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King Abdullah Petroleum Studies and Research Center

Commentary

Key Improvements in the Saudi Aviation Sector: Exploring the Performance of the Passenger Load Factor

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Introduction

Aviation is a significant contributor to the global economy, given that it, directly and indirectly, contributes to jobs, tourism, trade, and countries' gross domestic product (GDP) (IATA 2020). However, environmental issues, technological advances, consumer behavior, energy consumption, the volume of passenger and cargo air traffic, and the liberalization of markets have challenged this sector's ability to continue as a catalyst for future economic development. The unexpected changes caused by the COVID-19 pandemic in the aviation sector, such as the drop in demand, the disruption of the airline industry, and financial losses, have acted as a wake-up call to promote sustainable pathways. The pandemic has also shown that manufacturers, airlines, and governments need to implement evidence-based solutions when trying to mitigate such disruptive events. Hence, the roadmap for a sustainable future in the aviation sector will be achieved collaboratively.

Global aviation faces serious concerns around its performance indicators related to energy consumption and the environment due to its greenhouse gas (GHG) emissions and the difficulties in finding alternative energy sources. Consequently, the sector has aimed to improve those performance indicators in recent years by considering trade-offs between technology, the different stages of flight, seat density, and the percentage of available seating capacity filled with passengers, known as the passenger load factor (PLF). For example, seat density affects the aircraft's payload and passenger carrying capacity. Both factors affect the performance of the aviation sector since they could change energy consumption, impacting operational costs and GHG emissions per passenger. Therefore, the aviation sector has tried to increase passenger numbers to increase profitability and reduce emissions. However, the COVID-19 pandemic and the measures taken to contain and prevent the spread of the virus created one of the most significant disruptive events in aviation, negatively impacting the PLF. The recovery of the PLF to its pre-crisis levels, alongside the continued goal of making aviation sustainable, will require a sustained effort.

Factors Affecting the Performance of the Aviation Sector

Overall consumption in aviation has decreased since the 1960s by 70% because of engine fuel efficiency

Aircraft manufacturers and airlines have joined forces during the last years to improve fuel efficiency in the sector by improving new technology engines,[1] aircraft fleet renewal, seat density[2] (i.e., the number of aircraft seats according to the size of the aircraft), and the percentage exactly filled (PLF). For instance, Graver and Rutherford (2021) highlight that United States (U.S.) commercial airlines improved their fuel consumption by 23% (1.5% annually) from 2005 to 2019. Previous research developed by Nygren, Aleklett, and Höök (2009) pointed to the trend of decreasing fuel consumption reported in 2007, emphasizing that overall consumption in aviation has decreased since the 1960s by 70% because of engine fuel efficiency.

[1] Engine-airframe integration, new and improved materials, material processing techniques, and advances in turbo machine technology.

[2] "Seat density" is often used interchangeably with seating capacity.

Aircraft fleet renewal is factor that affects the aviation sector's performance. The retirement of older aircraft improves the current fleet's fuel efficiency, GHG emissions, and noise levels. A study developed by (Dray et al. 2014) for the global application of fleet replacement shows that carbon dioxide (CO2) emissions could be reduced by around one-third by 2050 compared to non-policy cases where fleet renewal is not considered.

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Other important operational measures exist to reduce fuel consumption, as evidenced by Janić (1999). These include improvements to air traffic control systems, direct flights to reduce the total travel distance per passenger, optimizing the fuel efficiency of aircraft climb/descent profiles, reducing cruising speeds, harmonizing fuel prices to discourage 'tankering,' prohibiting short-distance flights, improving load factor, and reducing long taxing and towering of aircraft at the airports.

Additionally, aircraft technology plays a vital role in improving the aviation sector's performance. Technological developments in recent years have been directed at reducing fuel consumption, emissions (both gaseous and particulate) and noise. For instance, fuel consumption reduction has been achieved through new engine designs. Suder and Heidman (2018) found that the aircraft fuel burn per seat-mile decreased dramatically from 1960 to 2010 by 50% due to improved aerodynamics, weight, and engine efficiency. It is also important to note that fuel burn per available seat-kilometer (km) is typically 15% to 25% less than that of the aircraft models new models replace (IATA 2019). In conclusion, technology will continuously attempt to improve fuel efficiency since it could be one of the most important factors in reducing the sector's operational costs.

