# INDICATORS OF FUNCTIONAL FITNESS AND COGNITIVE COMMITMENT IN ELDERLY

*INDICADORES DE APTIDÃO FUNCIONAL E COMPROMETIMENTO COGNITIVO EM IDOSOS*

*INDICADORES DE APTITUD FUNCIONAL Y COMPROMISO COGNITIVO EN ANCIANOS*

**ORIGINAL ARTICLE**
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## ABSTRACT

Introduction: Cognitive losses are among the most prevalent events in the elderly population and can cause functional deficits. Among the available non-drug prevention and treatment alternatives, the increase in functional fitness levels is presented as an important strategy suggesting improvements in the physical and cognitive function of the elderly triggered by exercise. Objective: To determine the predictive power of functional fitness indicators and establish their cutoff points as discriminators of cognitive impairment in the elderly. Methods: The sample comprised 310 elderly people who answered a questionnaire comprising sociodemographic information, lifestyle habits, hospitalization in the last 12 months, presence of comorbidity, and the Mini-Mental State Examination. Functional fitness was assessed using the Hand Grip Strength (HGS) and sitting and rising from a chair tests. To identify predictors of cognitive impairment, analysis of Receiver Operating Characteristic (ROC) curves was adopted, with a confidence interval of 95% (95%CI). Subsequently, the cut-off points with their respective sensitivities and specificities were identified. The analyses were performed respecting the significance level of 5%. Results: It was observed that some functional fitness indicators showed significant Area Under the Curve (AUC), and the sit-and-stand test (AUC=0.72; 95%CI: 0.64-0.77) showed the best results. The best cut-off points for the HGS and sit-and-stand tests were 18,8 kgf and eight repetitions, respectively. Conclusion: The results of the present study allow us to conclude that the sit-to-stand test is moderately efficient in discriminating the presence of cognitive impairment in the elderly. ***Level of Evidence III; Study Cross-sectional.***

**Keywords:** Functional Physical Performance; Cognitive Dysfunction; Health of the Elderly; Primary Health Care; Public Health.

## *RESUMO*

*Introdução: As perdas cognitivas estão entre os eventos mais prevalentes na população idosa, podendo causar déficits funcionais. Dentre as alternativas de prevenção e tratamento não medicamentosos disponíveis, o aumento dos níveis de aptidão funcional apresenta-se como uma estratégia importante sugerindo melhorias na função física e na função cognitiva de idosos, desencadeadas através da prática de exercícios. Objetivo: Determinar o poder preditivo dos indicadores de aptidão funcional e estabelecer seus pontos de corte como discriminadores do comprometimento cognitivo em idosos. Métodos: A amostra compreendeu 310 idosos que responderam a um questionário composto por informações sociodemográficas, hábitos de vida, hospitalização nos últimos 12 meses, presença de comorbidade e o Mini-Exame do Estado Mental. A aptidão funcional foi avaliada por meio dos testes de Força de Preensão Manual (FPM) e o de sentar e levantar da cadeira. Para identificação dos preditores do comprometimento cognitivo, foi adotada a análise das curvas Receiver Operating Characteristic (ROC), com intervalo de confiança de 95% (IC95%). Posteriormente, identificaram-se os pontos de corte com as respectivas sensibilidades e especificidades. As análises foram efetuadas respeitando-se o nível de significância de 5%. Resultados: Observou-se que alguns indicadores de aptidão funcional apresentaram Área Sob a Curva (ASC) significativas, sendo que o teste de sentar e levantar da cadeira (ASC=0,72; IC95%= 0,64-0,77) apresentou os melhores resultados. Os melhores pontos de corte para o teste de FPM e o teste de sentar e levantar da cadeira foram de 18,8 kgf e 8 repetições respectivamente. Conclusão: Os resultados do presente estudo permitem concluir que o teste de sentar e levantar da cadeira apresenta moderada eficiência para discriminar a presença de comprometimento cognitivo em idosos.* ***Nível de Evidência III; Estudo Transversal.***

***Descritores:*** *Desempenho Físico Funcional; Comprometimento Cognitivo; Saúde do Idoso; Atenção Primária à Saúde; Saúde Pública.*

