International Journal of Scientific Reports
Sagam DR. Int J Sci Rep. 2026 Feb;12(2):65-69
http://www.sci-rep.com
pISSN 2454-2156 | eISSN 2454-2164

DOI: https://dx.doi.org/10.18203/issn.2454-2156.IntJSciRep20260034

Original Research Article

Investigating the correlation between solar activity and human health outcomes

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Received: 17 August 2025
Revised: 06 January 2026
Accepted: 07 January 2026

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ABSTRACT

Background: Solar activity, characterized by sunspots and solar cycles, has been hypothesized to influence human health outcomes. This study investigates the correlation between solar activity and health outcomes, including cardiovascular, neurological, and heat-related mortality.
Methods: This observational ecological study analyzed solar activity data from 1950 to 2024, including sunspot numbers and geomagnetic indices (Kp). Health outcomes were obtained from the WHO mortality database, stratified by latitude. Statistical analysis included correlation, regression, and stratified analysis to assess the relationships while accounting for confounders such as temperature anomalies and air pollution.
Results: Geomagnetic activity (Kp Index) showed a significant correlation with cardiovascular (r=0.72, p<0.001) and neurological mortality (r=0.65, p<0.01). Sunspot numbers correlated with heat-related mortality (r=0.48, p=0.03). Regression analysis revealed that geomagnetic activity was the strongest predictor of cardiovascular outcomes, with a coefficient of 14.18 (p<0.001).
Conclusions: Geomagnetic activity significantly impacts cardiovascular and neurological health. Public health strategies should consider monitoring solar activity to mitigate risks during extreme geomagnetic events.

Keywords: Solar activity, Sunspots, Geomagnetic index, Cardiovascular health, Neurological health, Public health

INTRODUCTION

Solar activity, marked by periodic increases in sunspots and associated geomagnetic disturbances, impacts Earth's magnetosphere.[1,2] Recent studies indicate that solar phenomena can influence human physiology, potentially triggering cardiovascular, neurological, and infectious disease outcomes.[3-6] Sunspot cycles and geomagnetic storms also affect environmental radiation levels and biological processes such as circadian rhythms and immune modulation.[7-10]

Solar activity influences the earth primarily through modulation of the geomagnetic field, ionospheric disturbances, and variations in solar ultraviolet radiation.[11,19] These space weather phenomena have been proposed to affect human physiology by altering neuroendocrine signaling, autonomic nervous system balance, and circadian rhythm regulation.[9,10] Experimental and observational studies suggest that geomagnetic disturbances may influence heart rate variability, blood pressure regulation, and melatonin secretion, thereby increasing vulnerability to cardiovascular and neurological events.[3,4,9]

From a public health perspective, solar activity has been explored as an environmental stressor comparable to temperature extremes and air pollution. Several population-based studies have reported increased hospital admissions, sudden cardiac deaths, and neuropsychiatric disturbances during periods of heightened geomagnetic activity.[4,6,17] However, findings remain heterogeneous due to differences in study design, geographic latitude, and duration of observation. Long-term ecological analyses covering multiple solar cycles are therefore essential to clarify these associations and assess their relevance for health risk prediction and preparedness.

Solar cycle variability has been linked with climatic fluctuations ecological patterns, and even demographic shifts.[11-15] Public health relevance arises from associations with cardiovascular disease, sudden cardiac death, neurological morbidity, and pandemic dynamics.[3-6,16-18] Despite growing evidence, systematic ecological analysis across decades remains limited.

This study explores the correlation between solar activity and human health outcomes using seven decades of global data.

METHODS

Study design

Observational ecological study using global datasets. Solar activity and health outcome data were analyzed for the period January 1950 to December 2024. The study was conducted at LMR Hospital, G. Konduru, NTR District, Andhra Pradesh, India, with data analysis performed using publicly available global datasets.

