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Correspondence between brain volumetry by magnetic resonance imaging and the Pasquier visual scale of global cortical atrophy. A single-center observational study.

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Abstract

Introduction: The assessment of cortical atrophy is usually based on subjective visual scales such as the Pasquier scale. Given the limitations in sensitivity of these methods, this study aims to describe the correlation between automated brain volumetry values and Pasquier scale scores in patients at Alcívar Hospital.

Materials and methods: This was an observational, retrospective study conducted at Alcívar Hospital (Guayaquil) between 2023 and 2025. A total of 885 magnetic resonance imaging (MRI) scans of adults over 65 years of age were analyzed using probabilistic sampling. Variables included brain volumetry (segmented using 3D Slicer software) and the Pasquier visual acuity scale. The analysis was descriptive and employed measures of central tendency and frequencies. To mitigate bias, a structured guide of criteria and paired coding were applied to ensure data consistency and objectivity.

Results: 885 records were analyzed (100% of the sample), with a predominance of women and patients between 65 and 75 years of age. According to the Pasquier scale, 66.1% presented grade I atrophy, while grade III represented only 3.8%. The average global brain volume was 1,256.5 mL, demonstrating a progressive reduction in volume as severity increased on the visual scale: 1,256.5 mL (Pasquier I), 1,228.6 mL (Pasquier II), and 1,210.5 mL (Pasquier III).

Conclusions: There is a direct correlation between Pasquier's visual assessment and quantitative volumetry. A progressive reduction of approximately 20 mL of brain volume was observed for each degree of atrophy, supporting the use of volumetric measurements to objectively assess brain mass loss.

Keywords: Magnetic Resonance Imaging, Cerebral atrophy, Aging, Neurodegenerative diseases, Brain, Neuroradiology.

Introduction

The assessment of cerebral cortical atrophy is a fundamental component of current neuroradiological practice, particularly in the context of population aging and neurodegenerative diseases [1]. Traditionally, this assessment has been based on qualitative visual scales, among which the Pasquier Global Cortical Atrophy (GCA) scale is one of the most widely used in daily clinical practice, as it allows for a rapid estimation of the degree of widening of the cortical sulci and the overall loss of brain volume [2].

While these visual scales have demonstrated undeniable practical utility, they present limitations inherent to observer subjectivity, such as marked inter- and intra-observer variability and reduced sensitivity for detecting subtle or early changes in brain atrophy [3]. Recent literature shows that qualitative methods can significantly underestimate initial volume loss, especially in patients with mild cognitive impairment or in prodromal phases of dementia [4]. In response to this reality, the development and availability of magnetic resonance imaging techniques with volumetric acquisition have allowed for the incorporation of quantitative methods for brain analysis. Automated volumetric segmentation provides reproducible data, enables comparison of the patient with normative cohorts, and facilitates the identification of specific regional patterns that serve as biomarkers with prognostic value [5]. According to recent meta-analyses, integrating these quantitative metrics optimizes diagnostic accuracy and improves sensitivity by 10% to 30% compared with purely visual assessment [6].

Although brain volumetry has become established as a valuable complementary tool for reducing diagnostic uncertainty and supporting longitudinal follow-up, its use in daily clinical practice remains limited. Furthermore, there is a gap in the scientific literature regarding data exploring the direct correlation between automated volumetric values and conventional visual scales, a deficiency that is even more pronounced in Latin American populations.

Therefore, this study aims to describe the correlation between brain volume measurements obtained by magnetic resonance imaging and the degree of global cortical atrophy assessed using the Pasquier scale in an institutional series of elderly patients at Alcívar Hospital. The goal is to provide local data to support the justification and integration of quantitative methods in regional neuroradiological practice.

Materials and methods

Studio design

This study is observational; the source is retrospective.

Scenery

The present study was conducted at the Diagnostic Imaging Center of the Alcívar Hospital in Guayaquil, Ecuador. The study period was from January 1, 2023, to December 30, 2025.

Participants

Magnetic resonance imaging (MRI) scans of adults aged 65 years or older were included. Incomplete MRI studies or those with artifacts that prevented adequate structural assessment, as well as MRI angiographic studies, were excluded.

