

Factors affecting the labour productivity of brickwork and analyzing them using RII method

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Abstract

Productivity is one of the major problems which affects the duration of the project. There are many factors which affect productivity like climate, type of material, supervision etc. In the current research, the factors affecting the labour productivity of brickwork activity are identified through a literature survey and discussions with industry experts. Total 27 factors were identified and a survey questionnaire was prepared which was distributed among the site engineers to rate factors on a Likert scale from 1 to 5. To make the questionnaire simple the factors were distributed into 3 main groups such as (i) management, (ii) project specification and (iii) human and labour. The questionnaire was distributed among 130 under construction sites and data was obtained. The data analysis was done through the relative importance index and ranking of factors was done which showed results as (i) training, (ii) quality required, (iii) experience, (iv) safety training, (v) proper scheduling and (vi) over time. These top 6 factors were responsible for affecting the labour productivity of brickwork the most.

Keywords

Brickwork, Labour productivity, Relative importance index, Construction industry, Management.

1. Introduction

In the Indian construction sector, labour productivity is considered as one of the tedious problems which affect the total duration of the project [1]. As per Jergeas and McTague [2], the cost of labour contributes around 40% to 50% of the total cost of the project. Productivity is one of the major concerns which occurs during a discussion about the construction industry [3]. In 1950, the Organization for European Economic Cooperation (OEEC) introduced a formal definition of productivity as a quotient obtained by dividing output by one of the production factors. The United State Department of Commerce defined productivity as “dollars of output per person-hour of labour input” [4]. Peles [5] interpreted productivity as the task finished by labours, whereas Handa and Adballa [6] stated productivity as the ratio of outputs of goods and/or work with the input of resources such as material, labour, wages etc.

The American Association of Cost Engineers defined productivity as a as a comparison between the efficiency of a labour with the predefined base or norm [7] while Arditi and Mochtar [8] referred the productivity as the ratio between total outputs to the total input in dollars. Kenley [9] expressed productivity as how much is the output produced by providing input.

It is the imperious aspect in the construction industry as it allows cost savings and effective utilization of resources. It is considered to be the most important concern in both developed and developing countries [10]. As per the literature survey, it can be stated that productivity is defined as the ratio of output produced with the input provided for the given work to be accomplished.

There are many factors which affect labour productivity directly or indirectly, for example, age, experience, climate, inspection delay etc. It is necessary to identify those factors and find measures to avoid them so that productivity can be increased.

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Many studies have been carried out on labour productivity in different countries where researchers considered many factors in their research like 50 factors [11] in Malaysia, 45 factors [12] in Israel, 83 factors [13] in the United States of America, 45 factors [14] in Kuwait, 27 factors [15] in Egypt, 52 factors [16] in Yemen. Similarly, Rahman et al. [17] in Pakistan identified 33 factors affecting the labour productivity. It was observed in the literature survey that many researchers have used the method of the relative importance index (RII) to identify the top factors affecting productivity. The RII method requires factors to be rated on a Likert scale (3 points, 4 points, 5 points or 7 points Likert Scale). In current research 5 points, the Likert scale is used. It consists of nos. 1 to 5 and each no. indicates an opinion. In the current research 1 indicates not important, 2 indicates less important and so on. Through the literature survey, it is determined that many of the researchers have adopted RII method for determination of the top factors affecting productivity like M. R. Hafez et al. [15] has highest RII value of 91.1 and the least value as 59.8. Whereas Adnan Enshassi et al. [12] identified top 8 factors with highest RII value 84.21 and lowest as 54.74 likewise Jarkas and Bitar [14] kept the highest value to be 81.67 and lowest as 52.87 for top 10 factors. Similarly, Hafez et al [15] had a range of RII value as 87.74 to be the highest RII value and 76.73 to be the lowest value for selecting the top 10 factors. Gerges, M. et al. [18] kept the RII range for selecting the top 10 factors as 85.79 to 81.58. Similarly, Porntepkasemsant et al. [19] has a range of the top 16 factors as 71.3 to 54.9. Many of the previous researches showed the effect of factors on total productivity of the overall construction of a structure.

Through identification of factors affecting the different operations in construction like flooring, concreting, tiling, formwork etc. [20–24]. It will be very easy to increase the overall productivity. The current study tends to identify the factors affecting labour productivity only for the operation of brickwork. It is one of the most crucial and important activities that is considered in the industry. Following are objectives of current research.

