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# Fisheries Yield Status with Its Production and Marketing Challenges in Bangladesh

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## ABSTRACT

Bangladesh is comparatively rich in inland fishery though poor in the marine fishery. There is a lack of studies to evaluate the difference between inland and marine fisheries yield using sound statistical tests. Thus, the study objective was to evaluate the gap between inland and marine fisheries production via appropriate statistical tests along with production and marketing challenges. The Mann-Whitney-Wilcoxon U-test (MWWU) was used to check the significance level of difference, based on year-wise production from 2002 to 2021 collected from the country's fisheries department. Production and marketing challenges were summarized from the data collected through the interview of 45 respondents. There is a significant difference (*P*-value, 1.451e-11 < 0.01) between the inland and marine fisheries yield. From 2003 to 2021, the annual average fisheries production growth rate of Bangladesh was 4.83% (inland 5.32% and marine 2.65%), which was 1.86 times its population growth rate (2.57%). Bangladesh achieved its desired fish intake in 2016; however, this might not be sustained in the future because of the falling annual average growth rate ratio between production and population at 1.27 (< 1.94, FAO reference value) from 2.50 (> 1.94) after 2017. Increasing production costs, feed quality, and lack of producer organization are issues with a priority in the production process. Whereas, poor market conditions, lack of administrative area-based demand estimation techniques, and long marketing channels are the radical concerns in fish marketing. The country is going into a fisheries trade deficit condition, but its vision is to earn foreign currency and meet animal protein demand from the fishery. To achieve its vision, production and marketing challenges should be addressed.

## INTRODUCTION

Bangladesh is the 8th largest country in the world and the 5th in Asia by population size **(PopulationStat, 2023)**. Agriculture was 12.09% of its Gross Domestic Product (GDP) in FY'2020-21 **(Bangladesh Bureau of Statistics, 2022).** The contribution of the

fisheries sector was 2.54% of the GDP of Bangladesh in 2021 **(Manik, 2023)**. Either directly or indirectly, at least 12% of the country's population depends on fisheries and aquaculture-related activities for their livelihoods **(Department of Fisheries, 2020)**. The long-term Climate Risk Index shows a 28.3 score that ranks Bangladesh the 7$^{th}$ among the 10 most affected countries in the world due to climate change **(Eckstein *et al.*, 2021).** Ninety percent of global aquaculture is supplied by developing countries which are considered global climate risk hotspots **(Islam *et al.*, 2019)**. Overpopulation and climate change are main problems in Bangladesh.

In daily diet, protein consumption per person in the country was reduced to 63.80g in 2016 from 66.26g in 2010, but protein consumption from the fishery sources was grown to 11.6g in 2016 from 9.7g in 2010 **(Bangladesh Bureau of Statistics, 2019)**. In the daily diet of Bangladesh, the desired level of fish consumption per person is 60g **(Nahar *et al.*, 2013)**. The daily per capita fish consumption level of the country was 49.5g in 2010 and 42.1g in 2005 **(Bangladesh Bureau of Statistics, 2010).** The country achieved its daily fish intake requirement in 2016, which was 62.6 g per capita per day **(Bangladesh Bureau of Statistics, 2019).** The annual average of global fish consumption increased at the rate of 3.1% from 1961 to 2017; this rate is 1.94 times the annual world population growth rate (1.6%) for the same period, which means that the annual average growth ratio between the global fish consumption and the population growth rate is 1.94 **(Food and Agriculture Organization, 2020).**

Asian countries produced over 91% of the world's aquaculture production in 2017 **(Tacon, 2020)**. Bangladesh is one of the Asian hotspot countries for fisheries production because of its vast water area and favorable environment. Bangladesh has 57 major rivers that form almost 230 rivers throughout the country **(Afroz & Rahaman, 2013).** The inland water area of Bangladesh is about 45,000 km$^2$, almost 33% of its total area **(Ghose, 2014).** The country has a vast marine area of almost 118,813 km$^2$, with 81% of its total area in the Bay of Bengal **(Shuva & Uddin, 2021).** The country's coastal area is almost 32% of its total area **(Parvin *et al.*, 2017)**. It is worthnoting that the marine and coastal resources of Bangladesh are one of the most productive territories in the globe **(Afroz & Alam, 2013)**.

