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Economics of Production and Marketing of Potato (*Solanum tuberosum*) in Rasuwa District, Nepal

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Abstract Potato (*Solanum tuberosum*) is one of the important cash crops of Nepal which contributes a lot to the rural livelihood of Nepal. It accounts for 5.52 % to AGDP of Nepal. To study the economics of production and marketing attributes of potato farming, a study was conducted in Uttargaya rural municipality of Rasuwa district. Questionnaire-based household surveys along with field observations were conducted, taking in consideration a total of 60 potato farmers selected by simple random sampling method. Additionally, 10 traders were also selected to study about the marketing. Among the different varieties used by farmers, Cardinal was the most preferred (46.7%). The average cost of production was found to be NRs 209,238/ha with BCR of 2.02. The average productivity of potato in the study area was found to be 16.15mt/ha. The average gross margin per ha, market margin and producer's share were found to be NRs 206,604, 28/kg and 53.33% respectively. Similarly, four types of marketing channels were particularly identified. Five-point scaling technique was used for ranking the production and marketing problems. It identified that high cost and lack of quality inputs (I=0.87), scarcity of irrigation water (I=0.72), disease/insect/pest (I=0.78) were the major production problems whereas wholesaler's dominancy over the market (I=0.87), low market price (I=0.77) were the marketing constraints. Moreover, middlemen's dominancy influenced the farm gate price. Technical, infrastructure, government support through subsidies if provided will surely enhance the production and profitability of potato enterprise with the advantage of climatic condition of the district.

Keywords Potato (*Solanum tuberosum*); Economics; Rasuwa; Production; Marketing

Introduction

Potato (*Solanum tuberosum*) is one of the important cash crops of Nepal which contributes a lot to the rural livelihood of Nepal. It is a major vegetable crop in mid-hills and terai whereas it is a staple food crop in high hills of Nepal. It accounts for 5.52% of Agricultural Gross Domestic Product (AGDP) of Nepal in fiscal year 2021/22 (MoALD, 2022). It is considered as the fourth most important crops after wheat, rice and maize in the world (Bajracharya and Sapkota, 2017). Potato covers 198,788 ha with the production of 3,325,231 mt in Nepal (AITC, 2022). It is cultivated from 100m in southern terai to 4,000 m in northern mountains (Bajracharya and Sapkota, 2017). Its cultivation is increasing due to its wider adaptability, taste and favorable ecological requirement.

More than a billion people consumes potato every day and it is grown in more than 125 countries (Lutaladio et al., 2009). The global potato industry is going through a significant shift. Up until the early 1990s, farmers in regions like Europe, North America, and the former Soviet Union produced and consumed the majority of the world's potatoes. Since then, Asia, Europe, Africa, and South America have all seen substantial increases in potato production and consumption. A total of 376 million tons of potatoes are produced worldwide in 2021 (FAOSTAT, 2021). Similarly, land area of 18,132,694 ha is harvested globally in 2021, yielding an average of roughly 21 tons per hectare (Victoria, 2023). Potato plays a vital role in fulfilling the nutritional demand of numerous populations in the world contributing to achievement of Sustainable Development Goals (Jaganathan et al., 2020).

Potato is the major vegetable crop in terai and mid hills and a staple food in high hills of Nepal (Kafle and Shah, 2012). Potatoes are commonly grown at altitudes ranging from 100 masl in the southern Terai to 4,000 masl in the northern Himalayas of Nepal (Bajracharya and Sapkota, 2017). It is the fourth most important crop after rice,

maize and wheat in Nepal and now second staple food crop of Nepal in terms of production (Baral et al., 2021). Growing demand of potato in the form of chips, fries and other processed products have increase the potato production which has helped in increasing the living standard of small farmers (Subedi et al., 2019). Nepal's rank in potato production of world is 22nd (FAOSTAT, 2021). Even in the unfavorable climate and less cultivable land, potato provides a greater return to the farmers. However, different problems in marketing and production have affected the overall production in Nepal especially high hills (Timsina et al., 2011).

The total area dedicated to potato farming in Rasuwa is 2,606 ha with the production of 42,315 mt and productivity is 16.24 mt/ha. The production and productivity of potato is in increasing trend with depletion seen over some years (MoALD, 2022).

