



RESEARCH ARTICLE

# Cost and return analysis of jowar crop in Bundelkhand region of Uttar Pradesh

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## Abstract

The current study examines the land distribution pattern, cultivation costs and profitability of jowar crop growers across various farm-size groups. A total of 180 households that grow jowar were surveyed and divided into: marginal [69], small [47], medium [43] and large [21] farms. According to the where cultivation of jowar is being done land distribution, there were 412 hectares (ha) of total land, with an average land holding of 2.29 ha. There was significant variation in land holding among jowar cultivators in the study area, ranging from 0.78 ha in marginal farms to 6.74 ha in large farms. The per-hectare cost rises with farm size, from ₹25138.98 for marginal farms to ₹27323.78 for large farms, with an average cost of cultivation (CoC) was ₹25655.37. According to CoC analysis, particularly on marginal farms where family labor utilization was highest (17.40 %), human labor formed a significant cost component. The cost structure shows that medium and large farms invest more on hiring labor and fixed capital, marginal and small farmers rely more on families for labor. As farm size grows, profitability analysis shows a tendency of diminishing net income. Large farms had the lowest net revenue (₹29240.22/ha), while marginal farms had the highest (₹35721.02/ha). Similar trends were seen in the input-output ratio, which was lowest for large farms (3.78) and greatest for marginal farms (5.24 on Cost A1). Additionally, the benefit-cost ratio decreases from 1.42 for marginal farms to 1.07 for large farms.

**Keywords:** Bundelkhand; cost and return analysis; jowar; millets

## Introduction

A sizable section of the Indian population depends on agriculture, which continues to be the foundation of the country's economy. In this regard, coarse cereals often referred to as nutri-cereals are essential for guaranteeing food and nutritional security, especially in the arid and semi-arid areas of the nation (1). Jowar is the 5<sup>th</sup> most important cereal after maize, rice, wheat and barley, making it one of the most important crops in the world. Jowar is a major crop in dryland agriculture and the main source of food, feed and fodder because of its remarkable resistance to heat and drought. Its versatility makes it indispensable in regions where other basic cereals find it difficult to flourish, providing rural inhabitants with food as well as an essential component for industrial and livestock use (2).

Although its percentage of worldwide output varies, India is one of the world's top producers of jowar at the national level. Jowar production has demonstrated some resilience, especially in its important growing states, despite a general long-term drop in the area under coarse cereals due to diversification towards finer grains like rice and wheat. Jowar production in India is usually dominated by states like Maharashtra and Karnataka, which frequently account

for more than 60 % of the country's total output. Maharashtra was the top producer in the 2022–2023, with an expected production of about 31.12 lakh tonnes, farmed across 14.78 lakh hectares and a yield of 888 kg per ha (3). Uttar Pradesh (UP), one of the top 5 producing states, contributes significantly to the country's total food grain production, but its part in jowar production is relatively smaller. Although on a lower scale than the top states, UP's jowar output in 2022-2023 was about 3.15 lakh tonnes, covering an area of 1.98 lakh hectares and demonstrating a better productivity rate of about 1593 kg per hectare, indicating effective land utilization (4).

Conventional agriculture faces difficulties in the Bundelkhand region of UP because its semi-arid climate, irregular rainfall patterns and generally poor soil quality (such as Rakar and Parwa soils). Jowar is more than just a substitute crop in this area; it is a climatically essential crop that is vital to farm households' survival, particularly during the kharif (monsoon) season. Despite its inherent agroclimatic limitations, the Bundelkhand region accounted for roughly 36.6 % of the total millet area and 34 % of the total millet production in UP, according to published figures (e.g. from 2018-19 data) (5). With an estimated 54.9 thousand hectares (or 36.6 % of the total millet area) and an output of 62000 tonnes in the region, sorghum (jowar) was

the most significant millet (6). The region's total Jowar production, is roughly at 114 kg/ ha during that time, was less than the UP-state average of 125 kg/ ha, indicating a substantial yield gap and the necessity of focused intervention (7).

Jowar farming in UP's Bundelkhand region is characterized by a complicated interplay between high weather risk and erratic economic rewards. Jowar's natural tolerance to drought offers farmers in this precarious area a crucial safety net, but a variety of circumstances frequently limit its profitability. The high cost and poor quality of agricultural inputs (such as seeds, insecticides, pesticides and fungicides), improper and unbalanced fertilizer application and major marketing obstacles like inadequate support price mechanisms and insufficient market guidance and infrastructure are just a few of the non-climatic constraints that have been identified by prior research (8).