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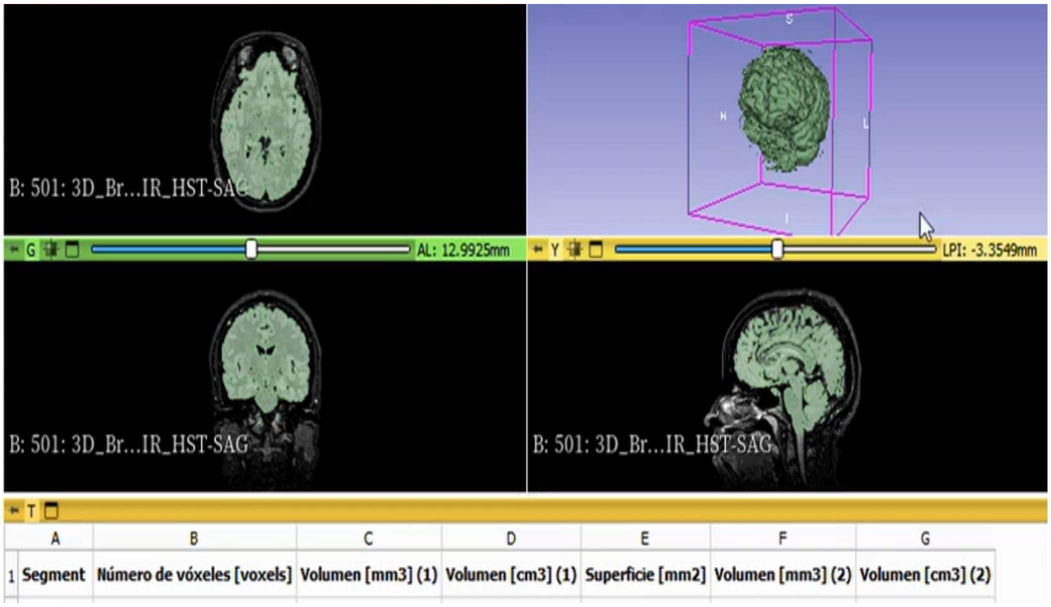
Variables

Brain volume variables obtained by magnetic resonance imaging and global cortical atrophy grades evaluated by the Pasquier visual scale were included.

Data sources/measurements

Data collection was performed using a primary source: the institution's magnetic resonance imaging (MRI) database. Global brain volume was calculated by segmenting the brain parenchyma from volumetric MRI images using the open-source software 3D Slicer (Figure 1). The resulting volumetric values were categorized according to the Pasquier Global Cortical Atrophy Scale to assess their descriptive correlation.

Figure 1: Volumetric brain segmentation using 3D Slicer software from brain magnetic resonance imaging



Biases

To mitigate interviewer bias and ensure standardization in data collection, a structured guide of pre-interview definition criteria was implemented. This instrument provided objective operational descriptions for each variable and category of analysis. By strictly adhering to these unified parameters, subjective biases, personal interpretations, or evaluator expectations were prevented from influencing question formulation or response coding, thus ensuring the internal consistency of the process. Data interpretation bias was controlled through triangulation and blinded coding. The analysis did not rely on a single researcher; instead, paired (interjudgmental) coding was used, in which two researchers independently analyzed the data following a pre-established codebook and then calculated their level of agreement. Additionally, a validation strategy was applied with the participants, returning a synthesis of the findings to a sample of the interviewees to confirm that the methodological interpretations faithfully reflected their original perspectives, thus ensuring the reflexivity and objectivity of the analysis.

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Study size

The sample was probabilistic. In the city of Guayaquil, with a population of 2,950,000, the percentage of adults over 65 is 9%, representing 265,500 people. With an expected frequency of 50%, a confidence level of 5%, and a confidence level of 99%, the sample size was 662 cases.

Quantitative variables

Results are presented as frequencies and percentages. Variables collected on a scale were not converted into categorical variables.

Statistical analysis

The data analysis was performed descriptively. Epidemiological variables were summarized using measures of central tendency and percentages, and represented using bar graphs.