## *RESUMEN*

*Introducción: Las pérdidas cognitivas se encuentran entre los eventos más prevalentes en la población anciana y pueden causar déficits funcionales. Entre las alternativas de prevención y tratamiento no farmacológico disponibles, el aumento de los niveles de condición física funcional se presenta como una estrategia importante que sugiere mejoras en la función física y cognitiva de los ancianos, desencadenada por la práctica de ejercicios. Objetivo: Determinar el*




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*poder predictivo de los indicadores de aptitud funcional y establecer sus puntos de corte como discriminadores del deterioro cognitivo en adultos mayores. Métodos: La muestra estuvo compuesta por 310 ancianos que respondieron un cuestionario que comprendía información sociodemográfica, hábitos de vida, hospitalización en los últimos 12 meses, presencia de comorbilidad y el Mini-Examen del Estado Mental. La condición física funcional se evaluó utilizando la fuerza de agarre manual (FAM) y las pruebas de sentarse y levantarse de una silla. Para identificar predictores de deterioro cognitivo, se adoptó el análisis de curvas Receiver Operating Characteristic (ROC), con intervalo de confianza del 95% (IC95%). Posteriormente se identificaron los puntos de corte con sus respectivas sensibilidades y especificidades. Los análisis se realizaron respetando el nivel de significancia del 5%. Resultados: Se observó que algunos indicadores de aptitud funcional mostraron un Área Bajo la Curva (ABC) significativa, y la prueba de sentarse y pararse (ABC=0,72; 95%IC: 0,64-0,77) mostró los mejores resultados. Los mejores puntos de corte para el test FAM y el sit-and-stand test fueron 18,8 kgf y 8 repeticiones, respectivamente. Conclusión: Los resultados del presente estudio permiten concluir que el test sit-to-stand es moderadamente eficiente para discriminar la presencia de deterioro cognitivo en adultos mayores.* ***Nivel de Evidencia III; Estudio Transversal.***

***Descriptores:*** *Desempeño Físico Funcional; Disfunción Cognitiva; Salud del Anciano; Atención Primaria de Salud; Salud Pública.*

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## INTRODUCTION

Cognitive losses are among the most prevalent events among the elderly population. A meta-analysis in 2022, which looked at the occurrences of cognitive impairment from 1995 to 2021, showed that 2410 (44.78%) of its sample of elderly people had mild impairment.[1]

Losses in cognitive function are important events that compromise the health and quality of life of the elderly. Increasing functional fitness levels is an important strategy among the prevention and non-drug treatment alternatives available.[2]

Brain stimuli throughout life, such as more complex work and physical and leisure activities, can promote neuronal growth and consequently foster neuroplasticity. This process may contribute to the construction, formation, and maintenance of higher levels of cognitive reserve, which could promote greater resistance to brain damage in elderly individuals.[3]

Although some authors relate deficits in physical function to cognitive impairment,[2,4] studies on the discriminatory capacity of functional fitness indicators for screening cognitive impairment are incipient. This study aimed to determine the predictive power of functional fitness indicators and establish their cut-off points as discriminators of cognitive impairment in the elderly.

## MATERIALS AND METHODS

This is a cross-sectional study based on the results of the first phase of the household survey entitled "Monitoring the Health Conditions of the Elderly in a Small Municipality (MONIDI)", carried out in the municipality of Ibicuí (located in the southwestern region of Bahia) in 2014. A total of 310 elderly people registered with the Family Health Strategy (ESF) in the municipality of Ibicuí, of both sexes, were randomly selected.

The target population of this study was represented by elderly people living in the rural and urban areas of the municipality. Thus, the inclusion criteria used were individuals aged 60 or over registered with the ESF in Ibicuí (BA). Exclusion criteria included bedridden elderly people who had Alzheimer's disease or any other type of neurological disease that affected cognition and, in some way, compromised the integrity of the information collected.