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Seat density is another important element to consider, since the greater the number of seats, the more considerable the reduction of unitary costs per passenger. Therefore, seat density and the PLF are important for the airlines' business models. Seat density is the sole responsibility of airline carriers. It could benefit fuel efficiency, as was detailed by Morrell (2009), who suggests that fuel efficiency is strongly related to seat density. Still, Morrell offers no conclusive results on the impact of the PLF.

The seat density metric has mainly been used to assess the energy used relative to the carrying capacity of passengers, expressed in seats miles. This is known as the available seat miles (ASM). Aircraft with single-class high-density layouts have up to twice the number of seats for approximately the same fuel burn per aircraft kilometer as mixed-class layouts (Kozuba and Ojciec 2019). Therefore, the PLF is significant for the assessment of aviation performance because it can be used to compare the real energy used rather than using seat density. It is clear that seat density underestimates energy consumption when it is analyzed per passenger carried.

The Passenger Load Factor (PLF) as a Key Performance Indicator

The PLF measures the percentage of available seating capacity filled with passengers, regardless of the seating capacity designation made by the airline or the cabin layout. It is instrumental in assessing the profitability of airlines since it indicates that an airline has sold most of its available seats, which allows it to divide its costs among the total passengers carried. The higher the PLF, the more an airline can spread its energy consumption and GHG emissions among passengers.

The PLF has been used to assess energy consumption concerns and GHG emissions. Arul (2014) noted that PLF was used to monetize GHG emissions. The findings shows that the GHG emissions monetization per seat changes substantially according to the number of passengers carried, the number of empty seats, and cabin class layouts. The PLF has also been used in aviation for other assessments, such as: a. analyzing its effect on establishing strategic alliances; b. assessing whether passengers travel via first, business or economy class; c. competition in the Chinese airline industry; or d. predicting airline passenger numbers. These are detailed in Steven and Merklein (2013); Miller, Lapp, and Parkinson (2019); Yun, Hongbing, and Zongcheng (2009); and Laik, Choy, and Sen (2014), respectively.

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The PLF, as a key indicator of aviation fuel consumption and GHG emissions is also a crucial indicator for other transport modes, including land transport such as cars, buses, and rail transport. For instance, the bus fuel consumption assessment carried out by Carrese, Gemma, and La Spada (2013) on two bus routes in Rome highlighted the importance of the PLF because fuel consumption can vary from 7% to 26%, thereby impacting emissions reductions significantly. However, Norhisham et al. (2020) and Bunker (2015) drew attention to the service performance achieved by the PLF, regardless of the fuel or GHG emissions, for the public bus services in West Klang Valley (Malaysia) and Brisbane (Australia), respectively. Schipper et al. (1992) also demonstrated the importance of the PLF in eight OECD countries[3] by assessing energy intensity related to the PLF of cars, buses, rail, and air transport. The results suggested that the change in energy intensities of each mode was caused by changes in the PLF, and specifically in aviation, the increasing number of larger aircraft contributed to an increased PLF. It also drew attention to the existing, underutilized, less energy-intensive modes (i.e., rail and buses), which could contribute to energy savings if modal shifts to these modes occur.

As a result, the PLF has gained importance in the aviation sector since it could be used to assess energy-related matters, aviation concerns, or crucial airline indicators. Therefore, the evolution of the PLF could shed light on the performance of the commercial aviation sector in countries such as Saudi Arabia, and its evolution could bring insights into aviation energy consumption and CO2 emissions when analyzed per passenger.

[3] United States, Japan, United Kingdom, West Germany, France, Italy, Sweden, and Norway. The study was carried out in 1992 when West Germany was a separate country.

Saudi Aviation Sector

The Saudi aviation sector has increased in size tremendously since the early 1980s, when only three airports[4] existed in Saudi Arabia (Al-Jarallah 1983), compared to the 27 airports operating in 2022 (13 international and 14 domestic), with one airport currently under construction.[5] This huge development of the aviation sector correlates to an increase in flights and passengers from 2010 to 2019, with a composite annual growth rate (CAGR) of 9%. The years 2020 and 2021 were excluded because aviation demand dropped due to the COVID-19 pandemic precautions taken in the Kingdom to contain the spread of the virus. Figure 1 shows the growth in the number of flights and passengers from 2010 to 2021. Demand peaked in 2019 with more than 103 million passengers,[6] comprised of nearly 50% domestic and 50% international.