Results

Participants

885 brain magnetic resonance imaging records were analyzed, representing 100% of the sample size.

Sociodemographic description of the group

There were 372 cases in 2023, 246 cases in 2024, and 267 in 2025. The highest percentage was observed among women (Figure 2) and patients aged 65 to 75 years (Figure 3).

Figure 2. Sex of patients studied.

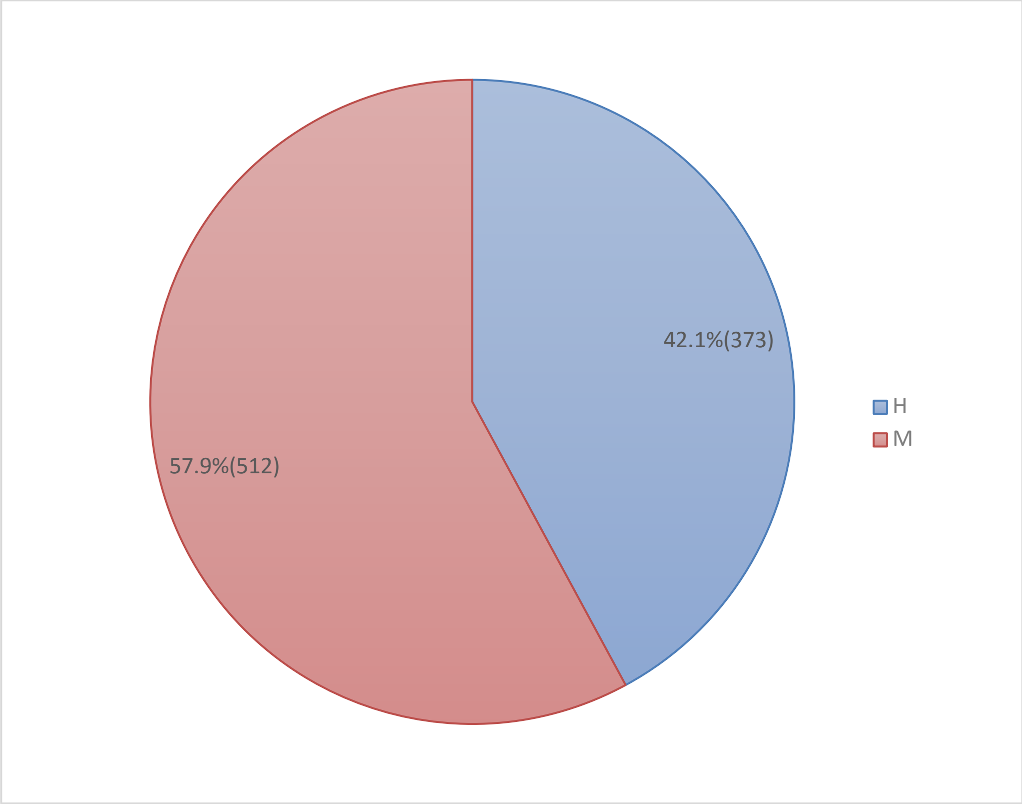

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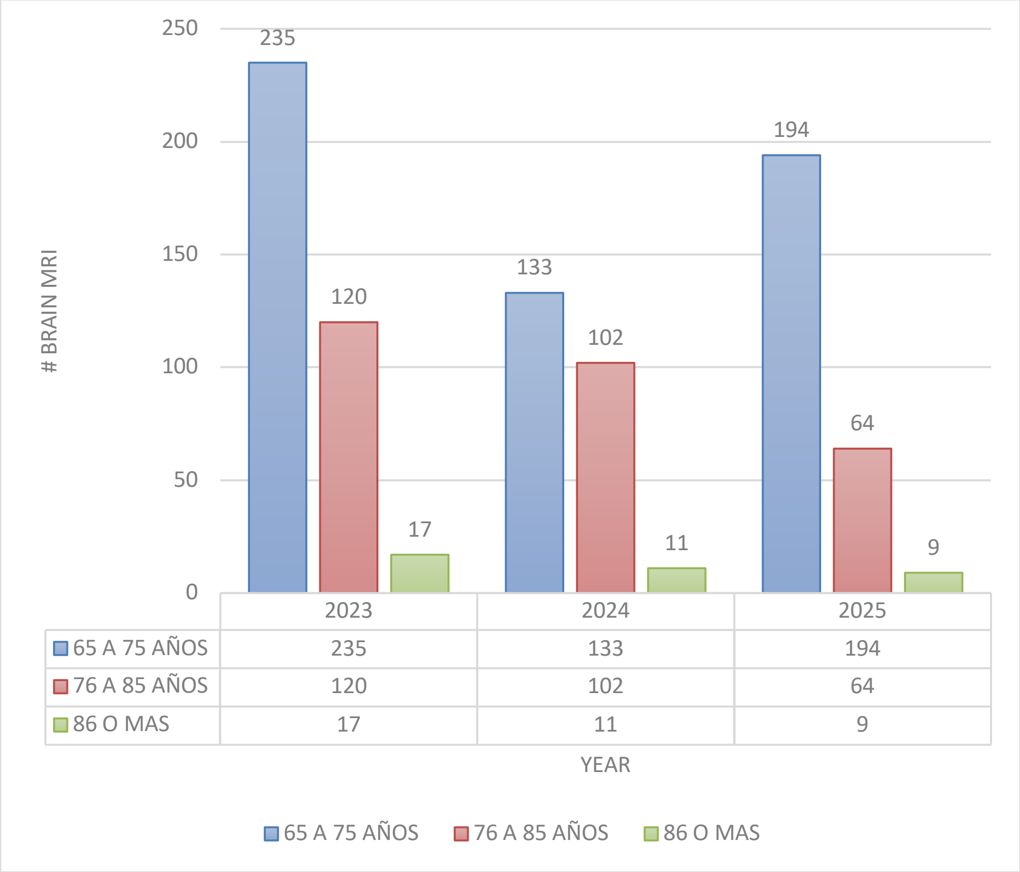
Figure 3. Sex of patients studied.



Distribution of global cortical atrophy grades