To determine the sample size, we used the criteria proposed by Luiz and Magnanini[5] for finite populations, assigning a significance level of 5%, Confidence Interval (CI) of 95%, and Tolerable Error (TE) of 3%; more details on the sample design have been published in previous studies.[6,7]

10% more subjects were included in the sample to compensate for possible losses and refusals. Thus, considering the sampling process for this type of study, in which numerical representativeness is a characteristic. After applying the eligibility criteria and accounting for losses (moving out of the municipality, not being found more than three times at the ESF or home, and refusals), the final sample consisted of 310 elderly people (201 from the urban area and 109 from the rural area) selected at random. (Figure 1)

Data was collected using the previously created and validated Elderly Health Assessment Instrument (IASI).[8] Participants were invited to the USF on the collection days and were informed about the research, its importance, and objectives. All the interviewees signed an Informed Consent Form, agreeing to participate voluntarily in this study. With

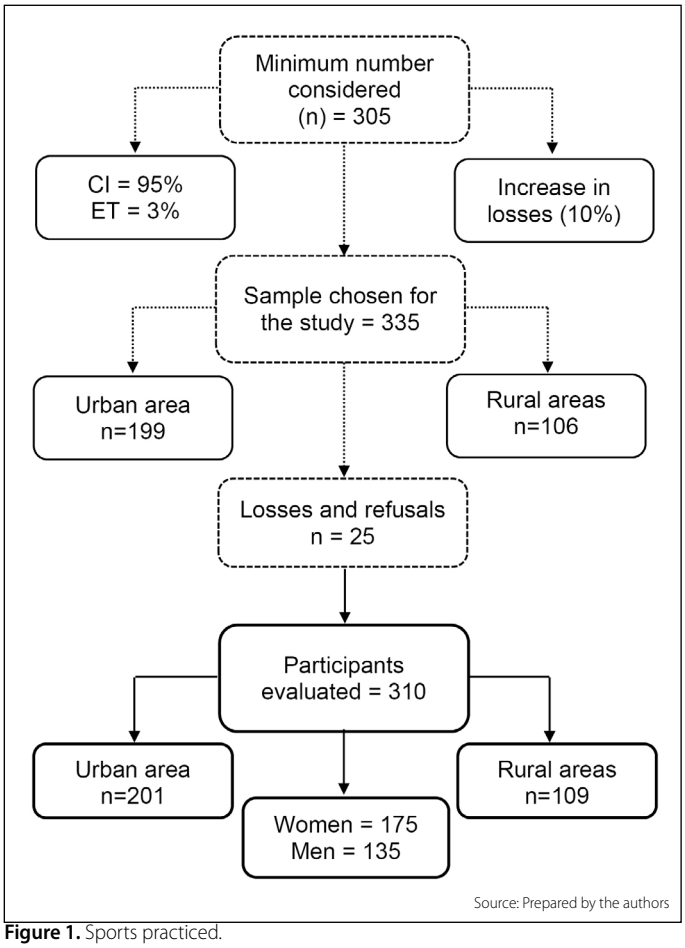


**Figure 1.** Sports practiced.

a previously trained team, the elderly were interviewed individually, followed by anthropometric and motor performance assessments.

As for the variables, this study included sociodemographic information: gender (male and female), age in complete years and categorized by age groups (60-79 years and greater than or equal to 80 years), schooling (illiterate or literate), race/color (white, yellow, brown, indigenous and black), current marital status (with a partner or without a partner), living situation (accompanied or alone) and number of children (none, one child and at least two).

Lifestyle habits categorized as consumption of alcoholic beverages (yes or no), current or former smoking (dichotomous, "yes" being considered for at least one of them), physical inactivity (classified according to the criteria of Pitanga and Lessa[9]), where those who reported not participating in physical activities during leisure time were considered to be inactive during leisure time, considering the usual typical week), hospitalization in the last 12 months and presence of comorbidity (the presence of one or more self-reported comorbidities was considered: diabetes and stroke).

The cognitive impairment variable was also assessed using the Mini-Mental State Examination (MMSE);[10] the cut-off points were established based on the criteria of Bertolucci et al.[11] To assess functional fitness, the handgrip strength test (HGS) was used: assessment using an Electronic Hand hydraulic dynamometer (E. Clear - Model: EH101), using as a reference the method standardized by Vianna, Oliveira and Araujo;[12] and the sit and stand test, using the protocol proposed by Rikli and Jones.[13]

Descriptive statistics procedures were used to analyze the data. The Receiver Operating Characteristic (ROC) curve was used to estimate the cut-off points for functional fitness indicators in the discrimination of cognitive impairment, with the respective sensitivity and specificity scores, using the *Software for Statistics and Data Science* (STATA version 14.0) and *MedCalc for Windows*, version 11.4.4 (MedCalc®). The total area under the ROC curve was initially identified between the HGS, the sit and stand test, and the presence of cognitive impairment, using a 95% CI.