Despite jowar's strategic significance, farmers, legislators and extension agents frequently lack a thorough, current and region-specific cost and return analysis, which makes it challenging for them to make wise judgments (9). To ascertain the true profitability and farm-level net returns of jowar cultivation, a precise evaluation of the cost of cultivation (CoC) combining the specific cost concepts of the Commission for Agricultural Costs and Prices (CACP), such as Cost A<sub>2</sub>, Cost B<sub>2</sub> and Cost C<sub>2</sub> is crucial (10). The need to determine whether the low returns are primarily due to high input costs, low yields, low output prices, or a mix of these factors is further highlighted by the low regional productivity estimates compared to the state average. Therefore, in order to give a micro-level economic assessment of jowar farming in the Bundelkhand region, this study must go beyond typical agricultural limits (11).

## Materials and Methods

The data collected was analysed for interpretation based on following sampling framework, 3 districts (Chitrakoot, Banda and Jalaun) out of 7 districts of Bundelkhand region were selected purposively having higher share in area and production of major millet crops.

A total of 180 millet growing sample farms were selected using multistage random sampling method from 6 blocks namely Baberu, Naraini, Madhogarh, Rampura, Karwi and Manikpur were selected followed by 18 villages, finally 180 millet growing farmers were selected using probability proportional to size (Table 1).

Tabular analyses were used for working out various cost concepts, different income measures, CoC, input output ratio, cost benefit ratio (C:B ratios), weighted average etc.

## Results and Discussion

### Land distribution

The land distribution structure of the 180 chosen jowar-growing households in the Bundelkhand region is shown in Table 2. Four operational landholding groups were used to categorize the sample:

**Table 2.** Land distribution of selected jowar growing respondents in Bundelkhand

Land holdings (ha.)	Size group of sample farms				
	Marginal (69)	Small (47)	Medium (43)	Large (21)	Total (180)
Total land holdings (ha.)	53.75 (13.05)	82.25 (19.96)	134.5 (32.65)	141.5 (34.34)	412.00 (100.00)
Average size of land holdings (ha.)	0.78	1.75	3.13	6.74	2.29

**Table 1.** Village-wise proportionate sample selected of jowar growers in Bundelkhand

District	Block	Village	Household engaged in cultivation of jowar	
			Total population	Sample selected (jowar's growers) (In numbers)
Chitrakoot	Karwi	Mukundpur	212	9
		Manhai mafi	234	10
		Khamariya	255	11
	Manikpur	Rampur	165	7
		Semardha	358	15
		Deokali	180	8
		Shah Patan	285	6
Banda	Naraini	Gudha Kalan	865	19
		Gopara	214	5
	Baberu	Byonja	232	6
		Hardoulee	587	16
		Tola kalan	256	8
Jalaun	Madhogarh	Nichavadi	48	2
		Sultanpura	112	6
	Rampura	Bangra	436	22
		Mai	236	16
		Mahuta	73	5
<b>Total</b>			<b>4887</b>	<b>180</b>