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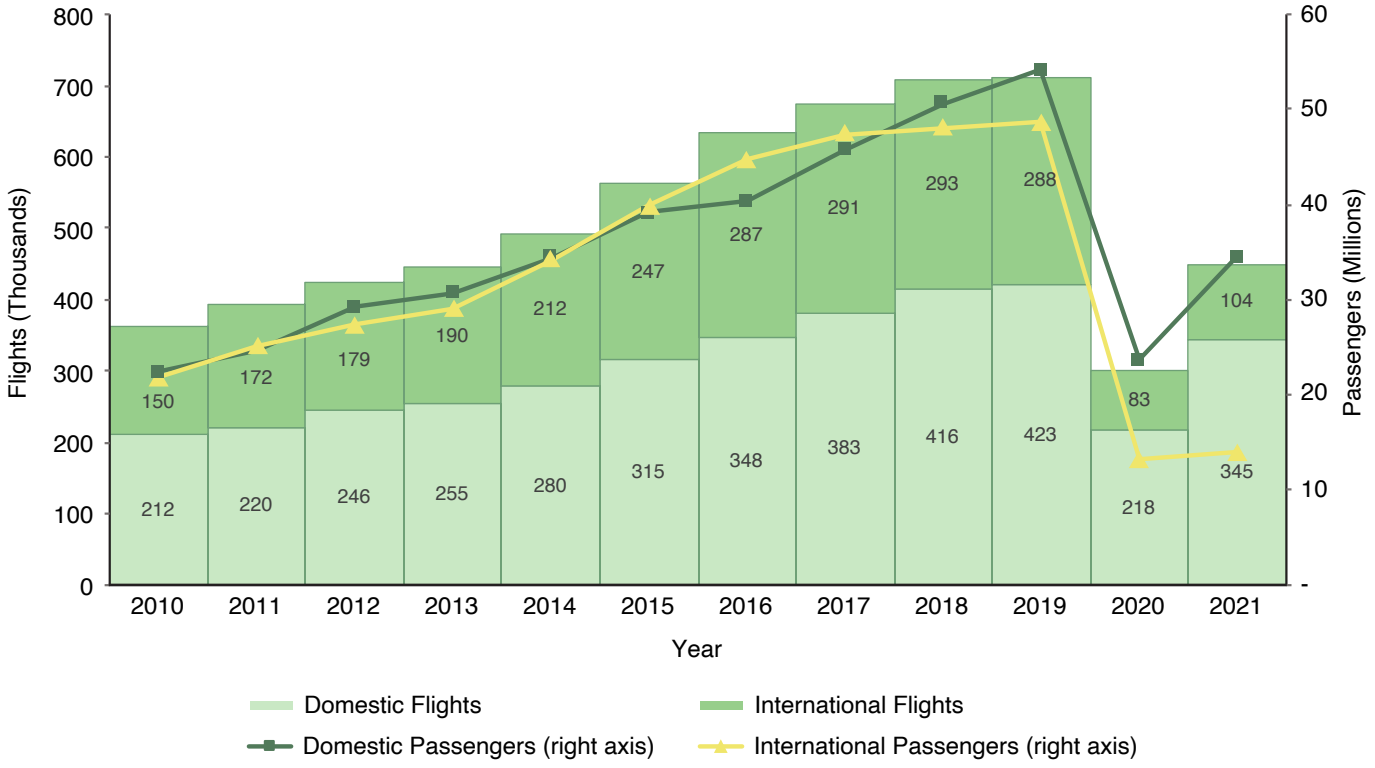
Figure 1. Evolution of the aviation sector of Saudi Arabia (2010-2021).



Source: KAPSARC Analysis based on GACA data.

[4] Located in Jeddah, Riyadh, and Dharan.

[5] As of 2022, the Red Sea Airport is under construction in the Tabuk region and is expected to be operational soon.