Farmers are unable to make a sizable profit from their produce because they lack information about the price structure. Due to the dominance of traders and middleman in the marketing channel, farmers cannot receive the profit they need to receive. Inefficient marketing system, problems in transportation has led to difficulty in marketing. Lack of improved quality seed, problem in irrigation, incidence of disease and pests, costly farm implements, availability of labor are some of the problems faced by the farmers during potato production (Subedi et al., 2019).

This study aims to comprehensively analyze the economic benefits and market dynamics of potato cultivation in Rasuwa district of Nepal. This includes evaluating the cost structure and returns of potato production, identifying key factors of potato productivity and profitability, investigating the main marketing channels and their efficiency, and determining the major challenges and constraints faced by farmers in production and marketing processes. Through these analyses, the study hopes to provide practical recommendations for policymakers, agricultural support institutions, and farmers to improve the economic viability and sustainability of potato cultivation, thereby enhancing farmer's livelihoods.

1 Materials and Methods

1.1 Site selection

The research was conducted in Rasuwa district of Nepal. Its area is 1,544 km^2. Its territory ranges from 614 to 7,227 m above mean sea level. Rasuwa had 5 rural municipalities, including Uttargaya, Kalika, Aamachhodingmo, Naukunda, Gosaikunda. The specific municipality in which the study was carried out was Uttargaya rural municipality. The site was chosen due to its ideal climatic conditions, availability of more farmers, more commercial farmers and inclusion in the PMAMP potato zone.

1.2 Sampling, data collection and analysis

Sampling frame of 104 was purposively selected considering registered potato farmers of Uttargaya rural municipality under PMAMP. Sample size of 60 was calculated from sample frame of 104 using Rao-soft software. Households were selected using simple random sampling technique. In order to analyze the market or to identify the marketing channel, marketing margin and marketing system, traders and consumers was interviewed with a sample population of 10 respondents. Household survey was performed to collect data. Both the qualitative and quantitative data obtained from the survey was analyzed by using IBM SPSS statistics 25 and Micro-soft Excel.

1.2.1 Cost of production

For the purpose of analyzing the cost of production, only the variable cost components for potato production were considered. Seeds, organic manure, chemical fertilizers, pesticides, irrigation, labor, irrigation, transportation, harvesting cost and tractor power were among the variable cost elements. The total cost of production was determined by adding up all variable input costs.

1.2.2 Gross margin analysis

Gross margin is the difference between the gross return and the incurred variable costs. Planning activities or analyzing a farm business in this way was easy and quick. For the examination of the gross margin, only variable costs were taken into account. The calculation formula is as follows:

$$GM = GR - TVC$$

Where, GM = Gross Margin; GR = Gross Return = Price of potato * Total quantity marketed; TVC = Total Variable Cost

1.2.3 Benefit-cost analysis

It is the ratio between the gross return and total cost of any business. It provides information about the investment done on the resources will give a profitable return or not. The calculation formula is as follows:

$$BCR = GR/TVC$$

Where, BCR = Benefit cost ratio; GR = Gross revenue; TVC = Total variable cost

1.2.4 Marketing margin and producer's share

Marketing margin is the difference between the farm-gate price received by the farmer and the retailer's price paid by the consumer. The calculation formula is as follows:

Marketing margin = Retailer's price (Pr) - Farmgate price (Pf)

Producer's share is the price received by the farmer expressed as a percentage of the retail price, i.e., the price paid by the consumers. The calculation formula is as follows:

Producer's share = Farm gate price (Pr)/ Retailer's price (Pf) * 100

1.2.5 Index of production and marketing problems

Scaling technique provides the direction and attitude of the respondents towards propositions. Farmer's perception towards the production and marketing problems was represented by five-point scale. The scale value of 1, 0.8, 0.6, 0.4 and 0.2 was used. 1 indicated most serious whereas 0.2 indicated least serious. The calculation formula is as follows:

$$Iimp = \Sigma \left(\frac{Sifi}{N} \right)$$

Where, Iimp = Index of importance; Σ = Summation; Si = Scale value; fi = Frequency of importance given by the respondents; N = Total number of respondents

2 Results and Analysis

2.1 Household and farm characteristics

2.1.1 Age of the respondents

Majority of the respondents in the study area were between the age group 45-55 (35%) and minimum (8.3%) were under 25 (Table 1).