- Identification of factors affecting the labour productivity of brickwork.
- Categorizing the factors into main groups.
- Calculating the relative importance index of each factor.
- Ranking them on the basis of RII value.

2. Methodology

The main aim of the current study is to identify the factors and prioritize them according to their RII calculation. The methodology is divided into four major steps such as (i) identification of factors, (ii) classification of factors into categories, (iii) preparation of questionnaire and (iv) analysis of data and ranking of the factors. To accomplish the above aim intensive literature review is being done and 22 factors were identified also additional 5 factors like (i) over man (quantity of labour more than the required), (ii) education, (iii) health, (iv) physique and (v) quality required were also considered in case of brickwork labour productivity. These 5 factors were added after interacting with more than 15 engineers, 10 contractors and 20 labours. All the 27 factors which are considered for research shown in *Table 1*.

Table 1 Factors affecting labour productivity

Training	Rad and Kim [23]
Inspection Delay	Olomolaiye et al. [20]
Design Rectification	Zakeri et al. [21]
Crew Size	Olomolaiye et al. [20]
Proper Scheduling	Soekiman et al. [22]
Language Barrier	El-Gohary and Aziz [24]
Supervision	Soekiman et al. [22]
Habits	Rad and Kim [23]
Labour Strikes	Soekiman, et al. [22]
Absenteeism	Olomolaiye et al. [20]
Bonus/Incentives	El-Gohary and Aziz [24]
Safety Training	Dai et al. [13]
Government Policies	Abdul et al. [11]
Experience	Enshassi et al. [12]

Overtime/Fatigue	Enshassi et al. [12]
Alcoholism	Enshassi et al. [12]
Material Delay	Abdul et al. [11]
Types of Material	El-Gohary and Aziz [24]
Site Environment	Zakeri et al. [21]
Climate	Zakeri et al. [21]
Equipment Availability	Jarkas et al. [14]
Age	Enshassi et al. [12]
Over manning	Discussion with industrial experts
Education	Discussion with industrial experts
Health	Discussion with industrial experts
Physique	Discussion with industrial experts
Quality required	Discussion with industrial experts

2.1. Classification of factors

The previous research on labour productivity showed that the researcher classified all the identified factors into main groups. The identification of the factors and its classification vary from country to country and activity to activity. Alaghbari et al. [16] in Yemen classified identified factors into four groups (i) human/labour factors, (ii) management factors (iii) technical and technological factors and (iv) external factors whereas Jarkas et al. [14] in Kuwait divided factors into 4 main groups (i) management, (ii)

technological, (iii) human/labour and (iv) external. This group of factors will help in finding out which group is affecting productivity more. Therefore, in the current study 27 factors were classified into three major groups (i) management, (ii) project specification and (iii) human and labour. The classification helps in identifying which groups is more responsible for affecting the productivity of brickwork. *Figure 1* gives a detail classification of factors into three major groups.