Visual assessment of global cortical atrophy using the Pasquier scale showed a clear predominance of mild grades. Pasquier grade I was the most frequent, accounting for approximately 66.1% of studies in the cohort. Intermediate grades of cortical atrophy (Pasquier II) constituted a smaller proportion of the sample, while severe grades of global cortical atrophy (Pasquier III) represented only 3.8% of the cases analyzed (Figure 4).

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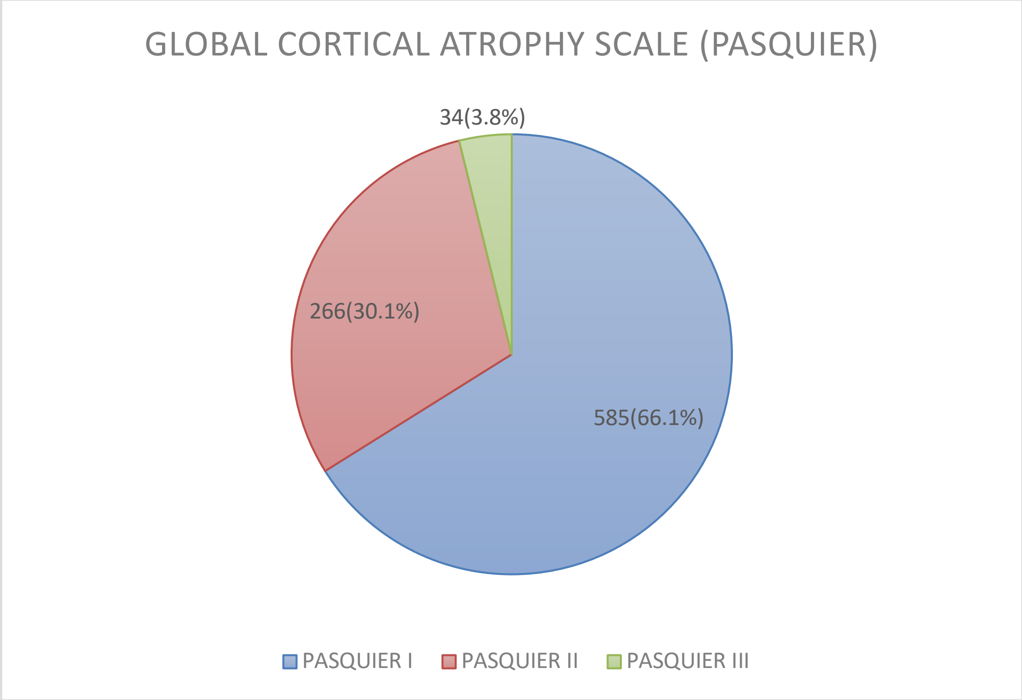
Figure 4. Distribution of global cortical atrophy grades according to the Pasquier scale in the studied cohort (Hospital Alcívar, 2023–2025).