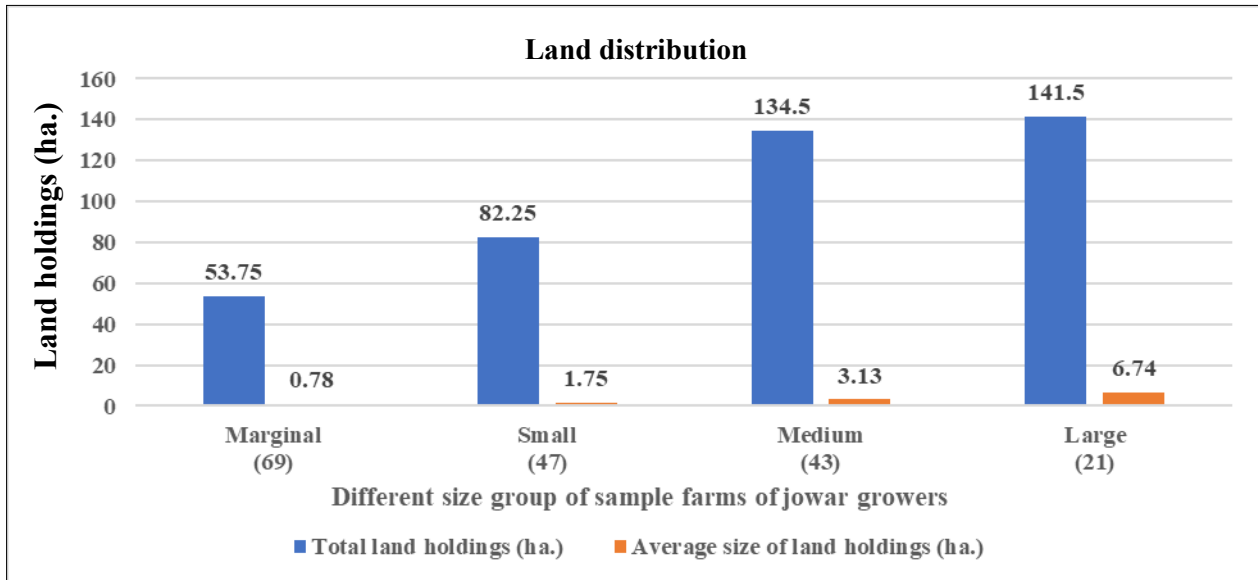
small, medium, large and marginal farmers. The sample's total operating landholding was 412 ha. Among them, small farmers (47 households) owned 82.25 ha (19.96 %) and marginal farmers (69 households) owned 53.75 ha (13.05 % of total land). Large farmers (21 families) accounted for the largest land share with 141.50 ha (34.34 %), while medium farmers (43 households) supplied a somewhat higher proportion of 134.50 ha (32.65 %) in Fig. 1.

All categories saw a steady growth in the average landholding size. Small farmers operated an average of 1.75 ha, while marginal farmers held an average of 0.78 ha. A distinct gradient of farm size expansion with higher categories was seen in the average operational landholding of medium and big farmers, which was 3.13 ha and 6.74 ha, respectively. The sample had an average landholding size of 2.29 ha. In terms of farmer numbers, this distribution shows that small and marginal holdings predominate, while medium and big farmers control a significant amount of the study area's total cultivated land.

### Cost of cultivation

The cost of growing the jowar crop varied greatly among farm-size categories, reflecting variations in labor dependence, scale benefits and resource use intensity in Table 3. With significant differences across marginal, small, medium and big farms, the overall average cost of cultivating jowar per hectare was ₹25655.37.

Particularly on marginal farms, where it accounted for 23.84 % of the total cost (₹5992.66), human labor comprised a significant share of operating costs. Family labor dependency accounted for the



**Fig. 1.** Land distribution of selected jowar growing respondents in Bundelkhand.

**Table 3.** Cost of cultivation of jowar crop per hectare in different size group of farms

Sl. No.	Particulars	Size group of farms				Overall average
		Marginal (69)	Small (47)	Medium (43)	Large (21)	
1	Human labour	5992.66 (23.84)	5656.00 (22.35)	5667.55 (21.75)	5394.00 (19.74)	5757.25 (22.44)
	a. Family labour	4374.31 (17.40)	4144.00 (16.38)	2019.87 (7.75)	1908.98 (6.99)	3464.10 (13.50)
	b. Hired labour	1618.35 (6.44)	1512.00 (5.98)	3647.68 (14.00)	3485.02 (12.75)	2293.14 (8.94)
2	Machinery charges/ Tractor charges	4600.00 (18.30)	4792.00 (18.94)	4953.85 (19.01)	4712.84 (17.25)	4747.83 (18.51)
3	Seed cost	1344.40 (5.35)	1440.00 (5.69)	1505.43 (5.78)	1498.05 (5.48)	1425.76 (5.56)
4	Manures and fertilizers	1571.96 (6.25)	1604.80 (6.34)	1600.00 (6.14)	1520.00 (5.56)	1581.17 (6.16)
5	Irrigation	1600.00 (6.36)	1560.00 (6.17)	1534.84 (5.89)	1488.72 (5.45)	1561.01 (6.08)
6	Plant protection	431.93 (1.72)	400.00 (1.58)	401.00 (1.54)	1700.00 (6.22)	564.14 (2.20)
7	Total working capital	11166.64 (44.42)	11308.80 (44.69)	13642.80 (52.36)	14404.63 (52.72)	12173.05 (47.45)
8	Interest on working capital @ 4 %	446.67 (1.78)	452.35 (1.79)	545.71 (2.09)	576.19 (2.11)	486.92 (1.90)
9	Rental value of owned land	6000.00 (23.87)	6000.00 (23.71)	6000.00 (23.03)	6000.00 (21.96)	6000.00 (23.39)
10	Interest on fixed capital	866.00 (3.44)	1097.00 (4.34)	1478.00 (5.67)	1950.00 (7.14)	1198.98 (4.67)
11	Sub-total	22853.62 (90.91)	23002.15 (90.91)	23686.38 (90.91)	24839.80 (90.91)	23323.06 (90.91)
12	Managerial cost (10 % of sub-total)	2285.36 (9.09)	2300.22 (9.09)	2368.64 (9.09)	2483.98 (9.09)	2332.31 (9.09)
	Gross total	25138.98 (100.00)	25302.37 (100.00)	26055.02 (100.00)	27323.78 (100.00)	25655.37 (100.00)