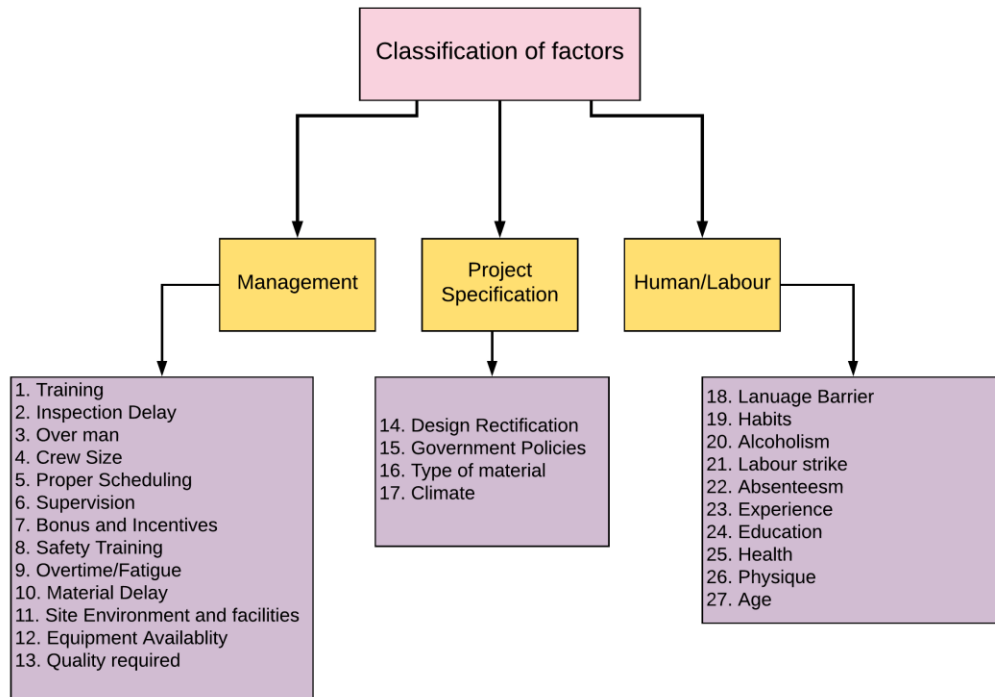


Figure 1 Classification of factors

2.2. Preparation of questionnaire

The current research aims at identifying the factors affecting the labour operation for data were collected from 118 under construction sites. For the collection of this data, a questionnaire was prepared and distributed among them. It consisted of various

entities like the name of the engineer, name of the site etc. These 27 factors were lined across which there was 5 points Likert scale and an individual has to choose only one option for it. *Figure 2* shows the sample of the questionnaire.

Name of the site: _____
 Name of the site engineer: _____
 Location: _____
 Type of construction: _____

Following are some of the factors which are being selected so please give your response on the scale of 1 to 5 by ✓
NOTE: Only one option can be selected in each category.

Sr. No.	Group	Factors affecting Labour productivity	Rating				
			Very Important	Important	Somewhat Important	Less Important	Not Important
			5	4	3	2	1
1	Management	Training					
2		Inspection Delay					
3		Over man					
4		Crew Size					
5		Proper Scheduling					
6		Supervision					
7		Bonus/Incentives					
8		Safety Training to avoid Accidents					
9		Overtime					
10		Material Delay					
11		Site Environment					
12		Equipment Availability					
13		Quality Required					
14	Project Specification	Design Specification					
15		Government Policies					

Figure 2 Sample questionnaire

2.3. Data Analysis

The RII method was applied to rank the factors affecting productivity as the data received from the respondent's analysis was conducted for the calculation of RII value. The RII method is a determined approach for calculating employee satisfaction [25, 26] hence it is very suitable to use it for current research. It helps in the decision making of an individual and easy for selecting the factors responsible for it. Following formula is being used to analyze the collected data [14].

$$\text{Relative Importance Index (\%)} = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5}{5(n_1 + n_2 + n_3 + n_4 + n_5)} \times 100$$

Where, n_1, n_2, n_3, n_4 and n_5 are the no. of respondents selected: (1) not important (2) less important (3) somewhat important (4) important and (5) very important respectively. For all the data analysis Microsoft Office Excel was used.

3.Results

The main aim of the current study was to identify the top 6 factors affecting the labour productivity of brickwork. The relative importance index was calculated for each factor. The 27 factors were divided into three categories 13 factors in the management group, 4 factors in project specification group and 10 factors in human and labour group. There are two methods used for giving ranks to all the factors viz. (i) ranking according to the group and (ii) overall ranking of all factors. The hard copies of the questionnaire were distributed among the engineers of the 130 under construction sites in Dombivli region. Only 118 respondents were received which is 90.76 % of the total distribution.

3.1. Ranking according to the groups

In this method of ranking the factors was done according to the RII value in their individual group

and comparison was done with the rank of a factor in the overall ranking.

3.1.1.Management group

This group consists of 13 factors as shown in *Figure 1*. The relative importance indices of the factors classified under the management group are shown in *Figure 3*. The factor “training” has the maximum RII value 76.44%, which indicates that if the workers are given proper training of brickwork the productivity may increase. This factor was ranked 1st in the overall ranking of 27 factors as shown in *Table 2*. Others factors like quality required, site environment, safety training, proper scheduling, overtime, crew size, supervision, equipment availability and inspection delay have the RII value in descending order. In overall ranking 5 factors from the management group were observed in top 10 hence it can be concluded that this group plays a vital role in labour productivity.