The perspective of the country's fisheries department is to encounter animal protein demand, decrease poverty and grow export income from the fisheries resources **(Ministry of Fisheries and Livestock, 2019).** Bangladesh exports its fishery product to more than 55 countries, where the European Union is the hub **(Shamsuzzaman *et al.*, 2017)**. However, Bangladesh is still a trade deficit country in terms of its fisheries resources which is opposite to the vision of the country. To acquire the vision of the country and sustain the required fish intake in the future, it is better to increase fisheries production. In a free-market economy, the market demand for a product plays a key role in increasing production.

In Bangladesh, there is an apparent difference between the inland and marine fisheries production trend from FY'1984-85 to FY'2018-19 **(Sunny *et al.*, 2021).** The trend of freshwater fisheries yields from 2007 to 2019 presents a production gap between freshwater capture and freshwater culture **(Hasan *et al.*, 2021).** Previous studies show the difference between inland and marine production from the sample distribution, but what about the population distribution? Here, the sample distribution means the year-wise distribution of fisheries yields estimated from the sample data. On the other hand, population distribution means the year-wise distribution of actual fisheries yields in Bangladesh. Without doing an appropriate hypothesis test, one cannot say that the estimated parameters from sample are the representative of the population. Therefore, this study was conducted to evaluate the significance level of the difference between inland and marine fisheries yields via a sound statistical test along with fisheries production and marketing challenges in Bangladesh. The objective of this study was to evaluate the difference between inland and marine fisheries yield using appropriate statistical tests to provide the actual scenario of the inland and marine fisheries production in Bangladesh. Further, it provided the production and marketing challenges in the fish industry so that policymakers can take the initiative to achieve the vision of the country.

## MATERIALS AND METHODS

To check the significance level of difference between inland and marine fisheries yields, the study relied on the non-parametric, Mann-Whitney-Wilcoxon U-test (MWWU) rather than the parametric t-test due to the data nature. The MWWU is the most widely used test for an alternative to the t-test when the data set violates the t-test assumption **(Gupta & Kapoor, 2004)**. The MWWU test has more power and efficiency than the t-test when the data set violates the normality assumption and has less than or equal to 20 observations **(Fay & Proschan, 2010).** The MWWU test has been used as an alternative to the t-test for violating the normality assumption of the data set **(Manik *et al.*, 2023)**. To understand the fisheries production and marketing challenges, the study relied on the depth interviews, a popular qualitative research technique of 45 key informants, 15 sub-districts fisheries officers of the government, 15 fish farmers, and 15 fish traders from 15 randomly selected sub-districts out of 492 of the country with an open-ended questionnaire. There were three participants, one sub-district fisheries officer, one fisherman, and one fish trader in each randomly selected sub-district.

The fishing sector is divided into two sub-sectors inland and marine; again, the inland sub-sector is the sum of two groups, inland culture and inland capture. The country has no marine culture; marine production means marine capture production. Yearly production data (2002 to 2021) and trading data (2016 to 2019) are collected from the website of the Department of Fisheries of the government of Bangladesh. For an analytical purpose, data were rearranged according to the calendar year although it was in

the fiscal year in the original data file, e.g., the yield of FY'2018-19 has been calculated as the yield of 2019. To find out fisheries production and marketing challenges, data were collected from the informers during the interview session.

## RESULTS AND DISCUSSION

### 1. Aggregate fisheries production along with human and fish population growth

Fig. (1) presents the year-wise fisheries yield trend of inland, marine and total in hundred thousand tonnes. In 2002, the total yield was 18.90 hundred thousand tonnes, whereas for inland fisheries yield, it was 14.75 hundred thousand tonnes (78.0%), and marine was 4.15 hundred thousand tonnes (22.0%). In 2021, the production reached 46.21 hundred thousand tonnes, where inland was 39.40 hundred thousand tonnes (85.3%), and marine was 6.81 hundred thousand tonnes (14.7%).

