta, Laplante, Wang, and Wheeler (2002) explored in their research that people are concerned more with income and jobs than an unspotted environment at the initial stage of industrialization. That's why pollution increases speedily. Much stress is placed on the world environment due to the economic growth in the second phase of industrialization. The side effects of environmental pollution have been ignored because people cannot pay for the reduction. People that concerned with the environment are willing to pay and build environment-friendly policies. The EKC hypothesis identifies a link between economic expansion and environmental deterioration.

EKC hypothesis identifies a connection between economic expansion and environmental deterioration. M. Khan and Ozturk (2021) explored the immediate and long-term impacts of financial development on the environment's quality by using data from 88 selected underdeveloped nations. The research concluded that pollution holds a nature of financial development in underdeveloped areas, and output further added to two major hypotheses in those countries– the pollution heaven hypothesis and the EKC hypothesis. Where Human capital does not support CO2 emission, increasing population size is the booster of CO2 and pollution emissions. Gyamfi, Bein, Udemb, and Bekun (2021) investigated the pollution heaven theory for Sub-Saharan African oil and non-oil economies. According to Gyamfi, Bein, Udemb, and Bekun (2021) findings, FDI incursion into the region threatens the quality of the environment for the region's economies since the hypothesis mentioned above. An inverse relationship between economic growth and CO2 emissions was found by M. Khan and Ozturk (2021), which points to Pakistan's economy as an emitter.

The detrimental effects of economic growth and the use of natural resources on environmental quality were revealed by Nathaniel, Yalciner, and Bekun (2021), just like M. Ahmad et al. (2021). The second largest source of pollutant emissions in South Africa after coal use, according to Joshua and Alola (2020); Sarkodie, Ackom, Bekun, and Owusu (2020). The connection between coal use, economic expansion, and CO2 emissions in South Africa is examined by Joshua and Alola (2020). The outcome showed that the economy's largest emitter is coal use, but the FDI influx reduces CO2 emissions. M. K. Khan et al. (2020) investigated the relationship between a nation's financial progress and environmental quality in the economies of the OECD (Organization for Economic Cooperation and Development). The results showed that financial growth takes place with enhanced environmental quality and energy innovation.

Al-Mulali and Ozturk (2015) investigated the causes of environmental degradation in the MENA (Middle East and North Africa) region, which is made up of 14 economies, using the Pedroni Cointegration Test and the Modified Ordinary Least Square Approach, which is made up of 14 economies. The test's outcome shows that the relevant factors cointegrated, even if the long-term environmental quality is ultimately degraded by energy use, urbanization, trade openness, and industrial growth. However, political stability acts as a catalyst for the improvement of the environment. Fodha and Zaghdoud (2010) investigated whether EKC hypothesis supports Tunisia’s economic growth and pollutants (CO2 and SO2) for the duration 1961 to 2004.
The research results showed that GDP and CO2 excessive release have a monotonically growing connection, but SO2 and GDP have an inverted U relationship. For the Middle East and North Africa (MENA) area between 1981 and 2005, Arouri, Youssef, M'henni, and Rault (2012) looked at the connection between CO2 excretion and economic growth. Their findings suggest that all 12 MENA countries have long-run CO2-EKC; however, the turning points vary across countries, with some having very low turning points and others having very high turning points, which provides weak support for the EKC hypothesis at the national level. Ozcan (2013) examined whether the EKC hypothesis is supportive and applicable for 12 Middle Eastern Nations between 1990 and 2008. The output of this study strengthens the position of the U-shaped EKC curve in five of the nations, the inverted U-shaped EKC in three, and the lack of a fundamental relation between CO2 excretion and economic expansion in four of the target nations. According to Joshua and Alola (2020), the excessive use of fossil fuels threatens environmental quality, but the use of energy improves it.