The greater the area under the ROC curve, the greater the discriminatory power of the functional fitness indicators for the presence of cognitive impairment. The CI determines whether the predictive capacity of the indicators is not due to chance, and its lower limits must not be less than 0.50. Subsequently, the cut-off points were identified with their respective predictive values, sensitivities, and specificities.

This research followed all the ethical recommendations of the Declaration of Helsinki[14] and Resolution No. 466/2012 of the National Health Council.[15] The study was approved by the Research Ethics Committee of the Universidade Estadual do Sudoeste da Bahia (CAAE: 22969013.0.0000.0055).

## RESULTS

The average age of the interviewees was 71.62 (±8.16) years. The majority of the elderly included were female (56.45%), aged between 60-79 (83.87%), literate (56.13%), with an average monthly income of 708.26 (± 303.70) reais, black or brown (68.60%), living in a household (78.39%) and with children (94.95%). (Table 1)

Regarding lifestyle habits, the majority reported not drinking alcohol regularly (95.79%), 56.13% were smokers or had smoked, and 69.03% were inactive during leisure time. The overall prevalence of cognitive impairment was 4.19%. (Table 1)

Analysis of the ROC curves showed that the functional fitness indicators had Area Under the Curve (AUC) scores of 0.65 (95%CI = 0.60-0.70) for the HGS (Figure 2) and 0.72 (95%CI = 0.64-0.77) for the sit and stand test. (Figure 3)

**Table 1.** Distribution of sociodemographic characteristics, lifestyle habits, and health status - Ibicuí (BA), 2014.

| Variables | Frequencies | |
|---|---|---|
| | n | % |
| **Sex** | | |
| Female | 175 | 56.45 |
| Male | 135 | 43.55 |
| **Age group** | | |
| 60-79 years | 260 | 83.87 |
| 80 or more | 50 | 16.13 |
| **Education** | | |
| Illiterate | 136 | 43.87 |
| Literate | 174 | 56.13 |
| **Race/Color** | | |
| White/Yellow/Indigenous | 92 | 31.40 |
| Black/Brown | 201 | 68.60 |
| **Marital status** | | |
| With Companion | 152 | 50.00 |
| Without a partner | 152 | 50.00 |
| **Housing situation** | | |
| Accompanied by | 243 | 78.39 |
| Alone | 67 | 21.61 |
| **Has children** | | |
| No | 15 | 5.05 |
| Yes | 282 | 94.95 |
| **Alcohol consumption** | | |
| Yes | 13 | 4.21 |
| No | 296 | 95.79 |
| **Smoking** | | |
| Yes | 174 | 56.13 |
| No | 136 | 43.87 |
| **Physical inactivity** | | |
| Yes | 214 | 69.03 |
| No | 96 | 30.97 |
| **Hospitalization*** | | |
| Yes | 93 | 30.00 |
| No | 217 | 70.00 |
| **Presence of comorbidity** | | |
| Yes | 58 | 18.71 |
| No | 252 | 81.29 |
| **Cognitive impairment** | | |
| Present | 13 | 4.19 |
| Absent | 297 | 95.81 |

*Last 12 months.

**Table 2.** Comparison of the areas under the ROC curves between functional fitness indicators and cognitive impairment in the elderly - Ibicuí/ BA, 2014.

| Functional Fitness Indicators | Area | IC (95%) | p-value |
|---|---|---|---|
| HGS | 0.65 | 0.60 – 0.70 | 0.023 |
| Sit and stand test | 0.72 | 0.64 – 0.77 | 0.0001 |

When analyzing the sensitivity and specificity values of the functional fitness indicators, it was observed that the cut-off points that best discriminated cognitive impairment were ≤ 18.8 kgf (sensitivity = 69.2% (95% CI= 38.6-90.7%) and specificity = 59.6% (95% CI= 53.8-65.2)) for the HGS and ≤ 8 repetitions (sensitivity = 76.9% (95% CI=46.2-94.7) and specificity = 61.6% (95% CI=55.8-67.2)) for the sit and stand test. (Table 2)