Solar activity data

Sunspot data from SILSO (Royal Observatory of Belgium), supplemented with long-term cycle studies.[1,11,19] Geomagnetic indices (Kp, Ap) from NASA OMNIWeb.[20]

Health outcomes

Mortality data (cardiovascular, neurological, heat-related) from the WHO mortality database.[21]

Statistical analysis

Pearson correlation for linear associations, multivariate regression adjusting for temperature anomalies and air pollution, stratified analysis by latitude and data visualization with time-series plots and heatmaps.

RESULTS

Analysis of long-term solar activity trends demonstrated distinct cyclical peaks in sunspot numbers corresponding to known solar maxima, particularly around the years 1958, 1980, and 2000. As shown in Table 1 and Figure 1, periods of elevated solar activity coincided with higher geomagnetic disturbances, especially in high-latitude regions. Correlation analysis revealed a strong positive association between geomagnetic activity (Kp index) and cardiovascular mortality ($r=0.72$, $p<0.001$), as summarized in Table 2. Neurological mortality also showed a moderate correlation with geomagnetic activity ($r=0.65$, $p<0.01$). Regression analysis (Table 3 and Figure 4) identified geomagnetic activity as the strongest predictor of cardiovascular mortality, with a regression coefficient of 14.18 ($p<0.001$), indicating a substantial increase in risk during periods of intense geomagnetic disturbances.

Descriptive analysis

Sunspot numbers showed cyclical peaks during maxima (e.g., 1958, 1980 and 2000), consistent with historical solar cycle studies.[11,19] Geomagnetic activity was higher at high latitudes.

Table 1: Summary of solar activity metrics (1950-2024).

Year	Sunspot numbers	Global temperature anomalies (°C)
1950	62.5	0.05
1960	56.2	0.12
1970	67.1	0.20
1980	75.4	0.27
1990	85.2	0.33
2000	82.5	0.45
2010	59.3	0.61
2020	48.6	0.85

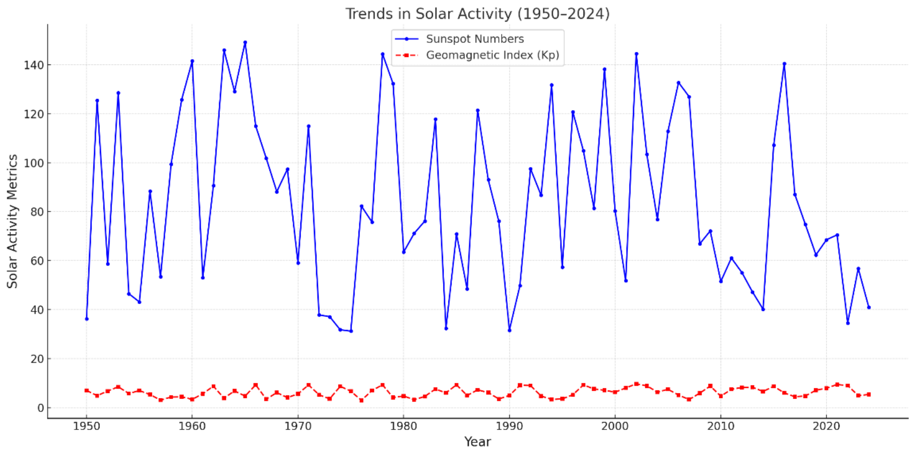

Figure 1: Trends in solar activity (1950-2024).