Al-Rawashdeh, Jaradat, and Al-Shboul (2014) looked at how the EKC theory and two significant environmental contaminants, SO2 and CO2, relate to one another. On a national scale, they found that the pollutant SO2-KEC affects Turkey, Jordan, Morocco, and Yemen, while CO2 (U-shaped or inverted relationship) is also found in Turkey, Jordan, Tunisia, and Morocco; As a whole, they just found a monotonically linear and positive relation but no traces or evidence for excretions of both pollutants, SO2 and CO2 for the MENA region which includes Saudi Arabia. Farhani, Mrizak, Chaibi, and Rault (2014) also confirmed the use of the KEC hypothesis. Their study's findings demonstrate that the KEC hypothesis holds strength at the panel level but that it dissipates at the national level, indicating that Saudi Arabia's CO2 emissions are positively impacted by income and have a negative-positive effect on energy consumption as well.

A number of researches are conducted to examine the impact of remittances on energy consumption for different countries with different specifications. But in this study, we check the sector-wise impact on energy. This study used fossil fuel as the dependent variable.

3. Data and Methodology

The research collected data from 1990 to 2019 (annually). The source of the data is WDI (World Development Indicators). After data collection, data is subjected to estimation, followed by analysis and an important conclusion.

### Table 1

<table>
<thead>
<tr>
<th>Variables</th>
<th>Measurements</th>
<th>Source of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGRI (Agricultural growth)</td>
<td>Annual % Growth</td>
<td>World Development Indicators (WDI)</td>
</tr>
<tr>
<td>IND (Industrial sector growth)</td>
<td>Annual % Growth</td>
<td>WDI</td>
</tr>
<tr>
<td>SER (Services sector growth)</td>
<td>Annual % GDP</td>
<td>WDI</td>
</tr>
<tr>
<td>REMIT (remittances)</td>
<td>Annual % Growth</td>
<td>WDI</td>
</tr>
<tr>
<td>EXP (Exports of goods)</td>
<td>Annual % Growth</td>
<td>WDI</td>
</tr>
<tr>
<td>Fossil fuel energy consumption</td>
<td></td>
<td>WDI</td>
</tr>
</tbody>
</table>

3.1 Model Specifications

An econometric model is constructed in which energy consumption (Fossil fuel) is the dependent variable. The first model may be expressed as follows in the econometric form:

\[ EC = \alpha_0 + \alpha_1 AGRI + \alpha_2 IND + \alpha_3 SER + \alpha_4 REMIT + \alpha_5 EXP + \mu \] (1)

\(\alpha_0\) is intercept and \(\alpha_1\) to \(\alpha_5\) co-efficient represent the change in fossil fuel due to the change in agriculture, industries, services, exports of goods, and personal remittances and \(\mu\) indicates error term.
ARDL bounds testing model has been constructed among variables to find long-run relationships.

\[
\Delta E_{CT_t} = \theta_0 + \theta_1 AGRI_{t-1} + \theta_2 IND_{t-1} + \theta_3 SER_{t-1} + \theta_4 REMIT_{t-1} + \theta_5 EXP_{t-1} + \sum_{i=1}^{q} \sigma_1 \Delta AGRI_{t-i} + \\
\sum_{i=1}^{q} \sigma_2 \Delta IND_{t-i} + \sum_{i=1}^{q} \sigma_3 \Delta SER_{t-i} + \sum_{i=1}^{q} \sigma_4 \Delta REMIT_{t-i} + \sum_{i=1}^{q} \sigma_5 \Delta EXP_{t-i} + \mu_t
\]  

For the short-run ARDL calculations, the following ECM equation would require the form shown below (equation 2)

\[
EC_t = \sigma_0 + \sum_{i=1}^{q} \sigma_1 \Delta AGRI_{t-i} + \sum_{i=1}^{q} \sigma_2 \Delta IND_{t-i} + \sum_{i=1}^{q} \sigma_3 \Delta SER_{t-i} + \sum_{i=1}^{q} \sigma_4 \Delta REMIT_{t-i} + \sum_{i=1}^{q} \sigma_5 \Delta EXP_{t-i} + \\
\theta EC_{CT_t-1} + \mu_t
\]  

3.2 Methodological Framework

Firstly, it is vital to keep an eye on the variables' stationary levels for time series analysis. Mostly, time series data exhibits trends that imply non-stationary, due to which regression results could be spurious. At two different levels, the ADF (Augmented Dicky-Fuller) test was used to observe the stationary of the acquired data.