2.1.2 Religion of the respondents

The study revealed that two religion groups were found namely, Hindu and Buddhist. It was revealed that 80% of the respondents were Hindu and 20% were Buddhist (Table 2).

Table 1 Age of the respondents in the study area

Age groups	Frequency	Percent (%)
Under 25	5	8.3
25-35	9	15.0
35-45	12	20.0
45-55	21	35.0
55-65	7	11.7
Above 65	6	10.0
Total	60	100.0

Source: Field survey, 2023

Table 2 Distribution of the respondents by religion in the study area

Religion	Frequency	Percent (%)
Hindu	48	80.0
Buddhist	12	20.0
Total	60	100.0

Source: Field survey, 2023

2.1.3 Ethnicity of the respondents

Out of the total respondents, 45% respondents belonged to Brahmin ethnic group, 16.67% respondent belonged to Chhetri ethnic group, 25% of respondent belonged to Janajati ethnic group, 3.33% of respondents belonged to Dalit ethnic group and 10% belonged to others (Figure 1).
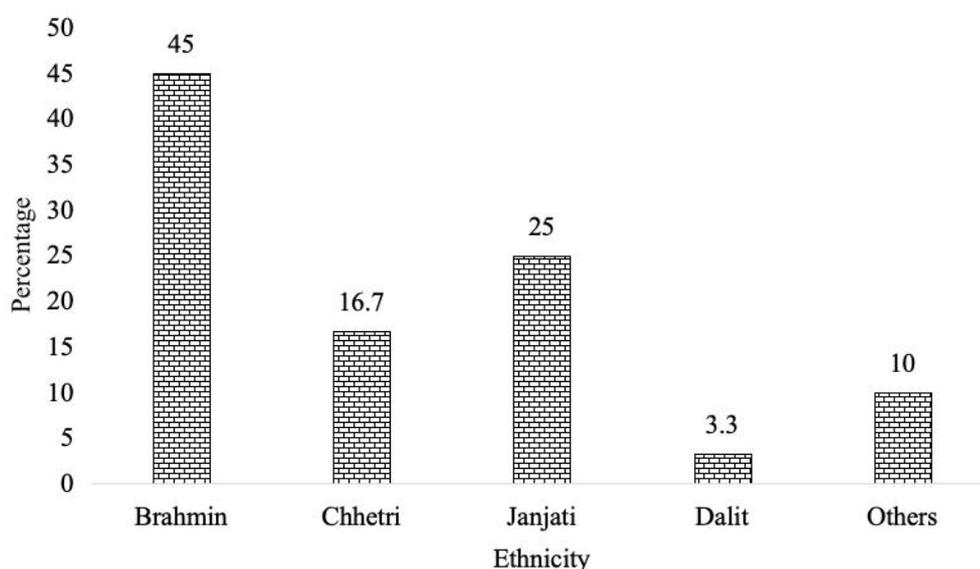

Figure 1 Ethnicity status of the respondents of the study area (Source: Field survey, 2023)

2.1.4 Education status of the respondents

The study showed that the highest 31.7% of farmers were illiterate, 25% of farmers were able to read and write, 8.3% had primary level, 6.7% of farmers had secondary level, 20% had done see, 6.7% had attained intermediate level and only 1.7% of farmers were graduate (Figure 2). Despite of being the majority of the respondents being illiterate, they were eager to learn about new techniques.
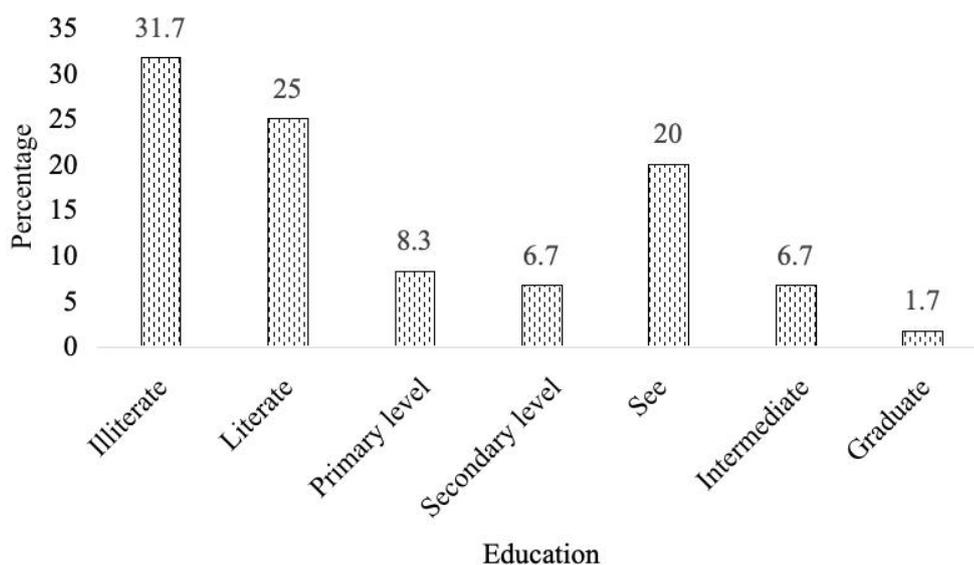
Figure 2 Educational status of the respondents in the study area (Source: Field survey, 2023)

