




# Prevalence of and Factors Associated with Cognitive Impairment Among Adults in Central Sudan: A Community-Based Cross-Sectional Study

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**Background:** Cognitive impairment is a major global public health challenge; however, data from sub-Saharan Africa, particularly Sudan, remain scarce. This study investigated the prevalence of cognitive impairment and the factors associated with it among adults in East Gezira, central Sudan.

**Methods:** This community-based cross-sectional study was conducted from April to June 2025. Using multistage stratified random sampling, 336 adults aged  $\geq 18$  years were recruited. Cognitive status was assessed using the Montreal Cognitive Assessment (MoCA), with a score of  $< 26$  indicating cognitive impairment. Depression and anxiety were assessed using the Patient Health Questionnaire (PHQ-9) and the General Anxiety Disorder (GAD-7) scales, respectively. Multivariable binary logistic regression was used to identify independent factors associated with cognitive impairment.

**Results:** Of the 336 adults, 227 (67.6%) were men and 109 (32.4%) were women. Their median (interquartile range) age and body mass index were 42.0 (30.0–55.0) years and 22.6 (19.3–27.0)  $\text{kg}/\text{m}^2$ , respectively. The overall prevalence of cognitive impairment (MoCA score  $< 26$ ) was 73.5%. The prevalence of mild, moderate, and severe cognitive impairment was 51.5%, 21.7%, and 0.3%, respectively. In multivariate binary analysis, factors independently associated with cognitive impairment were older age (adjusted odds ratio [AOR], 1.02; 95% confidence interval [CI]: 1.004–1.05), low education level (AOR: 5.22; 95% CI: 2.70–10.09), unemployment (AOR: 2.46; 95% CI: 1.03–5.91), and depression (AOR: 2.98; 95% CI: 1.30–6.83).

**Conclusion:** The prevalence of cognitive impairment in this central Sudan community is remarkably high. Age, low education, unemployment, and depression are significant factors. These findings underscore the urgent need for public health interventions to detect and manage cognitive impairment early in this population.

**Keywords:** cognitive impairment, depression, age, education, employment, Sudan

## Introduction

Cognitive impairment, defined as a decline in cognitive function beyond that expected from normal aging, is a major global public health challenge.<sup>1,2</sup> It contributes substantially to disability and dependency in older adults and is a precursor to dementia.<sup>1,2</sup> Although its burden is well documented in high-income countries, limited data are available from low- and middle-income countries (LMICs), including those in sub-Saharan Africa (SSA), which are projected to face the most rapid increase in the number of people with dementia.<sup>2,3</sup> Understanding the local prevalence and associated risk factors is therefore essential for effective public health strategies.

Various tools are used by researchers to assess cognitive status, including the Montreal Cognitive Assessment (MoCA) and Mini-Mental State Examination (MMSE).<sup>4,5</sup> The MoCA is widely used as a screening tool for cognitive evaluation because of its higher sensitivity than the MMSE for screening and detecting mild cognitive impairment.<sup>5,6</sup>

The prevalence of cognitive impairment varies widely in different populations, including in SSA.<sup>7</sup> Thailand has a high prevalence of cognitive impairment in adults (52.45%)<sup>8</sup> compared with 43.8% in Ethiopia.<sup>9</sup> In the East African region, 7–44% of participants aged  $\geq 50$ –70 years had cognitive impairment,<sup>10</sup> whereas its prevalence is low (8.8%) in India.<sup>4</sup>

Several factors have been reported to be associated with cognitive impairment, including older age,<sup>4,8,9</sup> female sex,<sup>9</sup> low education level,<sup>4,8,9</sup> marital status,<sup>7</sup> unemployment,<sup>4,11</sup> smoking,<sup>4</sup> alcohol consumption,<sup>8</sup> and high body mass index (BMI),<sup>12</sup> as well as diabetes mellitus,<sup>8</sup> hypertension,<sup>8</sup> depression,<sup>8,13,14</sup> and anxiety.<sup>12</sup> Notably, we recently demonstrated a high prevalence of these conditions among the Sudanese population, including adolescents and adults.<sup>15,16</sup>

However, there is a scarcity of data that has assessed cognitive impairment in Sudan,<sup>17</sup> with most focusing on specific populations or conditions, such as a hospital-based study<sup>17</sup> that assessed the prevalence of cognitive impairment in stroke survivors in Khartoum. The researchers discovered that more than half of the participants' MoCA scores were at the severe end (0–10).<sup>17</sup> Furthermore, no study has conducted a comprehensive community-based assessment of the prevalence of and factors affecting cognitive function in Sudan,<sup>17</sup> especially since the outbreak of the war in 2023. This knowledge gap is a significant barrier to evidence-based policymaking and resource allocation for cognitive health in the country.