Brain volumetric analysis

The average global brain volume observed in the cohort was 1,256.5 mL. Average brain volumes were determined by the degree of global cortical atrophy on the Pasquier scale (Figure). A progressive decrease in brain volume is observed as the degree of global cortical atrophy increases: Pasquier I (1,256.5 mL), Pasquier II (1,228.6 mL), and Pasquier III (1,210.5 mL).

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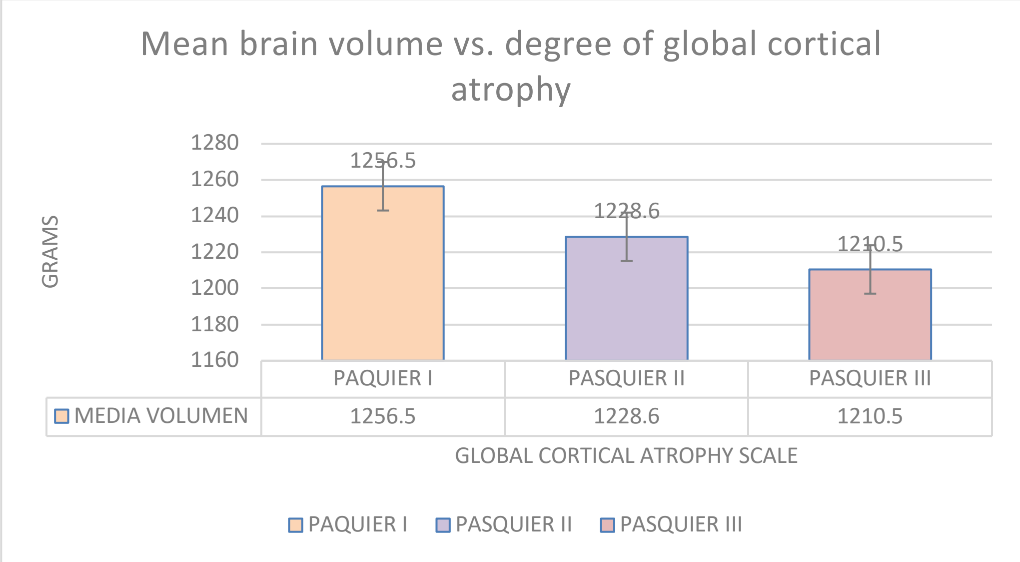
Figure 5. Mean brain volume according to the degree of global cortical atrophy of the Pasquier scale.



Discussion

In this institutional series of older adult patients evaluated at Hospital Alcívar between 2023 and 2025, the application of brain volumetry techniques enabled exploration of the descriptive correspondence with the visual assessment of global cortical atrophy using the Pasquier scale. The cohort was predominantly composed of patients aged 65 to 75 years, with a higher representation of females, a demographic profile common in neuroimaging studies focused on brain aging and cognitive pathology [1, 2].

The results show a clear predominance of mild categories of global cortical atrophy, particularly Pasquier category I, which represented more than two-thirds of the sample. This finding suggests that most of the included studies correspond to a spectrum of physiological or mildly pathological brain aging, rather than advanced neurodegenerative processes. Consistent with this visual distribution, the average global brain volume observed (1,256.5 mL) falls within the ranges described for older adults without evidence of accelerated atrophy, according to international series and data from Latin American populations [3–5].