## DISCUSSION

This study sought to determine the predictive power of functional fitness indicators and establish their cut-off points as discriminators of

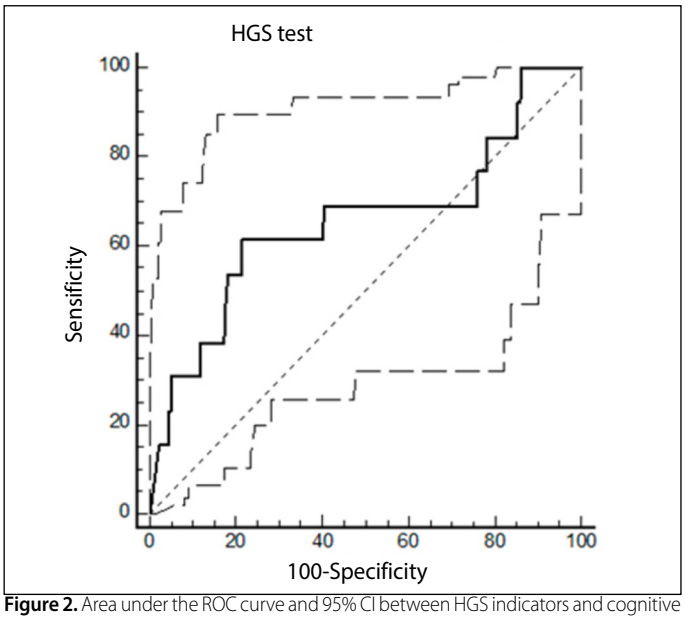


**Figure 2.** Area under the ROC curve and 95% CI between HGS indicators and cognitive impairment in the elderly - Ibicuí/BA, 2014.

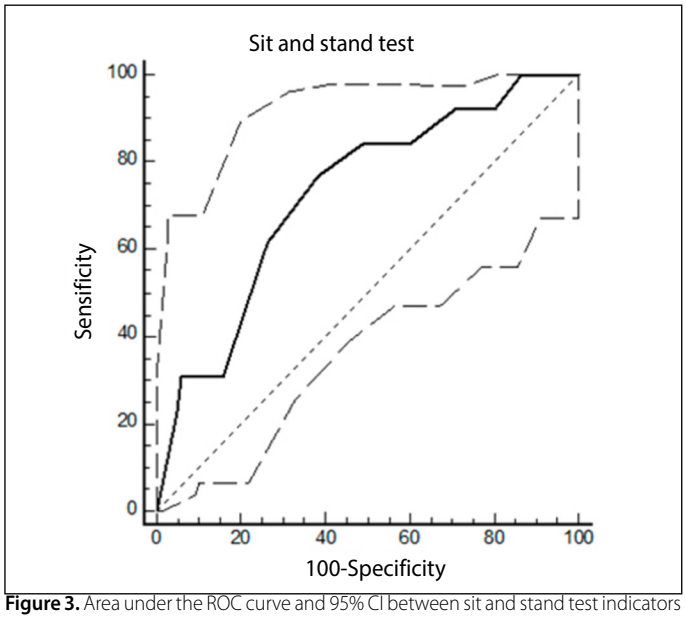


**Figure 3.** Area under the ROC curve and 95% CI between sit and stand test indicators and cognitive impairment in the elderly - Ibicuí/BA, 2014.

cognitive impairment in the elderly. The results showed that the sit and stand test is moderately efficient for predicting cognitive impairment in the elderly (AUC: 0.70-0.9), with a cut-off point of 8 repetitions, while the HGS test showed little efficiency in discriminating cognitive impairment (AUC: 0.5-0.7) (cut-off point: 18.8 kgf).

The construction of ROC curves has been recommended in epidemiological studies to determine cut-off points.[16] This type of analysis allows the determination of the best cut-off point and the results of the area under the curve, which translates the discriminatory power of an indicator for a given outcome. Its schematic representation, through the interpretation of the area under the curve, can determine a test's efficiency and how much its population can benefit from it.

Tests with an AUC >1 can be considered highly efficient. For example, those whose AUC is equal to 1 prove to be efficient for applying a particular disease in their population. Those with AUCs between 0.7 and 0.9 or between 0.5 and 0.7 are moderately or inefficient, respectively.[17] In this study, the sit and stand test, as one of the indicators of functional fitness analyzed, proved to be the best predictor of cognitive impairment in the elderly.