2.1.5 Major occupation of the respondents

Majority of the respondents were involved in agriculture (71.7%) whereas 1.7% sustained their livelihood by wages. Similarly, 15% were involved in public service and 5% in business activity (Table 3).

Table 3 Distribution of the respondents by occupation in the study area

Source of income	Frequency	Percent (%)
Agriculture	47	78.3
Public service	9	15.0
Wages	1	1.7
Business	3	5.0
Total	60.0	100.0

Source: Field survey, 2023

2.1.6 Population distribution of the household

The average household size of the respondents was found to be 5.78 persons per household in the study area which was higher than the district average 4.19 persons per household (CBS, 2021) with a minimum of 1 and maximum of 11 persons per household in the study area. Both male and female members of the family were equally involved in potato farming. In the study area, average male and female members involved in potato farming was found to be 1.4 and 1.35 per household (Table 4).

Table 4 Population distribution in the study area

Members in family	Frequency	Percent (%)
Up to 4 (small)	29	48.3
5-8 (medium)	24	40.0
More than 8 (large)	7	11.7
Total	60	100.0
Mean	5.7833	-
Standard deviation	1.99229	-
Maximum	1.00	-
Minimum	11.00	-

Source: Field survey, 2023

2.2 Economics of potato production

The average cost of production in the study area was found to NRs 209,238/ha with BCR of 2.02. BCR >1 indicated that the potato enterprise was profitable in the study area. The average productivity of potato was found to be 16.15mt/ha in the study area. The average gross margin per ha was found to be NRs 206,604. The average rate at which potato was sold was found to be NRs 32/kg.

2.2.1 Operational costs

The total cost of production was found to be NRs 209,238/ha (in average) in the study area. Clearly, highest portion of the total production cost was attributed by labor cost alone (24.31%) followed by chemical fertilizers (17.1%) suggesting that the wage rate and rate of fertilizers was high in the study area. Alone labor and chemical fertilizer cost accounted for 41.41% of the total cost. Labor was used for performing different operations such as planting, weeding, fertilization application, earthing up, harvesting, loading/unloading and marketing. Field preparation, organic manure, tuber cost, irrigation cost, pesticide cost, harvesting cost, transportation cost, storage cost accounted for 12.13%, 4.02%, 10.92%, 1.85%, 7.47%, 13.37%, 6.77%, 2.002%, respectively of the total cost in the study (Table 5).

Table 5 Total cost distribution of potato in the study area per hectare

Items	Average cost (NRs/ha)	Contribution to total cost (%)
Field preparation	25387.678	12.13
Organic manure	8416.73	4.02
Chemical fertilizers	35736.5	17.1
Tuber cost	22867.8	10.92
Labor cost	50882.1	24.31
Irrigation cost	3889.46	1.85
Pesticide cost	15640.9	7.47
Harvesting cost	27985.9	13.37
Transportation cost	14182.1	6.77
Storage cost	4188.94	2.002
Total	209238	100

Source: Field survey, 2023

2.2.2 Gross returns, gross margin, BCR

Gross margin = Gross return - Total variable cost = NRs (206,604)
Benefit cost ratio = Gross revenue / Total cost = 2.02

Where, Total cost of potato production (NRs/ha) = 209,238; Total revenue from potato production (NRs/ha) = 415,842

3.2.3 Marketing margin and Producer's share

Market margin is termed as the difference between the price paid by the consumer and price received by the farmers. Similarly, producer's share is the proportion of the consumer's payment received by the producers. Lower marketing margin and higher producer's share ensures efficiency of marketing system hence they are the indicators of efficiency of existing marketing system. The marketing margin was found to be NRs 28/kg.