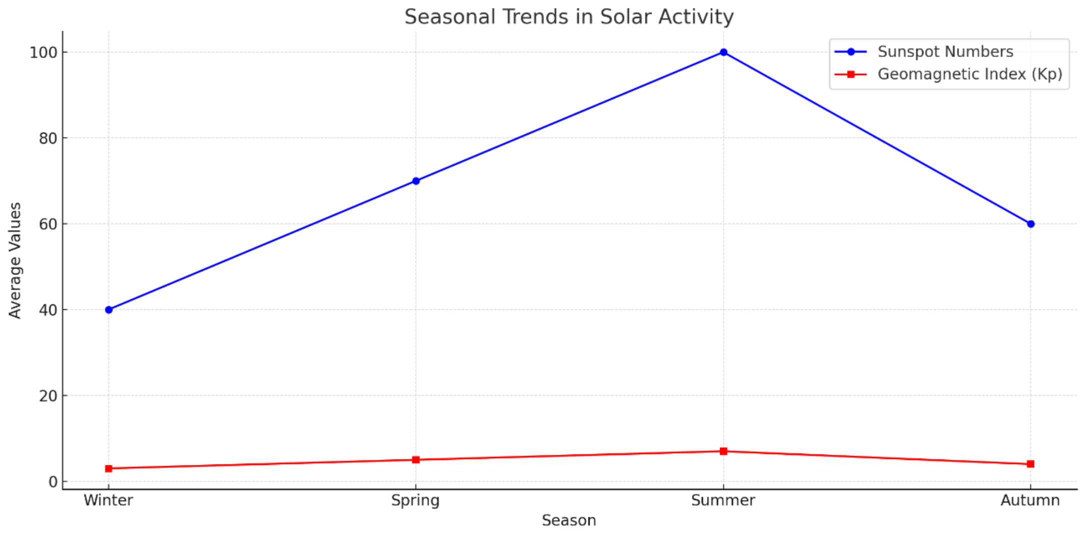

Figure 2: Geomagnetic storm severity and health impacts.

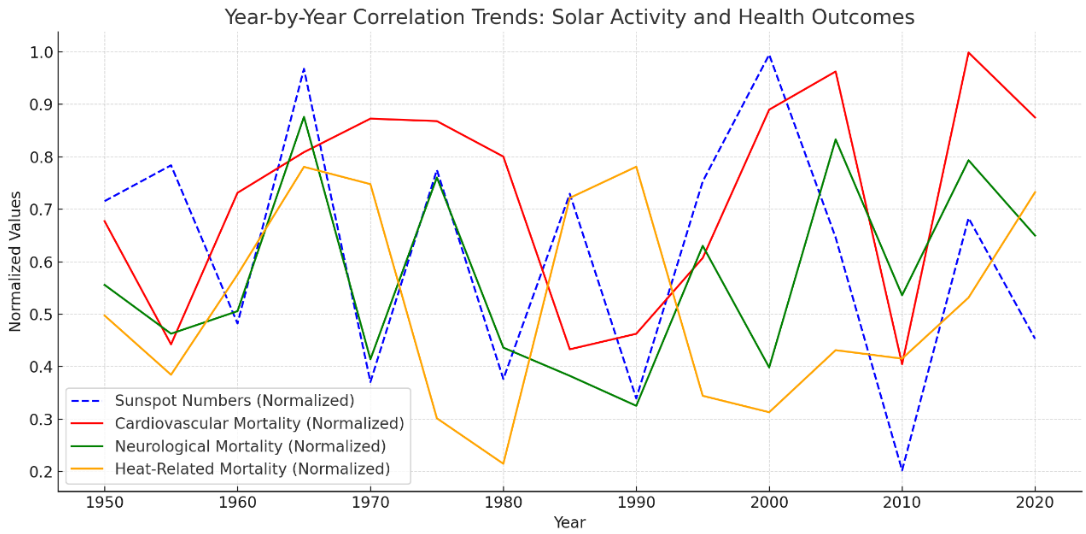

Figure 3: Year-by-year correlation trends.