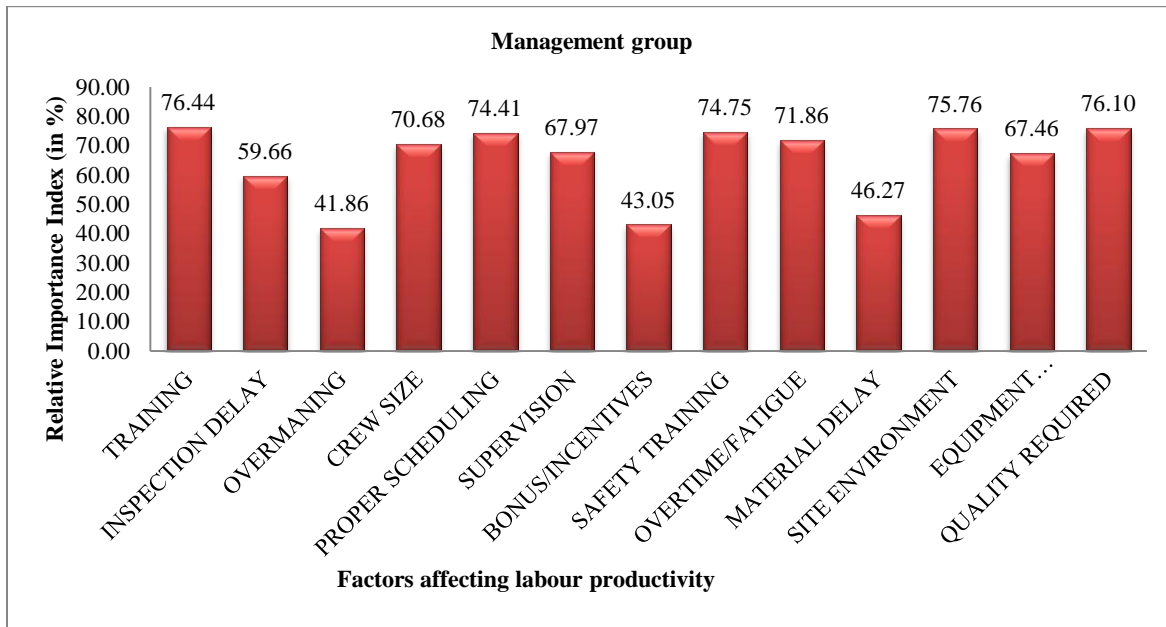


Figure 3 RII values of factors

3.1.2. Project specification group

This consists of 4 factors as shown in *Figure 1*. The top factor to an RII value of 71.18 was the “type of material”. It was ranked 7th in the overall ranking as shown in *Table 2*. Type of material generally decreases the productivity of brickwork if the brick is

of any other material other than the conventional brick. The density of the material also plays a major role in which construction of the brickwork. *Figure 4* shows the RII value of the factors of this group.