East Gezira is a predominantly rural region characterized by limited healthcare access, lower educational attainment, and ongoing socioeconomic challenges, particularly after the 2023 conflict. These contextual factors justify the need to study cognitive impairment in this specific community.

We therefore conducted a community-based cross-sectional survey to investigate the prevalence of and factors associated with cognitive impairment among community-dwelling adults in East Gezira, central Sudan. The findings are expected to provide a baseline for future research, inform decision-makers, and contribute to a global understanding of cognitive impairment in diverse populations.

## Methods

### Study Design and Setting

This community-based cross-sectional survey was conducted in Elrikiieb, East Gezira, Central Sudan, from April to June 2025. Gezira State is located in east–central Sudan, lying between the Blue and White Nile rivers. Elrikiieb was chosen because it comprises four sub-villages, and its inhabitants resemble those of the entire Gezira State. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

### Study Population and Sampling

Eligible participants were adults aged  $\geq 18$  years residing in the selected communities. Individuals unable to provide informed consent were excluded. We used a multistage stratified random sampling approach to select the participants. Within each selected sub-village, households were randomly chosen, and one adult per household was invited to participate. If there was no adult or they refused to consent, the next household would take. The number taken from each sub-village was proportional to its population.

### Sample Size Calculation

The OpenEpi Menu (OpenEpi, Atlanta, GA, USA) was used to calculate the sample size<sup>18</sup> using the formula,  $n = \frac{Z^2 P(1-P)}{d^2}$  where  $n$  is the sample size,  $Z$  is the confidence, and  $P$  is the expected prevalence. The required sample size was calculated as 336 based on an assumed prevalence of 50%. As there was no similar study in Sudan, this assumption was based on the findings of an Ethiopian community study that reported a prevalence of 43.8%.<sup>9</sup> Given that adults with depression were twice as likely to have cognitive impairment,<sup>19</sup> we assumed that 35% of the adults with cognitive impairment would also have depressive symptoms, compared with 20.0% of those with normal cognitive function. With these assumptions, a sample size of 336 would have 80% power at a 0.05 significance level ( $\alpha$ ).

## Data Collection

After obtaining a signed informed consent form, trained research assistants collected data through face-to-face interviews with each participant using a structured questionnaire. The questionnaire included data on sociodemographic factors, such as age, education level, marital status, employment status, smoking status, alcohol status, hypertension, and diabetes mellitus. Each participant's weight and height were measured using standard procedures, and their body BMI was calculated as (weight in kg)/ (height in m)<sup>2</sup>.

The participants were considered to have hypertension if they had an existing diagnosis of hypertension and were using medications (preexisting hypertension) or had systolic blood pressure  $\geq 140$  mm Hg or diastolic blood pressure  $\geq 90$  mm Hg (newly diagnosed hypertension). The participants were considered to have diabetes mellitus if they had had an existing diagnosis of diabetes mellitus or had HbA1c  $> 6.5\%$  (newly diagnosed diabetes mellitus).