Market margin = Consumer's price (Pc) - Price received by the farmers (Pf) = NRs (28/kg)
Producer's share= Pf/Pc * 100% = 53.33%

Where, Pc = 60; Pf = 32

2.3 Marketing

It was found that potato growers sold their produce in bulk to local collectors mainly and supplied the produce to other nearby districts like Kathmandu, Nuwakot, Chitwan, Dhading. Some potato growers directly sold their produce to local consumers and consumers especially of Nuwakot district.

2.3.1 Primarily sale of potato

The main actors that played role in the marketing of potato in the study area were local collectors, wholesalers, retailers and cooperatives. 50% potato farmers sold their produce to local collectors who collected it in bulk and sold to the wholesalers or nearby market. Few sold their produce (5%) directly to retailers. Farmers who purchased their seed tubers and other inputs for potato production were mainly found to be selling their produce to cooperatives. Especially, the farmers of the area where easy transportation facility were unavailable sold their potato to local consumers (15%) (Figure 3).
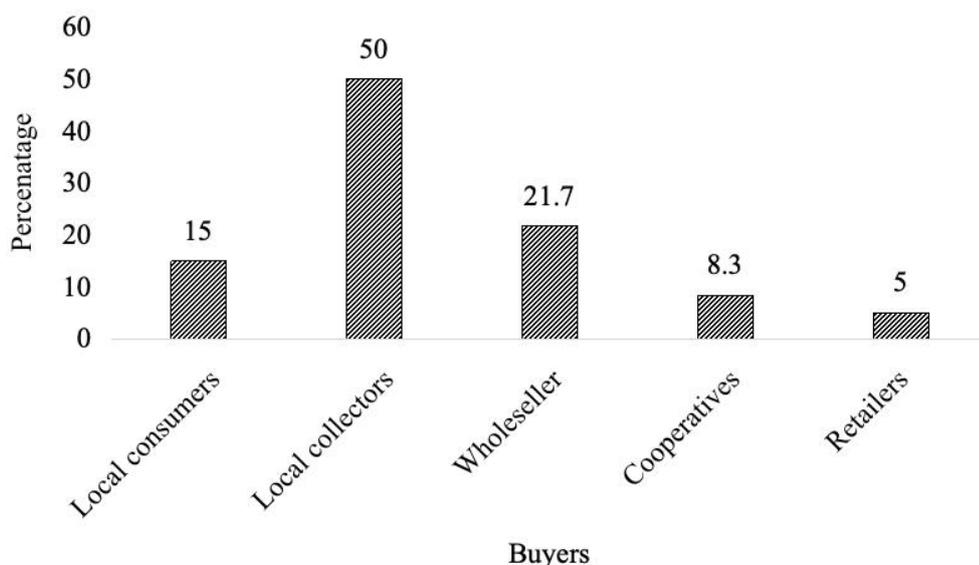

Figure 3 Sale of potatoes to different buyers (Source: Field survey, 2023)

2.3.2 Marketing channels

Marketing channel is the sequence of intermediaries or middlemen, and markets through which produce pass from producers to final consumers. Marketing channel makes sure that the goods and services are distributed from producers to consumers by involving a number of middlemen. Mainly, four marketing channels were found to be used as follows (Figure 4).
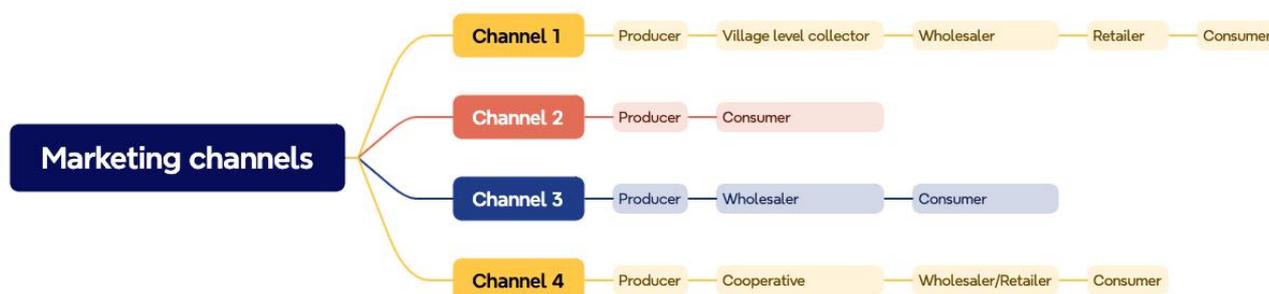