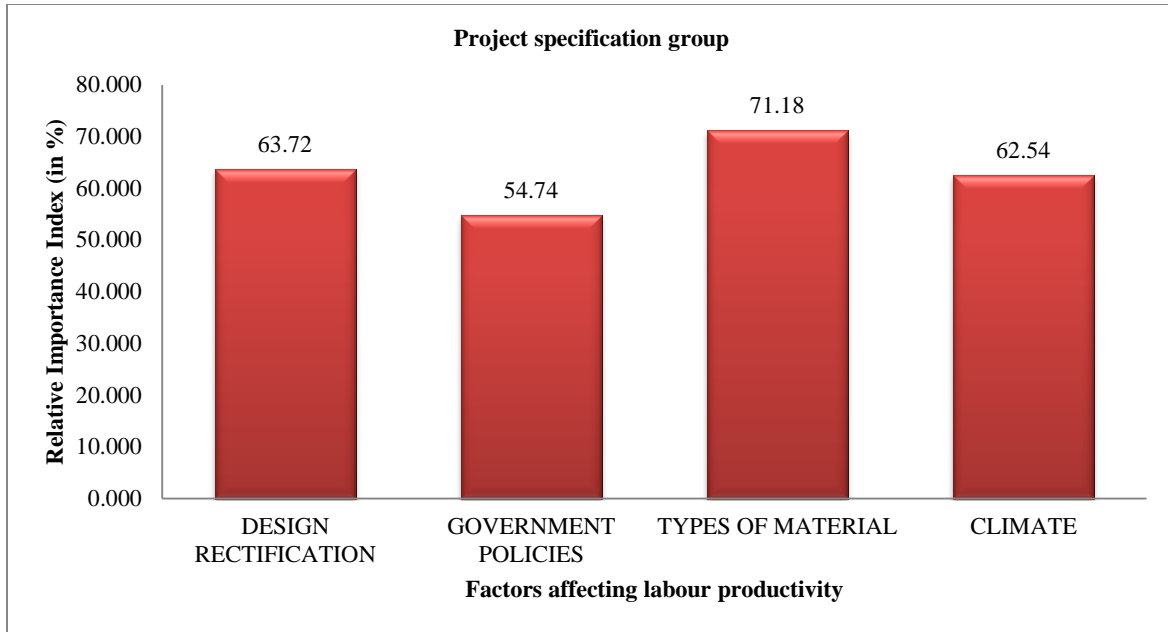


Figure 4 RII values of the factors

3.1.3. Human and labour group

This group consists of 10 factors as shown in *Figure 1*. This group mainly consists of factors related to labours personal details like their experience, age, health, physique etc. As per the result obtained the obtained data from different sites when RII was calculated of the factors it was observed that “experience” top of the group with 75.76%, which

was seen to be at 3rd rank in the overall ranking as shown in *Table 2*. In an activity like the brickwork experience of labour plays a major role in increasing productivity. *Figure 5* shows the RII of all the factors included in this group.

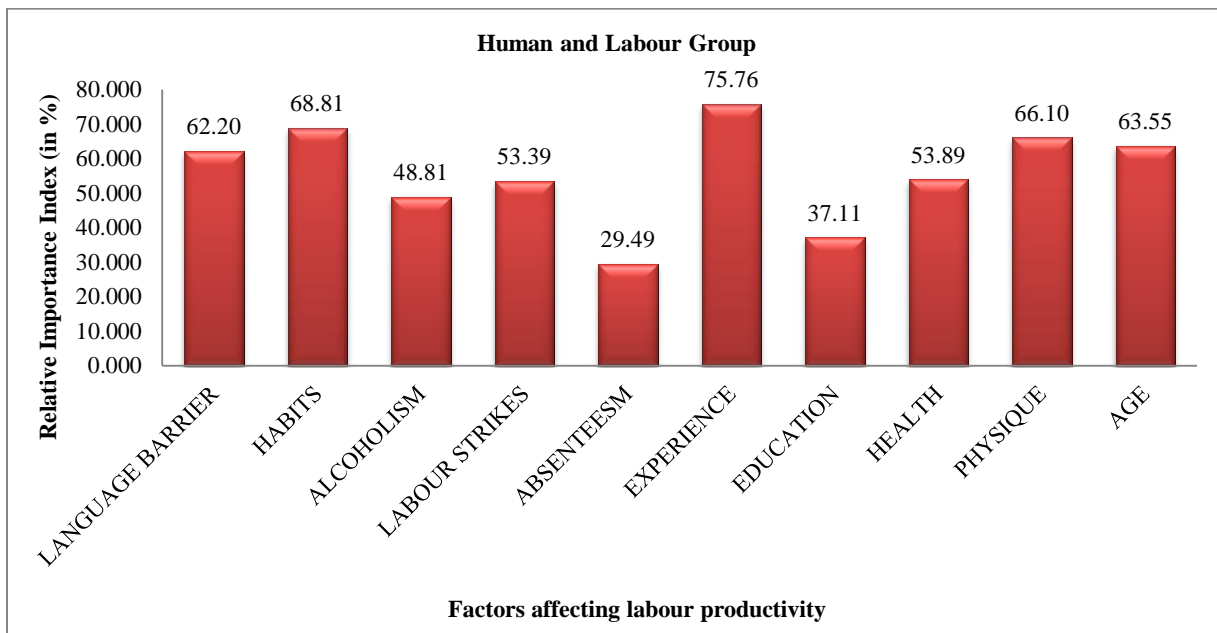


Figure 5 RII values of factors

3.2. Overall ranking

This method emphasis on ranking the 27 factors according to their respective RII value. This will help us to find the top factors affecting the productivity in brickwork activity and proper measures can be taken to increase productivity. *Table 2* below will show the overall ranking of 27 factors with their individual

RII. It can be observed that training is ranked 1 followed by quality required; experience, safety training, proper scheduling and over time have RII value as 76.441, 76.102, 75.763, 74.746, 74.407 and 71.864 respectively.