## Cognitive Health Assessment

Cognition was evaluated using the Arabic version of the MoCA, which assesses executive function, memory, language, attention, visuospatial skills, and orientation. The total score ranges from 0 to 30.<sup>5</sup> MoCA scores are categorized into four levels: normal (26–30), mild (19–25), moderate (11–18), and severe (0–10). We adjusted MOCA score cutoffs for education by adding a point for adults with  $\leq 12$  years of schooling. The MoCA has been previously used in Sudan.<sup>17</sup>

## Mental Health Assessment

The Patient Health Questionnaire (PHQ-9) and the General Anxiety Disorder (GAD-7) scales were used to assess depression and anxiety, respectively. These tests have been widely used in various African and Arab countries, including Sudan and other Arabic-speaking populations.<sup>15,16</sup>

The PHQ-9 is a widely used, brief, and validated self-report tool for screening, diagnosing, and monitoring the severity of depression. Its Arabic validated version comprises nine items, each scored from 0 to 3, yielding a total score ranging from 0 to 27.<sup>19</sup> A score of  $\geq 8$  was used as the cutoff for clinically significant depression,<sup>20</sup> which necessitates further evaluation and management.

The GAD-7 is a seven-item tool developed by Spitzer et al<sup>21</sup> that evaluates the symptoms of panic disorder and generalized anxiety disorder over the past 2 weeks. The responses are measured on a four-point Likert scale, ranging from 0 (“not at all”) to 3 (“almost every day”). The total score ranges from 0 to 21, with higher scores indicating higher anxiety levels.<sup>21</sup> The GAD-7 has good reliability, construct validity, and procedural validity. Based on a recent study,<sup>15</sup> participants with a score of  $\geq 10$  were classified as having significant clinical anxiety, which necessitates further evaluation and management.

## Data Analysis

SPSS for Windows (version 22.0; IBM, Armonk, NY, USA) was used to analyze the data. The Shapiro–Wilk test was used to assess the normality of continuous data, including age, BMI, GAD-7, PHQ-9, and MoCA scores, which were nonnormally distributed. Hence, they are reported as median and interquartile range (IQR). Descriptive statistics were used to summarize sociodemographic characteristics and scores on mental and cognitive scales, including GAD-7, PHQ-9, and MoCA. Both univariate and multivariate binary analyses were performed, with cognitive impairment as the dependent variable and sociodemographic variables (age, sex, marital status, education, occupation, diabetes, and hypertension), depression, and anxiety (both continuous and categorical) as independent variables. Variables with  $p < 0.2$  in the univariate analysis were included in the multivariate model. Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) were reported. A two-sided  $p$ -value of  $< 0.05$  was considered statistically significant.

## Results

### General Characteristics

A total of 336 adults were enrolled (227 [67.6%] men and 109 [32.4%] women). Their median (IQR) age and BMI were 42.0 (30.0–55.0) years and 22.6 (19.3–27.0) kg/m<sup>2</sup>, respectively. Of the participants, 87 (25.9%) had a level of

education  $\geq$  secondary, 102 (30.4%) were employed, and 248 (73.8%) were married. Furthermore, 54 (16.1%) were smokers, and 27 (8%) were alcohol consumers. Regarding hypertension, 155 (46.1%) had hypertension, with 53 (34.2%) of these participants having preexisting hypertension and 102 (65.8%) having newly discovered hypertension; 59 (17.6%) had diabetes, with 40 (67.8%) of these participants having preexisting diabetes and 15 (32.2%) having newly discovered diabetes.

Mental health assessment tools revealed that 62 (18.5%) and 14 (4.2%) participants had depression and anxiety, respectively. Furthermore, 89 (26.5%), 173 (51.5%), 73 (21.7%), and 1 (0.3%) had normal, mild, moderate, and severe cognitive impairment, respectively (Table 1).

**Table 1** Clinicodemographic Data of Participants in East Gezira, Sudan, 2025 (n = 336)

Characteristics		Median	Interquartile Range
Age, years		42.0	30.0–55.0
Body mass index, kg/m <sup>2</sup>		22.6	19.3–27.0
MoCA score		22	18–25
Depression score		3.0	1.0–6.0
Anxiety score		2.0	0.0–4.0
		Number	Percentage
Sex	Men	227	67.6
	Women	109	32.4
Education level	Secondary and higher	87	25.9
	Primary or lower	249	74.1
Occupation status	Employed	102	30.4
	Unemployed	234	69.6
Marital status	Married	248	73.8
	Unmarried/divorced	88	26.2
Smoking status	No	282	83.9
	Yes	54	16.1
Alcohol consumption	No	309	92.0
	Yes	27	8.0
Diabetes mellitus	No	277	82.4
	Yes	59	17.6
Hypertension	No	181	53.9
	Yes	155	46.1
Depression	No	274	81.5
	Yes	62	18.5
Anxiety	No	322	95.8
	Yes	14	4.2