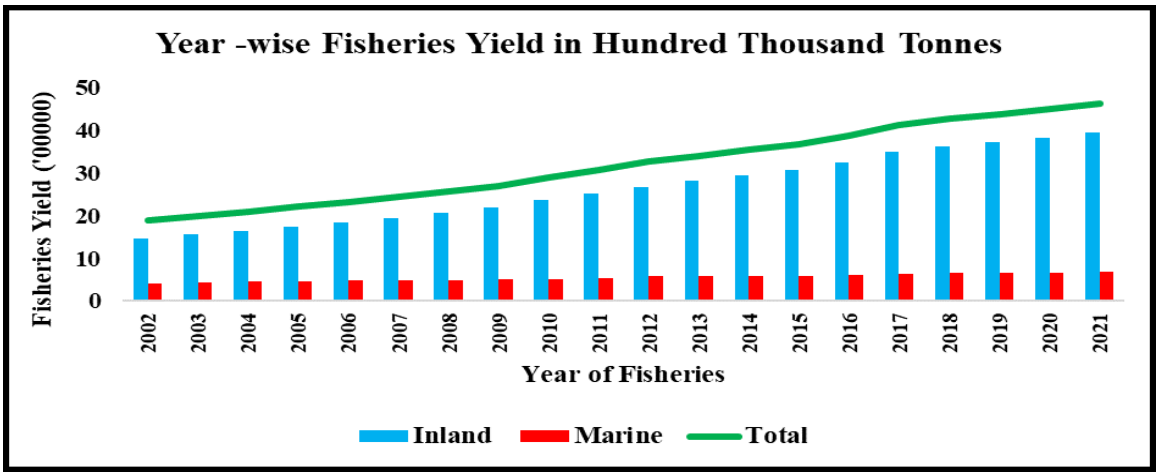


**Fig. 1.** Year-wise fisheries yield trend in Bangladesh from 2002 to 2021

Table (1) presents the year-wise fisheries yield growth rate, population growth rate, and growth ratio between fisheries yield and population growth rate from 2003 to 2021 in Bangladesh, where the population growth rate has been retrieved from the population stat (PopulationStat, 2023).

The highest fisheries growth rate was 6.60% in 2017, and the growth ratio was 2.81 in the same year. The average annual growth rate of total production was 4.83% (inland 5.32% and marine 2.65%) from 2003 to 2021; this rate is 1.86 times of average annual population growth rate (2.57%) of the country for the same period. Bangladesh achieved its per capita per day required level of fish intake in 2016, but there is slight anxiety about maintaining its required intake level in the future because of the falling average annual growth rate ratio between fisheries production and human population from 2.50 to 1.27 after the survey period. The last household income and expenditure survey in Bangladesh was conducted in 2016, and the annual average growth rate ratio of

the country was 2.50 (> 1.94, FAO reference value) from 2016 to 2017 during the survey period, but the ratio fell to 1.27 (< 1.94) from 2108 to 2021. However, the study suggests a statistical model-based time series study regarding the future sustainability issue of the required fish intake in Bangladesh.

**Table 1**. Yearly growth rate of fisheries yields and the population of Bangladesh

| Year | Inland fisheries growth (Gr.) rate% | Marine fisheries Gr. rate% | Total fisheries Gr. rate% | Population Gr. rate% | Gr. rate ratio (Fisheries/ Population) |
|---|---|---|---|---|---|
| 2003 | 6.19 | 3.97 | 5.70 | 2.95 | 1.93 |
| 2004 | 5.14 | 5.39 | 5.20 | 2.91 | 1.79 |
| 2005 | 5.74 | 4.26 | 5.42 | 2.87 | 1.89 |
| 2006 | 6.17 | 1.10 | 5.08 | 2.84 | 1.79 |
| 2007 | 5.62 | 1.59 | 4.79 | 2.80 | 1.71 |
| 2008 | 5.79 | 2.08 | 5.05 | 2.76 | 1.83 |
| 2009 | 5.86 | 3.43 | 5.39 | 2.72 | 1.98 |
| 2010 | 8.93 | 0.51 | 7.32 | 2.68 | 2.73 |
| 2011 | 5.60 | 5.62 | 5.60 | 2.64 | 2.12 |
| 2012 | 6.67 | 5.91 | 6.54 | 2.60 | 2.51 |
| 2013 | 5.15 | 1.79 | 4.55 | 2.55 | 1.79 |
| 2014 | 4.66 | 1.09 | 4.04 | 2.50 | 1.62 |
| 2015 | 4.46 | 0.75 | 3.84 | 2.45 | 1.57 |
| 2016 | 5.43 | 4.45 | 5.27 | 2.40 | 2.19 |
| 2017 | 7.54 | 1.75 | 6.60 | 2.35 | 2.81 |
| 2018 | 3.57 | 2.70 | 3.44 | 2.29 | 1.50 |
| 2019 | 2.83 | 0.80 | 2.52 | 2.23 | 1.13 |
| 2020 | 2.90 | 1.70 | 2.72 | 2.18 | 1.25 |
| 2021 | 2.81 | 1.51 | 2.62 | 2.18 | 1.20 |
| **Annual average (2003-2021)** | **5.32** | **2.65** | **4.83** | **2.57** | **1.86** |