majority of this high percentage (17.40 %), indicating poor cash expenditure capability and insufficient mechanization. Large farms, on the other hand, used more machinery and paid labor, as seen by their lower labor cost share (19.74 %) and decreased reliance on family labor (only 6.99 %). Due to their larger operational scale and the scarcity of family labor, medium-sized farms had the largest percentage of hired labor (14 %).

From marginal to medium farms, machinery expenses gradually increased, reaching their maximum in medium farms (₹4953.85), which accounted for 19.01 % of total costs. Additionally, large farms used a lot of machinery (₹4712.84), suggesting that as

farms get bigger, they get more mechanized. The average cost of machinery was 18.51 % overall, indicating that mechanization is starting to play a significant role in jowar farming.

Irrigation fees, manures and fertilizers and seed costs were comparatively consistent across size groups. The cost of seeds varied from ₹1344.40 to ₹1505.43, accounting for roughly 5–6 % of the overall expenses for all groups. Similar levels of chemical nutrient use were indicated by the limited range of fertilizer costs (₹1520–₹1604.80). Due to their restricted access to private water supplies, marginal farms spent significantly more on irrigation, which accounted for 5.45–6.36 % of total costs.

Spending on plant protection showed a stark disparity. While marginal and small farms paid less than 1.7 %, large farms incurred extraordinarily high expenditures (₹1700), accounting for 6.22 % of total costs. This indicates that large farms have more intensive pest management, either as a result of their increased knowledge, or focus on commercial produce.

As holding size increased, total working capital rose, peaking on large farms (₹14404.63) as opposed to marginal farms (₹11166.64). Nonetheless, the proportion of working capital to overall expenses was consistent among groups (about 44–53 %). Across all categories, the rental value of owned land stayed about ₹6000/ha, accounting for roughly 22–24 % of the overall cost. As farms grew in size, interest on fixed capital increased steadily, reflecting greater investment in durable assets and machinery.

Because of the usual calculation process, the sub-total cost, excluding administrative expenses, remained almost constant in percentage terms (90.91 %) across all farm sizes. The largest sub-total cost (₹24839.80) was incurred by large farms. Large farms had the greatest gross cost of production (₹27323.78) after adding administrative costs (10 %), followed by medium farms (₹26055.02), small farms (₹25302.37) and marginal farms (₹25138.98). Higher-scale mechanization and increased usage of purchased inputs are indicated by the rising trend in cost with farm size in Fig. 2.

The results shown that small and marginal farmers have limited resources and they rely largely on family labor, which prevents them from using purchased inputs. On the other side, medium-sized and big farms exhibit greater input intensity, mechanization and investment in fixed assets and plant protection, which raised overall costs. This pattern implies that, depending on management techniques and resource availability, economies of scale function in some cost components (labor, irrigation), while diseconomies appear in others (plant protection, machinery).