(Continued)

**Table 1** (Continued).

Characteristics		Median	Interquartile Range
Cognitive status score	Normal	89	26.5
	Mild	173	51.5
	Moderate	73	21.7
	Severe	1	0.3

## Factors Associated with Cognitive Impairment

Of the 336 patients, 247 (73.5%) had cognitive impairment. In the univariate analysis, age, sex, education, occupation, diabetes, and hypertension were associated with cognitive impairment, whereas marital status, BMI, smoking, alcohol, depression, and anxiety were not (Table 2).

**Table 2** Univariate Binary Analysis of Factors Associated with Cognitive Impairment in the Study Population

Variable		Adults with Cognitive Impairment (n = 247)	Adults Without Cognitive Impairment (n = 89)	Univariate Analysis		
				Odds Ratio	95% Confidence Interval (CI)	P value
Age, years		45 (34–58)	35 (25–45)	1.03	1.02–1.05	<0.001
Body mass index, kg/m <sup>2</sup>		22.6 (19.6–27.1)	22.5 (18.2–26.7)	1.01	0.97–1.04	0.624
Depression score		4.0 (2.0–7.0)	3.0 (1.0–6.0)	1.04	0.97–1.12	0.194
Anxiety score		2.0 (0.0–4.0)	1.5 (0.0–3.7)	1.01	0.93–1.10	0.678
Sex	Men	69 (27.9)	40 (44.9)	Reference		
	Women	178 (72.1)	49 (55.1)	2.10	1.27–3.47	0.004
Education level	Secondary and higher	37 (15.0)	50 (56.2)	Reference		
	Primary or lower	210 (85.0)	39 (43.8)	7.27	4.21–12.55	<0.001
Occupation status	Employed	60 (24.3)	42 (47.2)	Reference		
	Unemployed	187 (75.7)	47 (52.8)	2.78	1.67–4.62	<0.001
Marital status	Married	184 (74.5)	64 (71.9)	Reference		
	Unmarried/divorced	63 (25.5)	25 (28.1)	0.87	0.50–1.51	0.635
Smoking	No	209 (84.6)	73 (82.0)	Reference		
	Yes	38 (15.4)	16 (18.0)	0.83	0.43–1.57	0.568
Alcohol consumption	No	224 (90.7)	85 (95.5)	Reference		
	Yes	23 (9.3)	4 (4.5)	2.18	0.73–6.49	0.161
Diabetes mellitus	No	196 (79.4)	81 (91.0)	Reference		
	Yes	51 (20.6)	8 (9.0)	2.66	1.20–5.86	0.015

(Continued)

**Table 2** (Continued).

Variable		Adults with Cognitive Impairment (n = 247)	Adults Without Cognitive Impairment (n = 89)	Univariate Analysis		
				Odds Ratio	95% Confidence Interval (CI)	P value
Hypertension	No	123 (49.8)	58 (65.2)	Reference		
	Yes	124 (50.2)	31 (34.8)	1.85	1.12–3.06	0.016
Depression	No	197 (79.8)	77 (86.5)	Reference		
	Yes	50 (20.2)	12 (13.6)	1.62	0.82–3.22	0.162
Anxiety	No	236 (95.5)	86 (96.6)	Reference		
	Yes	11 (4.5)	3 (3.4)	1.33	0.36–4.90	0.662

Multivariate binary analysis revealed the following factors to be associated with cognitive impairment: age (AOR: 1.02, 95% CI: 1.004–1.05), low education (AOR: 5.22, 95% CI: 2.70–10.09), unemployment (AOR: 2.46, 95% CI: 1.03–5.91), depression score (as a continuous variable) (AOR: 1.09, 95% CI: 1.01–1.18), and depression (as a categorical variable) (AOR: 2.98, 95% CI: 1.30–6.83). Diabetes and hypertension were identified as confounding factors (Table 3). Model diagnostics indicated good calibration, as evidenced by the Hosmer–Lemeshow goodness-of-fit test (P=0.775).