Its production growth rate is slower than India, a neighboring country and similar fisheries hotspot, which showed an impressive annual average growth rate in fisheries yield that was 10.88% from 2015 to 2019 **(Department of Fisheries, 2022).** In the same period, the annual average growth rate of Bangladesh was only 4.33%, which is less than 50% of India. Bangladesh and India have the same geographic location along with a similar environment, but the fisheries production growth rate of India is two times higher than Bangladesh. Although fisheries yields in Bangladesh are growing, this growth rate is not satisfactory compared to India. Most fisheries production in Bangladesh comes from the pond culture. The pond culture productivity of Bangladesh is approximately 50% of China. In 2019, the pond culture productivity of Bangladesh was 4964 kg/ha, whereas the productivity of China was 8432 kg/ha **(Hu *et al.*, 2021).**

According to the "Yearbook of Fisheries Statistics of Bangladesh 2020-2021", 53.1% of inland fisheries yields come from the pond culture, while the rest 46.9% come

from all other inland fisheries sources. The country has huge scope to increase its fisheries productivity. Bangladesh has a vast marine fisheries production scope, but lack of skilled manpower, technology and research, and enough funding, the country is unable to extract these marine fisheries. Bangladesh is not having enough success to extract its marine resources from the Bay of Bangle **(Manik, 2022).** China and India are the leaders of fisheries and aquaculture in the world, thus a competitive analysis is required between Bangladesh and India, or Bangladesh and China, regarding the productivity, production area, and growth rate ratio between fisheries yield and population to conclude whether Bangladesh is doing good or satisfactory in fisheries production.

## 2. Test of measuring location

For the location test of two data sets, the t-test might be a good option if the data sets are independent and follow the normality assumption. In the study, data sets are independent. To check the normality assumption, the paper relied on a Q-Q plot. According to Fig. (2), inland fisheries yield violates the normality assumption due to the lack of goodness of fit between the Q-Q plot (red) and the Q-Q line (blue).