Cognitive impairment negatively affects the quality of life of the elderly, reducing their functional capacity and, consequently, their autonomy to carry out their daily activities. This repercussion tends to become more pronounced with advancing age.[18] During the natural aging process, there are declines in the somatosensory (proprioceptive), visual, and vestibular systems that control balance.[19]

The central nervous system can undergo changes that affect postural control and balance, including neuronal loss, dendritic loss, reduced branching, decreased metabolism, cerebral perfusion, and altered synthesis of neurotransmitters.[20] In addition, muscle strength, especially in the lower limbs, is also impaired with advancing age, with a decrease in the recruitment and activation of motor units. The combination of low fitness levels and an unhealthy lifestyle is closely related to social isolation and reduced physical mobility, which can lead to loss of functional autonomy and neurological disorders in some cases, affecting performance in cognitive tests.[21,22]

A study of 13,828 elderly Americans found that the lower the level of strength applied to the HGS test, the greater the chances of cognitive impairment.[23] Thus, the HGS has been used to monitor cognitive changes when its reduction has been a predictor of cognitive loss with advancing age.[23,24] However, in the present study, it proved to be a low-efficiency test for discriminating cognitive impairment in the elderly.

Few studies report a specific association between the sit and stand test and cognitive impairment. However, considering that it is a method of assessing functional capacity, it is possible to infer that, in general, motor performance associated with tests that assess strength, mobility, aerobic fitness, and body composition can predict cognitive decline.[2,4]

The sit and stand movement is an important measure of lower limb strength, based on balance control or the risk of falls, which are fundamental for assessing individuals' mobility and functional independence.[25] The HGS measure is an important marker for screening age-related changes in physical performance,[26,27] a simple measure of low mobility, which has a linear relationship with the deficit in ADLs.

The prevalence of cognitive impairment among the elderly investigated (4.19%) was lower than other national[18,28] and international studies.[29] The difference may be influenced by sociodemographic factors, geographical conditions, and the population's living conditions regarding whether they live in the community or long-term care facilities. Biological factors may be involved in these differences, associated with the processes of neuroplasticity and cognitive and metabolic reserves, to have repercussions on sex differences in cognitive aging.[30]

The study's limitations include its methodological design since a cross-sectional study does not allow for the evaluation of cause and effect between the variables studied. In addition, the outcome variable was assessed using a screening instrument, which, despite being widely used in scientific literature, is subject to recall bias.

On the other hand, the study was conducted with a population that has been little studied in Brazil, making it possible to disseminate useful and valid information that can contribute to healthcare policies, as well as reorienting the assessment of functional fitness among the elderly, to guarantee the quality of life and survival of these patients. Thus, as indicators of functional fitness, these tests contribute as health intervention measures to discriminate cognitive impairment in the elderly, which is constantly on the rise in the country.

## CONCLUSION

The results of this study showed that the sit and stand test had moderate discriminatory efficiency for predicting cognitive impairment in the elderly. In contrast, the HGS test had low discriminatory efficiency for the outcome. These findings confirm the importance of assessing

physical performance in the elderly using functional fitness indicators, which are quick and easy to perform.

The inclusion of this practice as a strategy for the primary health care of the elderly, especially in the context of the FHS, associated with the patient's clinical data, will contribute to the early identification of functional limitations, to the assessment of health status, to the saving of resources (such as unnecessary treatment, reduction of hospitalizations), to clinical decision-making, as well as to prior interventions in the treatment of these repercussions that can be caused to the health of the elderly person and their family, and may predict other health conditions that may be related, such as cognitive impairment.

All authors declare no potential conflict of interest related to this article

**AUTHORS' CONTRIBUTIONS:** All of the authors made significant individual contributions to the manuscript's development. CRCD was responsible for conceptualization, formal analysis, methodology, original draft writing, revision and editing, supervision, research, and data curation. SVR contributed to conceptualization, formal analysis, revision and editing of the writing, supervision, research, and data curation. JPC provided original draft writing, proofreading, editing, and data curation. BMPF contributed to proofreading, editing, and research. AFC provided proofreading, editing, and research. CAS contributed to original draft writing, proofreading, editing, and research.

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