[6] Including departures and arrivals (49 million international passengers and 54 million domestic passengers).

Recently, the Kingdom of Saudi Arabia has established several national strategic objectives and targets, including for the aviation sector, as part of Saudi Vision 2030. One critical element of Vision 2030 is to transform the country into a logistics and global transport hub, benefiting from its strategic proximity to three continents (Asia, Africa, and Europe). The resultant supply-side changes are envisaged to transform the Kingdom's aviation sector and generate enormous demand for it in the near future. Therefore, wider concerns about energy demand and CO2 emissions will be important, motivating the study of the PLF in countries like Saudi Arabia.

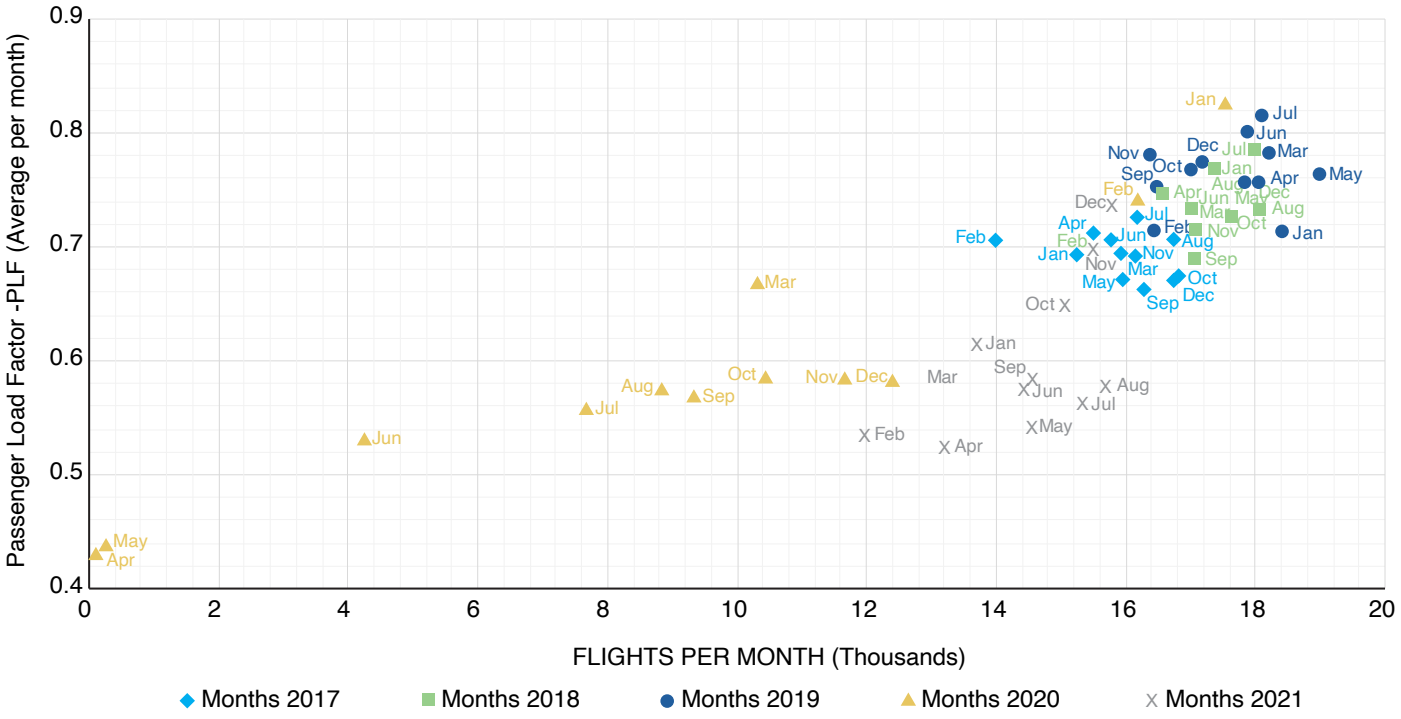
Passenger Load Factor Evolution in Saudi Arabia

The PLF conducted in this research is developed exclusively for Saudi Arabia's aviation sector. It considers the evolution in the number of flights and passengers, both domestic and international. The data for airlines and passengers in Saudi Arabia was obtained from the General Authority of Civil Aviation (2022) for the period 2017-2021, while the aircraft capacity was drawn from the airline fleet information available at Planespotters.net (2022).[7] The final data was obtained by combining the airline passengers with the maximum capacity of the corresponding aircraft fleet. It provides the average PLF per month before and after the COVID-19 pandemic in Saudi Arabia. The data also distinguishes between domestic and international air transport, as shown in **Figure 2** and **Figure 3**.