The co-integration has been examined using the ARDL bounds test. A conditional unconstrained ECM estimate is used as the foundation for the bounds test in a co-integration study using ordinary least squares (OLS) (Pesaran, Shin, & Smith, 2001). To utilize ARDL, the variable series must have a mixed order of integration (either I (0) or I (1)). The values of the F-statistics (provided by Pesaran, 2001) cannot be comprehended if variable(s) stationary at the second difference (i.e., with an order of integration I (2)) are present. ARDL’s coefficients describe the connection in long-run equilibrium, while ECM exhibits equilibrium throughout the long-term and short-run dynamics.

4. Conclusion and Results
4.1 Unit Root Results

According to ADF, whether the probability value is ≥ 5%, the void hypothesis accepts or rejects the alternative hypothesis, and in case of probability value is ≤ 5%, it is assumed that it rejects the alternative hypothesis. According to the results of the ADF stat, the variables have an integration order between zero and one.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>ADF Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variables</strong></td>
<td><strong>statistics of Level Test (Prob.)</strong></td>
</tr>
<tr>
<td>Fossil Fuel</td>
<td>-2.1386 (0.2319)</td>
</tr>
<tr>
<td>R.E.C</td>
<td>-2.2371 (0.1983)</td>
</tr>
<tr>
<td>Agri</td>
<td>-6.3248** (0.000)</td>
</tr>
<tr>
<td>Export</td>
<td>-4.5360** (0.0012)</td>
</tr>
<tr>
<td>Ind</td>
<td>-4.6197** (0.001)</td>
</tr>
<tr>
<td>P. W</td>
<td>-0.2444* (0.0210)</td>
</tr>
<tr>
<td>Services</td>
<td>-1.3433 (0.5956)</td>
</tr>
</tbody>
</table>

*Variable stationary at 10%
**Variable stationary at 5%
***Variable stationary at 1%
4.2 Diagnostic Tests

This study used the Breusch-Godfrey Serial Correlation LM test, which is appropriate for this model, to evaluate the autocorrelation in the given model. The table shows the results of diagnostic tests which are employed in the model. The study's findings imply that there is not any autocorrelation in this investigation. Furthermore, the Breuch-Pagan-Godfrey test's results detected no heteroskedasticity issue in this model.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Results of Diagnostics Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LM Test for Breusch-Godfrey Serial Correlation</strong></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>1.314877</td>
</tr>
<tr>
<td>Obs*R-squared</td>
<td>3.525832</td>
</tr>
<tr>
<td><strong>Heteroskedasticity Test: Breusch-Pagan-Godfrey</strong></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>0.423841</td>
</tr>
<tr>
<td>Obs*R-squared</td>
<td>3.589940</td>
</tr>
<tr>
<td>Scaled explained SS</td>
<td>2.662836</td>
</tr>
</tbody>
</table>

![Figure 2: Jarque-Bera Diagnostic Test Graphical Presentation](image)

4.3 Estimation of Short-run Relationship

The table shows the relationship between short-run dynamics. The Error Correction Term (ECM) is important in terms of statistics. The ECM value is negative (-0.577427) and significant statistically (0.006). The value of ECM (-0.577427) showed that if the model is in disequilibrium, it will move towards equilibrium with a speed of adjustment of 57%. However, ECM's negative value demonstrates the presence of a long-run relationship.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Short-run Forecasts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent Variable: Fossil Fuel Energy Consumption</strong></td>
<td></td>
</tr>
<tr>
<td>Independent variables/Agents</td>
<td>Coefficients</td>
</tr>
<tr>
<td>AGRI</td>
<td>0.143206**</td>
</tr>
<tr>
<td>IND</td>
<td>-0.393172**</td>
</tr>
<tr>
<td>SER</td>
<td>1.800199***</td>
</tr>
<tr>
<td>REMIT</td>
<td>-2.846156***</td>
</tr>
<tr>
<td>EXP</td>
<td>-0.041157**</td>
</tr>
<tr>
<td>Coint (-1)</td>
<td>-0.577427***</td>
</tr>
</tbody>
</table>