**Table 3** Multivariate Binary Analysis of Factors Associated with Cognitive Impairment in the Study Population

Variable		Multivariate Analysis		
		Odds Ratio	95% Confidence Interval	P value
Age, years		1.02	1.004–1.05	0.023
Depression score		1.09	1.01–1.18	0.038
Sex	Men	Reference		
	Women	2.09	0.85–5.15	0.107
Education level	Secondary and higher	Reference		
	Primary or lower	5.22	2.70–10.09	<0.001
Occupation status	Employed	Reference		
	Unemployed	2.46	1.03–5.91	0.043
Alcohol consumption	No	Reference		
	Yes	2.26	0.61–8.33	0.219
Diabetes mellitus	No	Reference		
	Yes	1.62	0.68–3.85	0.275
Hypertension	No	Reference		
	Yes	1.15	0.62–2.16	0.642
Depression	No	Reference		
	Yes	2.98	1.30–6.83	0.010

## Discussion

Our findings revealed an alarmingly high prevalence of cognitive impairment (73.5%) among adults in this community in central Sudan, underscoring a significant public health crisis in the region that deserves immediate attention and further investigation. This prevalence substantially exceeds that reported in other LMICs, including 43.8% in Ethiopia,<sup>9</sup> 52.45% in Thailand,<sup>8</sup> and 8.8% in India.<sup>4</sup> This discrepancy may be attributed to regional factors, including socioeconomic conditions, healthcare disparities, and the ongoing war. High mental health consequences, such as a high prevalence of posttraumatic stress disorder (PTSD), have been documented among the Sudanese population during the ongoing war.<sup>22,23</sup> Halaly et al reported a high prevalence of PTSD (70.3%) among internally displaced Sudanese, of whom 27.1% had severe symptoms.<sup>22</sup> The literature supports the long-term impact of war, including mental health consequences and cognitive impairments.<sup>24,25</sup>

The factors independently associated with cognitive impairment in this study, such as older age, low education, unemployment, and depression, are consistent with the established risk factors identified in many contexts.<sup>1,2</sup> The strong association between older age and cognitive impairment confirms the well-known association between aging and cognitive decline.<sup>4,9</sup> As the population of Sudan ages, the burden of cognitive impairment is likely to increase, necessitating proactive public health strategies.

The most striking finding was the significant association between low education and cognitive impairment (AOR: 5.22). This finding corroborates evidence from various studies worldwide that address the protective effect of education against cognitive decline.<sup>4,9</sup> The “cognitive reserve” hypothesis suggests that higher levels of education create a more resilient neural network, allowing individuals to better cope with brain pathology before the clinical manifestation of symptoms.<sup>26</sup> The high prevalence of cognitive impairment in this study population may partly reflect the low educational levels in this community, underscoring the importance of promoting educational opportunities as a long-term strategy for mental health. Moreover, the literature highlights the association between low education level and subsequent depression.<sup>27,28</sup>

Unemployment was also significantly associated with cognitive impairment (AOR: 2.46). This agrees with studies describing a complex and often bidirectional relationship between unemployment and mental health.<sup>29,30</sup> Unemployment can lead to financial strain, social isolation, and reduced cognitive stimulation, all of which are risk factors for cognitive decline.<sup>31,32</sup> Conversely, cognitive impairment itself can hinder an individual’s ability to maintain employment. This cycle highlights the importance of integrating vocational and social support programs with cognitive health interventions.

Depression independently predicted cognitive impairment (AOR: 2.98), highlighting the complex interplay between mental and cognitive health.<sup>14,27</sup> This relationship is also often considered bidirectional. Given the recent history of war and trauma in Sudan, the high prevalence of depression (18.5%) and anxiety (4.2%) in this study population<sup>15,16</sup> may be a significant contributing factor to the high prevalence of cognitive impairment. We previously reported that two-fifths (39.2%) of Sudanese adults had depression-anxiety.<sup>16</sup> This finding underscores the importance of integrating mental health screening and services into broader public health initiatives focused on cognitive health.