Figure 4 Four marketing Channels (Source: Field survey, 2023)

In the study area, among the channels given above, channel 1 is mostly used (24%). However, channel 3 (17%) is also frequently used. Some farmers directly sell their produce to local consumers (15%). 4% used channel 4.

2.4 Ranking constraints of potato production and marketing in the study area

Five-point scaling technique was used to determine the seriousness and for ranking the production and marketing constraints faced by the farmers. The scale value of 1, 0.8, 0.6, 0.4 and 0.2 was used. 1 indicated most serious, 0.8 indicated serious, 0.6 indicated moderate, 0.4 indicated a little bit whereas 0.2 indicated least serious.

2.4.1 Potato production constraints

High cost and lack of quality inputs, scarcity of irrigation water, disease mostly potato late blight, insect problem like red ant, potato tuber moth were some of the major production problems faced by farmers. It was revealed that clearly high cost and lack of quality inputs was a primary concern (I=0.87) followed by disease/insect/pest problem (I=0.78), scarcity of irrigation water (I=0.72), labor shortage (I=0.31) and natural hazards at the lowest level (I=0.27) in the study area (Table 6).

Table 6 Ranking of production problems of potato growers in the study area

Items	Intensity of problems					Weight	Index	Rank
	1	0.8	0.6	0.4	0.2			
Disease/Insect/Pest problem	7	37	14	2	0	46.8	0.78	II
Scarcity of irrigation water	11	14	32	3	0	43.2	0.72	III
High cost and lack of quality inputs	38	8	11	3	0	52.2	0.87	I
Natural hazards	0	0	1	18	41	16.2	0.27	V
Labor shortage	2	1	2	36	19	18.6	0.31	IV

Source: Field survey, 2023

2.4.2 Marketing constraints

Wholesalers/retailers dominancy over market, low market price was some of the major marketing problems faced by farmers. It was revealed that clearly wholesalers/retailers' dominancy over market was of primary concern (I = 0.87) followed by low market price (I = 0.77), lack of market information (I = 0.7), transportation problem (I = 0.41) and lack of shortage at the lowest level (I = 0.32) in the study area (Table 7).

Table 7 Ranking of marketing problems in the study area

Items	Intensity of problem					Weight	Index	Rank
	1	0.8	0.6	0.4	0.2			
Low market price	12	27	18	2	1	46.2	0.77	II
Lack of market information	11	18	21	6	4	42	0.7	III
Wholesalers/retailers dominancy over market	34	12	11	2	1	52.2	0.87	I
Transportation problem	2	3	6	31	18	24.6	0.41	IV
Lack of storage	0	2	4	19	35	19.2	0.32	V

Source: Field survey, 2023

3 Concluding Remarks

Gross margin being positive, benefit cost ratio 2.02 that is greater than 1 show that potato cultivation is a profitable enterprise in Rasuwa. The average productivity in the study area was found to close with the district's productivity. Chemical fertilizers and labor cost accounts the higher portion of the total cost. Farmers were not so knowledgeable about the price structure and had weak bargaining power.

Therefore, if the farm gate price is provided more, profit maximization would occur. A major volume of the produce is sold to local collectors in bulk. Middlemen plays a crucial role so farmers could not receive the profit they need to. Major problems are high cost and lack of quality inputs and low market price. Late blight of potato, potato moth attack during storage, monkey attack, lack of irrigation water, costly inputs were some of the major problems faced by the farmers.

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results and manuscript preparation. KT and PKS contributed to manuscript preparation. All authors read and approved the final manuscript.

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Conflict of Interest Disclosure

The authors affirm that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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