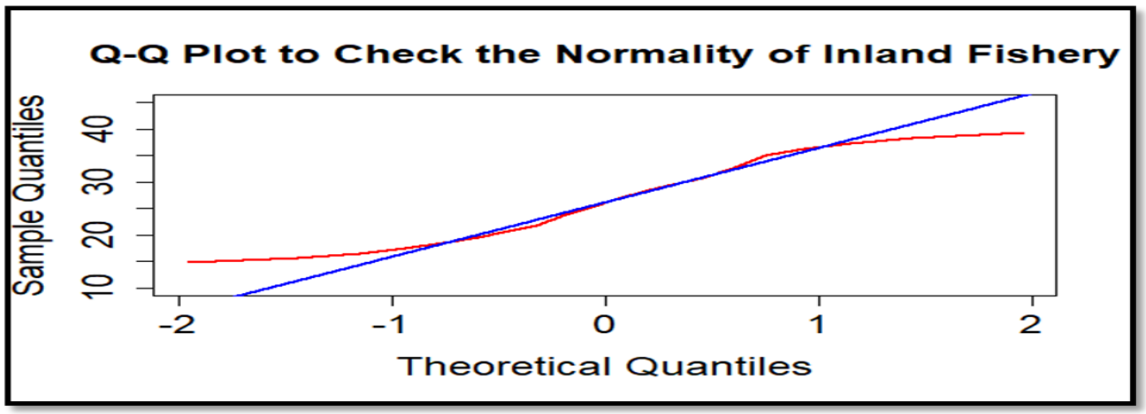


**Fig. 2.** Q-Q plot of the inland fisheries yield.

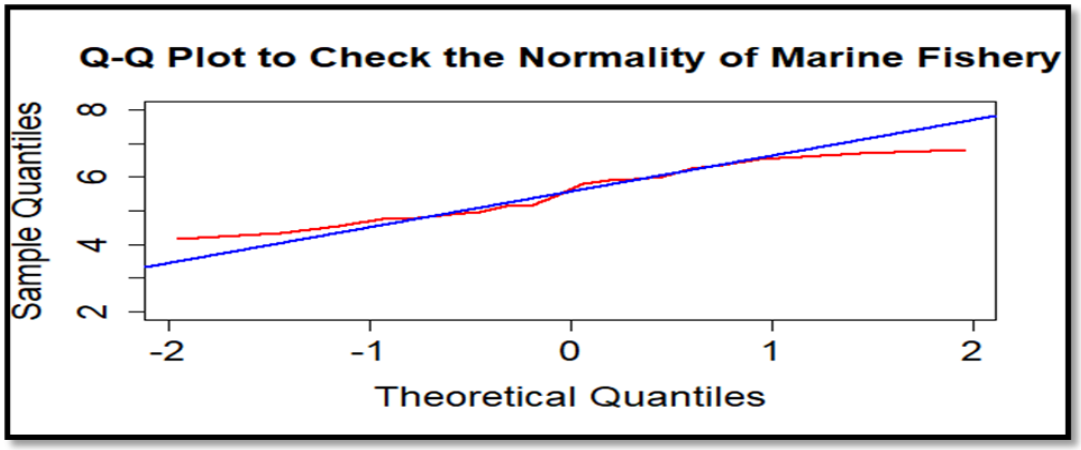


**Fig. 3.** Q-Q plot of the marine fisheries yield

According to Fig. (3), marine fisheries yield violates the normality assumption due to a lack of goodness of fit between the Q-Q plot (red) and the Q-Q line (blue).

For the violation of the normality assumption and 20 observations, the study depended on the MWWU test. The hypothesis of the MWWU test for testing equality of the median of two samples at the 1% level of significance is as follows-

$$H_0: M_1 = M_2$$
$$\text{vs.}$$
$$H_1: M_1 \neq M_2$$

Where, $M_1$ = Median of Inland Fisheries Yield
$M_2$ = Median of Marine Fisheries Yield

**Table 2.** The output of the MWWU test

| W- value | 95% CI | | *P*-value |
|---|---|---|---|
| | LL | UL | |
| 400 | 14.97366 | 25.69755 | 1.451e-11*** |
| Alternative hypothesis: true location shift is not equal to 0 | | | |
| Sample estimates: difference in location, 20.38151 | | | |

According to the output in Table (2), the null hypothesis might be rejected at the 1% level of significance since the *P*-value is 1.451e-11 < 0.01. The MWWU test concludes median yield of inland and marine fisheries differs significantly, meaning there is a significant difference between inland and marine fisheries yield in Bangladesh. Similar findings are found from the descriptive statistics in Table (3), where the median yield of inland and marine fisheries are 25.99 and 5.62 hundred thousand tonnes, respectively.

**Table 3.** Descriptive statistics of fisheries yield (hundred thousand tonnes)

| **Descriptive statistics** | **Inland fisheries** | **Marine fisheries** | **Total fisheries** |
|---|---|---|---|
| Number of observation | 20 | 20 | 20 |
| Missing value | 0 | 0 | 0 |
| Minimum value | 14.75 | 4.15 | 18.90 |
| Maximum value | 39.40 | 6.81 | 46.21 |
| Range | 24.65 | 2.66 | 27.31 |
| Sum | 527.89 | 111.14 | 639.03 |
| Median | 25.99 | 5.62 | 31.62 |
| Mean | 26.39 | 5.56 | 31.95 |
| SE. mean | 1.83 | 0.19 | 2.02 |
| CI. Mean (0.95) | 3.83 | 0.39 | 4.22 |
| Variance | 66.90 | 0.71 | 81.32 |
| Std. deviation | 8.18 | 0.84 | 9.02 |
| Coef. Var | 0.31 | 0.15 | 0.28 |

Table (4) reveals that most of the years, the country is passing within the trade deficit condition in terms of fisheries trade volume, which is the opposite of the vision of the country, growing export income from fisheries resources. To attain the vision of the country, policymakers should focus on fisheries production and marketing issues.