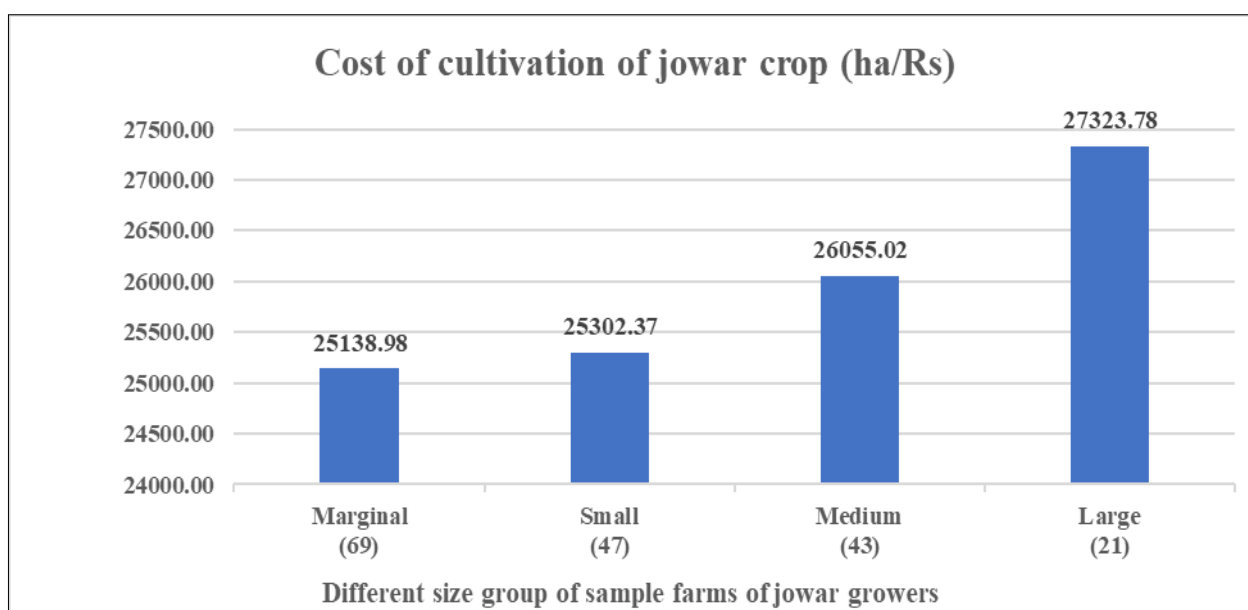
The study drawn attention to the structural variations in cost composition among farm sizes, which were indicative of different investment capacities and production patterns. The profitability, resource-use efficiency and policy interventions targeted at enhancing the economic feasibility of jowar farming in Bundelkhand are directly impacted by these variances.

## Cost and profits

There are distinct trends in the Bundelkhand region's cost structure, income generation, profitability and economic efficiency when looking at the per-hectare cost and profit metrics of jowar agriculture across various farm-size groupings in Table 4. The findings demonstrate that the cost of cultivation increases steadily as farm size increases, reflecting variations in labor management, resource utilization intensity and operational scale. With an average of ₹25655.37/ha, Cost C3, which stands for the total cost including managerial input, was highest on large farms (₹27323.78/ha) and lowest on marginal farms (₹25138.98/ha). All cost categories (A1/A2, B1, B2, C1, C2) show this tendency, suggesting that larger farms have higher fixed and variable costs possibly as a result of their greater reliance on hired labor and equipment.

Marginal and small farms were more productive than medium and large farms, with higher yields of both main product and by-product. Large farms had a grain yield of 15.8 quintal per hectare, while marginal farms had the maximum output of 17 quintal per hectare. By-product yield follows a similar pattern. Higher land-use efficiency, greater oversight and more timely and intensive labor application could all contribute to smaller farms' superior performance. As a result, gross income decreases as farm size grows, with marginal farmers making ₹60860/ha, small farmers making ₹58712/ha, medium farmers making ₹57280/ha and large farmers making ₹56564/ha. The results of numerous previous studies on Indian agriculture are in line with this inverse link between farm size and productivity.

This insight is further supported by profitability statistics. Large farmers had the lowest net income (₹29240.22/ha), while marginal farmers had the greatest (₹35721.02/ha). As farm size increased, family labor income, farm business income and farm investment income all showed a falling trend. These findings unequivocally show that jowar cultivation is more economically viable and profitable for small and marginal farms, primarily because of lower production costs per unit output and greater yield levels. Larger farms experience worse cost-efficiency, as evidenced by the cost of production per quintal, a crucial efficiency measure, rising steadily from marginal (₹1478.76/quintal) to large farms (₹1729.35/quintal).