Table 2 Overall ranking of the factors, according to the respective RII value

SR. NO.	Factor affecting labour productivity	Group	RII	Rank
1	Training	Management	76.441	1
2	Quality Required	Management	76.102	2
3	Experience	Human and Labour	75.763	3
4	Safety Training	Management	74.746	4
5	Proper Scheduling	Management	74.407	5
6	Overtime	Management	71.864	6
7	Types of Material	Project Specification	71.186	7
8	Crew Size	Management	70.678	8
9	Habits	Human and Labour	68.814	9
10	Supervision	Management	67.966	10
11	Equipment Availability	Management	67.458	11
12	Physique	Human and Labour	66.102	12
13	Design Rectification	Project Specification	63.729	13
14	Age	Human and Labour	63.559	14
15	Climate	Project Specification	62.542	15
16	Language Barrier	Human and Labour	62.203	16
17	Inspection Delay	Management	59.661	17
18	Government Policies	Project Specification	54.746	18
19	Health	Human and Labour	53.898	19
20	Labour Strikes	Human and Labour	53.390	20
21	Alcoholism	Human and Labour	48.814	21
22	Material Delay	Management	46.271	22
23	Bonus/Incentives	Management	43.051	23
24	Overmaning	Management	41.864	24
25	Site Environment	Management	38.305	25
26	Education	Human and Labour	37.119	26
27	Absenteeism	Human and Labour	29.492	27

4. Discussion

According to the results obtained from RII calculation, it can be stated “training” factors has the maximum RII value. This observation states that labour should be trained in brickwork operation to increase productivity. Similarly, “quality required” factors suggest us that if any site sets a target of the quality required of brickwork, then labours will commit a mistake in reaching that quality and also it

will very time-consuming. “Experience” factors suggest us that the labour should have the experience of the brickwork so that it can be utilized in increasing productivity. Another factor “safety training” is responsible for providing safety training to the labour. The avoidance of accidents will increase productivity since the labour will know how to avoid accidents. “Proper scheduling” instruct us that no over-lapping of activities should be there in

scheduling so that the completion of one work can be done and then the other can be started. In addition to the result, these factors “overtime” suggest that the labours should not be forced for working more. The efficiency of labour will be decreased if labours for more than assigned time. The result also showed that “management” is the most dominant group out of the three groups. The sub-factors in this group had maximum RII values which significantly affected the labour productivity. The group plays a major in completion of the work because all the decision-making power is with them. The result of previous researchers Abdul Kadir et al. [11] and Jarkas and Bitar [14] showed “management” group to be more responsible for affecting the labour productivity the most.

5. Conclusion

The current research aims to identify factors affecting the labour productivity of brickwork. Through the literature survey, 22 factors were identified and 5 factors were added, making 27 factors in all. These 27 factors were categorized into three main groups: (i) management, (ii) project specification and (iii) human and labour. A survey questionnaire was prepared and distributed among the site engineers of 130 under construction sites. Only 118 sites responded to the questionnaire. The obtained data analysis was done by using the Relative Importance Index method. Following factors were found in most significantly affecting the labour productivity of brickwork (i) training, (ii) quality required, (iii) experience, (iv) safety training, (v) proper scheduling and (vi) over time. It was also observed that management groups as the most responsible group for affecting labour productivity. In the overall ranking of the management group were found to be in the top 10. Following recommendations can be given on the obtained results.

- Proper training of the activity to be performed should be given to the labour so that the assigned work can be finished in stipulated time.
- Labours should be trained in safety precautions along with the training of activity to be performed.
- Proper scheduling of the activity plays a major role in labour productivity hence the overlapping of two activities should be avoided.
- Track of work completed should be supervised on the daily basis.

Acknowledgment

None.

Conflicts of interest

The authors have no conflicts of interest to declare.

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