*Variable stationary at 10%
**Variable stationary at 5%
***Variable stationary at 1%
4.4 Estimation of Long-run Relationship

Table shows the connection between fossil fuel and sector of the economic Growth.

<table>
<thead>
<tr>
<th>Variables/Agents</th>
<th>Coefficients</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGRI</td>
<td>0.371522***</td>
<td>0.007</td>
</tr>
<tr>
<td>IND</td>
<td>-0.281925***</td>
<td>0.002</td>
</tr>
<tr>
<td>SER</td>
<td>0.899821***</td>
<td>0.000</td>
</tr>
<tr>
<td>REMIT</td>
<td>-0.056635*</td>
<td>0.455</td>
</tr>
<tr>
<td>EXP</td>
<td>-0.015968**</td>
<td>0.025</td>
</tr>
<tr>
<td>C</td>
<td>14.250053***</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*Variable stationary at 10%
**Variable stationary at 5%
***Variable stationary at 1%

The rise of agriculture and the use of fossil fuels is significantly and positively correlated. These findings depict that a 1% increase in agriculture growth causes fossil fuel to increase by 0.371522 in Pakistan. On the other hand, there is a strong inverse link between the use of fossil fuels and the expansion of the industry. A 1% increase in the industrial sector’s growth causes fossil fuel to 0.281925 decreases in Pakistan. A 1% increase in the growth of the services sector causes fossil fuel to 0.899821 increases in Pakistan. This result shows the significant and positive relationship between fossil fuel and services sector growth. A 1% increase in exports of goods causes fossil fuel to 0.015968 decreases in Pakistan. Results show a significant but negative relationship between fossil fuels and exports of goods. A 1% increase in personal remittances causes fossil fuel to 0.056635 decreases in Pakistan. The result shows the negative and insignificant relationship between fossil fuel and personal remittances.

5. Conclusion

This paper aims to examine the effects of sectoral and economic expansion on energy consumption. This research empirically looked at how economic expansion affects energy use and other selected variables (fossil fuel, renewable energy consumption, agriculture, industry, services, personal remittances and exports of goods) in Pakistan using the ARDL bound testing procedure proposed by Pearson Shin & Smith (2001). The primary goals of this study were to determine the impact of Pakistan's economic growth on energy or fossil fuel consumption and on the basis of the finding, suggest recommendations to improve the economy. According to our knowledge as no study was done on sector-wise economic growth's impact on energy consumption (renewable and non-renewable) in Pakistan. In this regard, data had taken from the period 1990 to 2020. Economic growth has been measured by taking a number of agriculture, industry, and services, while energy consumption is measured by the usage of fossil fuels and alternative energy, and data for target indicators were derived from WDI (world development indicators).

5.1 Recommendations for Policy Making

The study recommends implementing policy suggestions based on its results:

- It is recommended that economic growth should be managed, which will directly improve energy consumption.
- Policy authorities must take developing causalities into consideration while designing policy actions. In this respect, the energy policies must be reformed according to the relationship between energy use and economic expansion and whether a specific direction is temporary or permanent, in other words, whether it changes with time passage.
**Authors Contribution**
Komal Urooj: study design and concept, introduction, methodology, conclusion
Muhammad Ali Zafar: literature search, data collection, analysis, results, and discussion

**Conflict of Interests/Disclosures**
The authors declared no potential conflicts of interest w.r.t the research, authorship and/or publication of this article.

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