**Table 4.** Trade statistics of fisheries resources in Bangladesh (tonnes)

| Year | Trade balance | Total fish yield | Trade balance % of total yield |
|---|---|---|---|
| 2016 | -13,256 | 3,878,324 | -0.3 % |
| 2017 | -10,200 | 4,134,434 | -0.2 % |
| 2018 | 26,225 | 4,276,641 | 0.6 % |
| 2019 | -14,341 | 4,384,221 | -0.3 % |

## 3. Challenges in fisheries production

Increasing production cost is one of the major challenges in the fish production process. Fisheries production cost includes the cost of feeding, labor, land, management, capital investment such as fishing vessel, machine to manage oxygen in pond, and miscellaneous. To manage production and business costs, in most cases, farmers, traders, and entrepreneurs must rely on a loan from the bank, non-government organization, government, relatives, and other sources with high-interest rates. In 2016, 29.7% of the country's households received loans from different sources **(Bangladesh Bureau of Statistics, 2019)**.

A group of fisheries officers has claimed that the labelling food conversion ratio on the feed packet is not always correct. The food value of fish is decreasing day by day in Bangladesh due to a lack of good aquaculture practices, feed quality, water pollution, poor market condition, and similar things. Different hazardous metals are found at an alarming level in various commercially significant fish species in Bangladesh **(Bristy *et al.*, 2021)**. A group of informants agrees that there is lacking skilled manpower and monitoring in the industry. In addition, there is a lack of specific laws and legal authority to control coastal fisheries in Bangladesh **(Shamsuzzaman *et al.*, 2017)**.

Most informants have realized the importance of the producer organization in each sub-district to increase production, share information, and negotiate with the government and other national and international bodies. Additionally, poor knowledge about pond preparation, pond environment management, feeding system, and feed management are issues in the production process.

## 4. Challenges in fisheries marketing

A group of industry experts has claimed that fish farmers and traders use formalin, a hazardous chemical for the human body, rather than ice to preserve fish for a long time. Using ice is a common and helpful technique in trading perishable products like fish, but consumers are not generally interest in icing fish in the marketplace. In most

cases, fish farmers and traders do not know the scientific way of icing in harvesting, transportation, and the marketplace.

The market may be offline or online. This study is only devoted to the offline (physical) market. Poor market conditions, including lack of sanitation, unhygienic handling methods, shortage of ice, and poor processing units are problems in fish marketing. A group of respondents claimed, hypothetically that 3 to 10 days in a month, based on location, there is a surplus or shortage of fish in the market hampering producers or consumers. An administrative area-based demand forecasting technique might be a solution to overcome this problem. Major constraints of an effective and efficient fish market system are poor logistics systems, long marketing channels, vulnerable transport systems, unwanted or unnecessary middlemen, and illegal subscriptions in transportation and marketplaces.

On the other hand, agriculture has a high impact on the economy of Bangladesh, but the country allocates nearly 5.5% of its national budget to the agro sector **(Manik, 2023)**. The budget allocation in this sector is poor compared to its importance in the economy. To achieve future food security and better economic performance, the government of the country should allocate more budget in farming and fishing sectors.

## CONCLUSION

It was deduced from the quantitative part of the study that there is a significant difference between the inland and marine fisheries production in Bangladesh. While, the qualitative part summarizes only the production and marketing challenges based on a small sample study rather than the conclusion. However, a large-scale survey is required to conclude production and marketing issues. Moreover, this study dealt with aggregate production, thus further study is required for sector-wise production. To attain the vision of the country and maintain the future required fish intake, it must increase its production amount by solving production and marketing challenges. The production challenges might be solved by providing interest-free loans and effective training for farmers, traders, and entrepreneurs, developing producer organizations, supporting sound technologies, and ensuring strong management and legal support.

An efficient market logistic system is also required to obtain optimum social well-being from perishable products like fish. Marketing issues might be solved by developing e-markets, fish processing centers, and administrative area-based demand estimation techniques, avoiding unwanted middlemen, and illegal subscriptions. The government should take initiatives to increase fisheries production, develop efficient and effective market systems, and generate demand for Bangladeshi fisheries in the international market that may bless to the food security and sustainable economic development of the country.

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**Conflict of Interest**

The authors have no conflict of interest regarding this research.

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