These figures depict the changes per month in the average PLF, showing that it improved every month during the pre-COVID-19 pandemic era (January 2017 to February 2020), regardless of the increase in the number of flights and whether they were domestic or international. On average, the monthly PLF for domestic flights in Saudi Arabia increased from 0.64 in 2017 to 0.71 in 2019 (pre-COVID-19 pandemic), while for international flights, it increased from 0.61 to 0.65 during the same period. The improvement in Saudi Arabia's PLF shows how the sector increased its efficiency in this key performance indicator. Even though the PLF for the Saudi aviation sector has been increasing over the years, there is still plenty of room for it to improve relative to the global PLF, which stood at 0.82 in 2019 (ICAO 2022). A higher load factor will benefit the airline industry and the related indicators across the aviation sector.

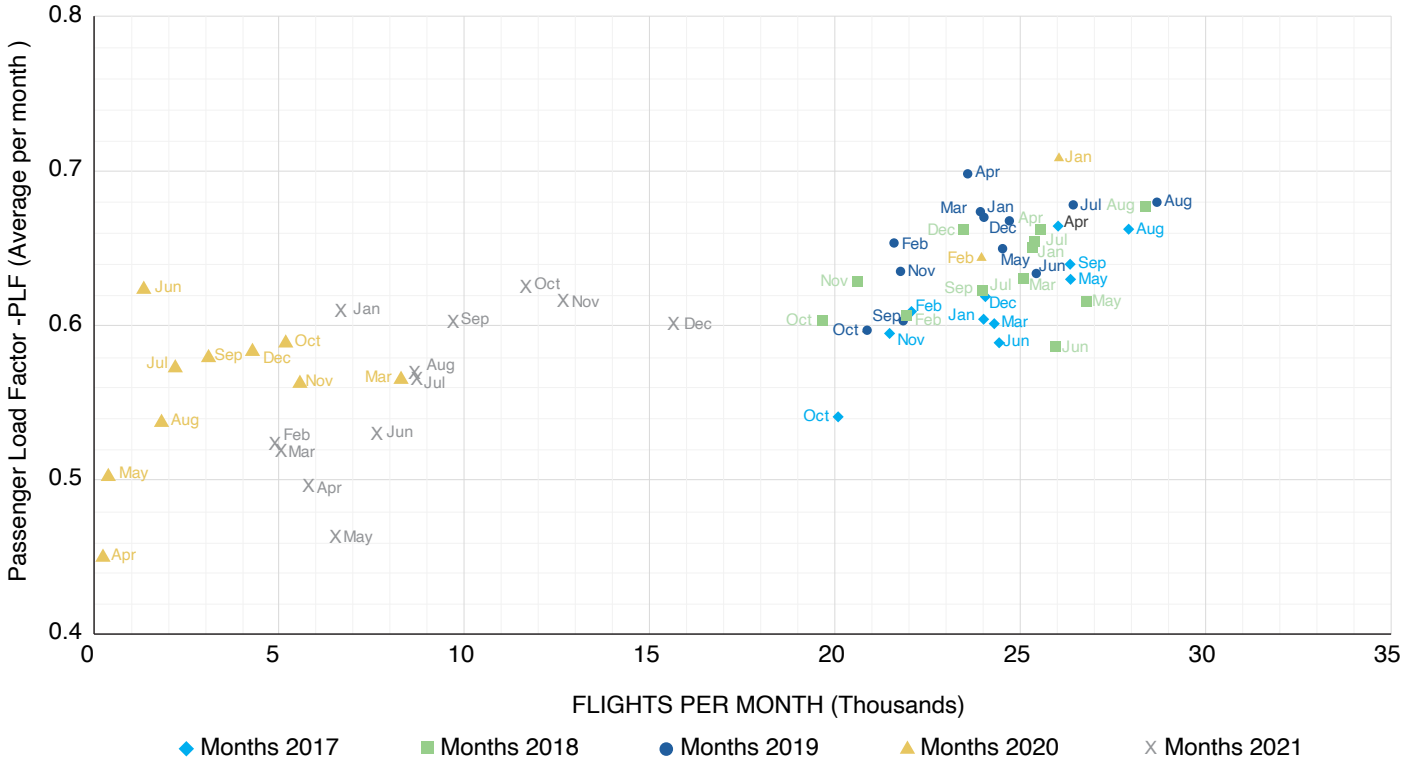
The improvement in the domestic PLF could be influenced by the entry of low-cost carriers (LCC) into the Middle East and North Africa region, including in Saudi Arabia. International LCCs have been limited to serving Gulf Cooperation Council countries rather than countries from other blocs.