Notably, the association of hypertension and diabetes mellitus with cognitive impairment was no longer significant in the final multivariate model, despite their known status as key risk factors globally.<sup>8</sup> This suggests that other variables, such as age or depression, may confound their effects. Possible explanations include the relatively young median age (42 years) and short disease duration, especially among the newly diagnosed cases. Raghuvver et al reported that a diabetes duration of  $\geq 7$  years was a substantial factor associated with cognitive impairment.<sup>33</sup> Moreover, the high prevalence of newly diagnosed cases in our cohort suggests that many individuals in this community may be unaware of their chronic conditions, highlighting a significant gap in healthcare awareness and access.

Similar to previous studies,<sup>14,29,31–33</sup> our findings imply that the factors associated with cognitive impairment are interconnected. For example low education can lead to unemployment, which increases the risk of mental health issues such as depression. This, in turn, can both cause and be a consequence of cognitive decline, creating a complex cycle of risk. Unlike other studies, however, we found no association between cognitive impairment and female sex,<sup>9</sup> marital status,<sup>7</sup> smoking,<sup>4</sup> alcohol consumption,<sup>8</sup> high BMI,<sup>12</sup> diabetes mellitus,<sup>8</sup> hypertension,<sup>8</sup> and anxiety.<sup>12</sup> In the context of our study, this may be due to the specific demographic and health characteristics of the studied Sudanese population, the

low prevalence or frequency of certain behaviors such as alcohol and smoking, and the overwhelmingly dominant influence of other risk factors such as low education, unemployment, and depression.

## Implications

The exceptionally high prevalence of cognitive impairment in our cohort has profound public health implications for Sudan. A substantial portion of the adult population in this region may be at risk of dementia and related disabilities, potentially imposing massive healthcare and social support costs if left untreated. These findings call for the immediate implementation of population-based screening programs for cognitive impairment, particularly targeting older adults and individuals with low levels of education, unemployment, or symptoms of depression. Integrating cognitive health into existing primary healthcare services and starting public awareness campaigns on the importance of cognitive health and modifiable risk factors, such as mental health, are critical. The political instability and socioeconomic crises in Sudan may have exacerbated these public health challenges, and addressing the root causes of unemployment and mental distress is crucial for meaningful improvements in cognitive health.

## Strengths and Limitations

This study is the first to evaluate cognitive status at the community level, especially during an ongoing war. Its community-based design also provides a more accurate representation of the general population than hospital-based studies. The use of a multistage stratified random sampling approach enhances the generalizability of these findings to the target population. The use of the MoCA, a validated tool for cognitive assessment, and other standardized questionnaires (PHQ-9 for depression and GAD-7 for anxiety) strengthens internal validity.

However, this study also has some limitations. First, its cross-sectional design prevents the determination of causality. Second, the predominance of male participants limits the generalizability of these findings to the female population. A comparable sex imbalance was also observed in another community-based study in Ethiopia,<sup>9</sup> suggesting a possible cultural or methodological bias in community-based studies that needs further investigation. Third, the study was conducted in a specific region of central Sudan, which may not reflect nationwide patterns, especially in internally displaced populations. Fourth, the MoCA cutoff (<26) may overestimate the prevalence of cognitive impairment, particularly in populations with lower average education levels. Finally, we did not investigate other important factors associated with cognitive impairment, such as physical activity,<sup>8,10</sup> which could have provided a more comprehensive understanding of the risk profile.

## Conclusion

The prevalence of cognitive impairment was alarmingly high (73.5%) among adults in the studied community in central Sudan, with age, low education, unemployment, and depression identified as the main risk factors. These findings underscore the pressing need for comprehensive public health strategies that prioritize the early detection and management of cognitive impairment in Sudan. Future longitudinal studies are required to elucidate causal relationships between these risk factors and inform targeted interventions addressing and preventing cognitive decline in this understudied population.

## Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Ethics Approval and Consent to Participate

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki and adhered to good clinical research practices. This study was approved by the Research Ethics Committee of the Faculty of Medicine and Health Sciences at the University of Gadarif in Gadarif, eastern Sudan (Ref. #2025, 04, date 13 January 2025). Written informed consent was obtained from all participants before data collection.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## Disclosure

The authors declare that they have no competing interests in this work.

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