From a neuroradiological perspective, these findings support the presence of a decreasing volumetric gradient with increasing visual cortical atrophy, although the present study did not aim to establish a formal statistical correlation. The descriptive correspondence between the categories of the Pasquier scale and the volumetric values reinforces the usefulness of brain volumetry as a quantitative tool that complements the visual scales traditionally used in clinical practice [6–8] (Table 1).

The low prevalence of severe global cortical atrophy (Pasquier III) observed in this sample contrasts with some international series that report higher proportions of advanced atrophy in populations of similar age [9, 10]. This difference could be explained by the relatively younger age composition of the cohort and by clinical and selection factors inherent to an institutional series based on studies commissioned for various clinical indications. Furthermore, the observed female predominance should be interpreted with caution, given

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known differences in global brain volume between the sexes, highlighting the importance of performing analyses adjusted for biological variables in future studies [11, 12].

The main limitations of the study include its retrospective, single-center design, the lack of longitudinal analysis, and the absence of correlation with clinical and neuropsychological assessments. Nevertheless, this work demonstrates the feasibility of incorporating volumetric segmentation techniques into daily neuroradiological practice and provides relevant local information on brain volumetric behavior in older adults evaluated by magnetic resonance imaging [13–15].

Table 1. Descriptive correspondence between the Pasquier global cortical atrophy scale and brain volume values estimated by magnetic resonance imaging.

Pasquier Scale	Morphological characteristics in MRI	Estimated brain volume (mL)	Neuroradiological interpretation
Pasquier O	Normal cortical sulci, without widening	~1275–1280 mL	Brain volume within expected ranges for older adults with no evidence of cortical atrophy
Pasquier I	Slight widening of cortical sulci	≈ 1256 mL	Mild cortical atrophy consistent with physiological aging
Pasquier II	Moderate widening of cortical sulci with cortical thinning	≈ 1235–1240 mL	Moderate cortical atrophy, possible incipient cognitive impairment
Pasquier III	Marked widening of sulci and overall reduction in brain volume	≈ 1215–1220 mL	Advanced cortical atrophy, suggestive of an established neurodegenerative process

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Conclusion

The volumetric analysis of the brain revealed an average global brain volume of 1,256.5 mL , consistent with the ranges described in the literature for older adults without evidence of accelerated neurodegeneration. Descriptively, a progressive decrease in global brain volume was observed as the degree of cortical atrophy increased according to the Pasquier scale, with reductions of approximately 20 mL between scale categories, suggesting a structural correspondence between the qualitative visual assessment and the quantitative volumetric measurements.

Abbreviations
MRI: magnetic resonance imaging.

Supplementary information
Supplementary materials have not been declared.

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Not declared.

Authors' contributions
Santiago Celi : Conceptualization, data curation, research, methodology, visualization, original draft writing.
Andrés Arroyo : Conceptualization, data curation, research, project management, and writing of the original draft.
Max Iván Cuesta Fernández : Conceptualization, formal analysis, software, validation, visualization, writing – revision and editing.
Paul San Martin : Conceptualization, data curation, research, project management, and writing of the original draft.
All authors read and approved the final version of the manuscript.

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Availability of data or materials
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Statements

Ethics committee approval and consent to participate
The study was approved by the Bioethics Committee of the Faculty of Medical Sciences of the International University of Ecuador.

Consent for publication
The publication of the magnetic resonance imaging model was authorized by the patient in writing.

Conflicts of interest
The authors declare no conflicts of interest.

Use of generative AI
The authors declare that they used generative AI responsibly in the “Introduction” section, without replacing their critical thinking, expertise, and judgment. AI was used under supervision and control to develop the discussion section. The use of the AI tool maintains the privacy and confidentiality of data and contributions, including published and unpublished manuscripts, as well as any personally identifiable information. The journal's policies, which permit the use of generative AI only in the introduction and discussion sections, have been followed. Only limited rights are granted to the AI to provide a service. The accuracy, integrity, and fairness of all AI-generated outputs were carefully reviewed and verified to ensure that the manuscript reflects an authentic and original contribution.

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