Figure 2. Monthly average passenger load factor (PLF) and the total number of flights per month for domestic air transport in Saudi Arabia (2017-2021).



Source: KAPSARC analysis based on GACA data.

Figure 3. Monthly average passenger load factor (PLF) and the total number of flights per month for international air transport in Saudi Arabia (2017-2021).



Source: KAPSARC analysis based on GACA data.

During the COVID-19 pandemic (March 2020 until December 2021), the PLF for Saudi aviation remained between 0.50 and 0.60 for domestic and international transport, indicating a drop in its previous efficiency gains. However, the number of domestic flights is recovering to pre-pandemic levels, which might restore the PLF to its previous levels in the short term. The relaxation of measures at the global level seems to be continuing. For this reason, aviation in countries such as Saudi Arabia and worldwide is expected to return to pre-pandemic levels. However, the PLF will continue to be a challenging issue in aviation.

Discussion and Concluding Remarks

The PLF is a key performance indicator for the aviation sector since it analyses energy and CO2 emissions per passenger rather than per available seat. Although the seat density and cabin layout still seem out of the regulator's control, the low PLF may lead to new policies and initiatives to increase the performance of the aviation sector. The Saudi aviation sector increased its PLF before the COVID-19 pandemic, but, as expected, protective measures reduced the number of passengers per flight in 2020 and 2021. Passengers per flight in Saudi Arabia dropped dramatically by almost 50% and 36% in April 2020 for domestic and international flights, respectively.

In conclusion, the PLF in Saudi Arabia has seen significant increases in both domestic and international transport. Domestic PLF steadily increased every month from January 2017 to February 2020, but international transport improved at a slower pace due to the aircraft cabin layout and seat density provided by airlines. However, there is much room for further improvement, such as a marked increase in the PLF to values above 0.80, in line with the global average. Nevertheless, it should be noted that seat density is exclusively up to their airlines, varying across aircraft types, even if from the same manufacturer. Therefore, seat density depends on supply and demand, airline ambitions, expectations, and business models, which are beyond the scope of government policies or regulations.

Finally, the comparison between the PLF for domestic and international transport suggests that airlines could be compensating for the low PLF in international transport with higher fuel efficiency. Therefore, further research could compare the differences between the efficiency of aircfaft at higher and lower PLFs. However, the conclusion here is that improving the PLF would help decrease overall energy and GHG emissions per passenger.

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About the Project

The KAPSCARC Aviation Model project's objective is to analyze the main drivers of aviation demand and assess energy concerns by considering the current and future use of fossil- and non-fossil-based fuels. Aviation is a key transport mode worldwide. It is essential for connecting the world and generating economic growth in many other sectors. Therefore, a better understanding of aviation in countries like Saudi Arabia is necessary to illustrate how policy decisions are framed so that they continue to be a catalyst for national development. This project explores current and future aviation and energy demand scenarios to generate policy-relevant insights. The ever-increasing needs related to aviation performance, energy demand, and consumption necessitate the development of better information management tools and methodologies, models, and technologies, which this project aims to provide.

About KAPSARC

KAPSARC is an advisory think tank within global energy economics and sustainability providing advisory services to entities and authorities in the Saudi energy sector to advance Saudi Arabia's energy sector and inform global policies through evidence-based advice and applied research.

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