**Fig. 2.** Cost of cultivation of Jowar crop per hectare in different size group of farms.

**Table 4.** Measures of per-hectare cost and profits (₹) of jowar in different size group of farms

Sl. No.	Particulars	Size group of farms				Overall average	
		Marginal	Small	Medium	Large		
1	Cost A1/A2	11613.31	11761.15	14188.51	14980.82	12659.98	
2	Cost B1	12479.31	12858.15	15666.51	16930.82	13858.96	
3	Cost B2	18479.31	18858.15	21666.51	22930.82	19858.96	
4	Cost C1	16853.62	17002.15	17686.38	18839.80	17323.06	
5	Cost C2	22853.62	23002.15	23686.38	24839.80	23323.06	
6	Cost C3	25138.98	25302.37	26055.02	27323.78	25655.37	
7	Yield (qtl/ha.)	(a) Main product	17.00	16.40	16.00	15.80	16.46
		(b) By product	34.00	32.80	32.00	31.60	32.93
8	Gross Income	(a) Main product	54060.00	52152.00	50880.00	50244.00	52356.93
		(b) By product	6800.00	6560.00	6400.00	6320.00	6585.78
		Gross income	60860.00	58712.00	57280.00	56564.00	58942.71
9	Net income	35721.02	33409.63	31224.98	29240.22	33287.34	
10	Family labour income	42380.69	39853.85	35613.49	33633.18	39083.75	
11	Farm business income	49246.69	46950.85	43091.49	41583.18	46282.74	
12	Farm investment income	45102.69	42806.85	41071.62	39674.20	42906.92	
13	Cost of production (₹/Qtl.)	1478.76	1542.83	1628.44	1729.35	1560.48	
14		Input - output ratio					
a.	On the basis of Cost A1	5.24	4.99	4.04	3.78	4.72	
b.	On the basis of Cost B1	4.88	4.57	3.66	3.34	4.32	
c.	On the basis of Cost B2	3.29	3.11	2.64	2.47	2.99	
d.	On the basis of Cost C1	3.61	3.45	3.24	3.00	3.41	
e.	On the basis of Cost C2	2.66	2.55	2.42	2.28	2.53	
f.	On the basis of Cost C3	2.42	2.32	2.20	2.07	2.30	
15	B:C ratio	1.42	1.32	1.20	1.07	1.30	

**Note:** C3= Cost C2+10 % of cost C2.

Significant variations in resource-use efficiency are shown by the input-output ratio based on different cost definitions. Large farms had the lowest I/O ratio (3.78), whereas marginal farms had the highest (5.24 on Cost A1), indicating the most efficient use of inputs. Similar trends were seen in the benefit-cost (B:C) ratio, which was 1.42 for marginal farms and just 1.07 for large farms. Although the region's general B:C ratio of 1.30 indicates that jowar production is profitable, small-scale farmers make much more money.

Overall, the findings show that Bundelkhand's marginal and small farms do better economically in jowar cultivation due to increased production and more effective labor use. The economic benefit of smallholder farming in the area is highlighted by the fact that larger farms face diminishing returns as a result of greater operating expenses and comparatively lower yields.

## Conclusion

Marginal farms are the most profitable, with a net income of ₹35721/ha and the highest B:C ratio of 1.42, according to the cost and return analysis of jowar agriculture in Bundelkhand. With a B:C ratio of 1.07 and a net income of only ₹29240/ha, large farms rapidly lose profitability. Jowar farming generates ₹33287/ha net income and ₹58942/ha gross income overall. Due to comparatively reduced per-hectare expenditures, it is evident that small and marginal

farmers benefit more financially from Jowar than medium and large farms.

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## Authors' contributions

PK carried out the survey. AK participated in the design of the study. MK participated and performed the statistical analysis. ANS helped in theory writing, conceived of the study, participated in its design and coordination. AP help to make setting paper and DNY supported financial help. APSY contributed to searching references and citations. SB helped in calculation of data. All authors read and approved the final manuscript.

## Compliance with ethical standards

**Conflict of interest:** Authors do not have any conflict of interests to declare.

**Ethical issues:** None

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