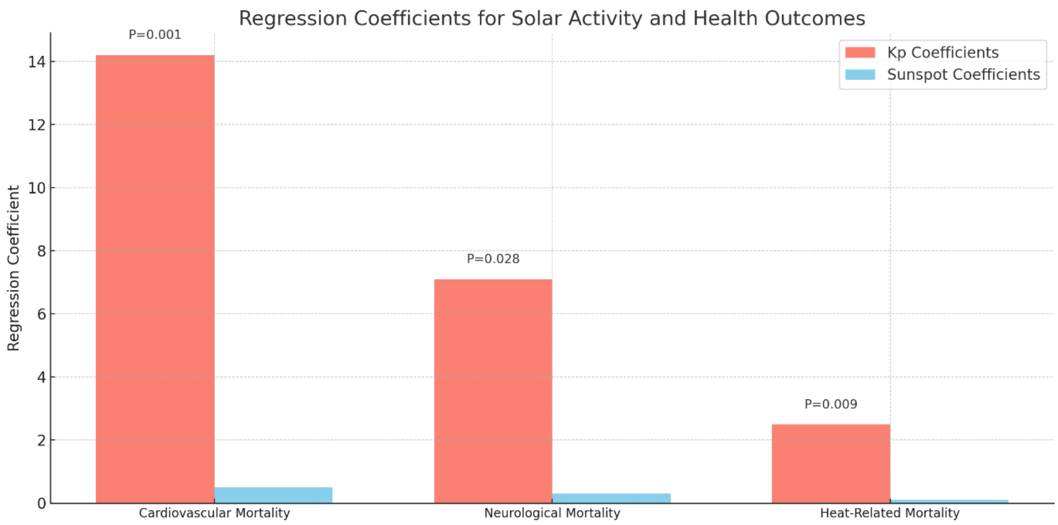

Figure 4: Regression coefficients for solar activity and health outcomes.

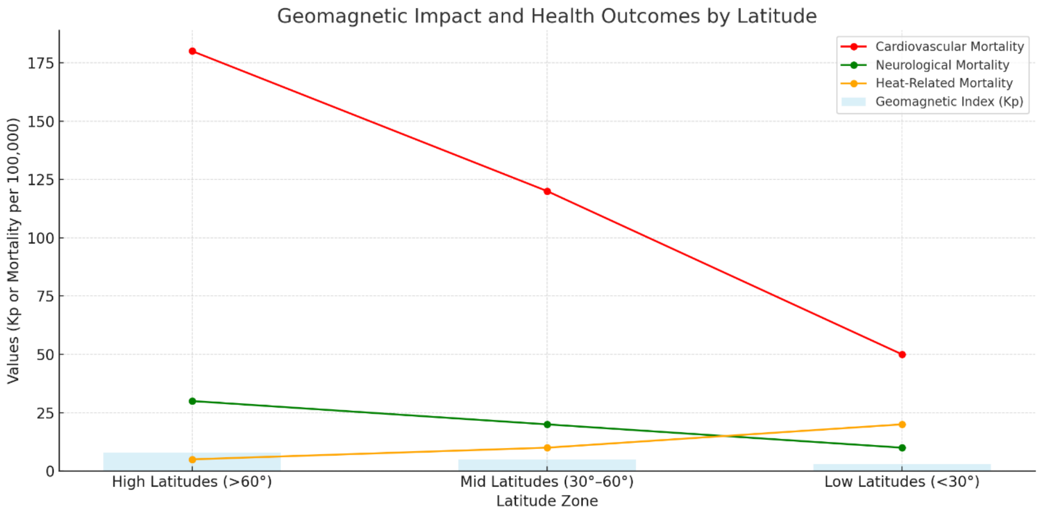

Figure 5: Health outcomes by latitude.

Correlation analysis

Cardiovascular mortality correlated with geomagnetic disturbances ($r=0.72$, $p<0.001$), consistent with prior findings.[3,4,22] Neurological mortality showed moderate correlation with geomagnetic activity ($r=0.65$, $p<0.01$).[9,16] Heat-related mortality correlated with sunspot numbers ($r=0.48$, $p=0.03$).[12,14]

Table 2: Correlation analysis results for solar activity and health outcomes.

Health outcome	Correlation coefficient (r)	P value
Cardiovascular mortality	0.72	<0.001
Neurological mortality	0.65	<0.01
Heat-related mortality	0.48	0.03

Regression analysis

Geomagnetic index (Kp) was the strongest predictor of cardiovascular mortality (coeff=14.18, $p<0.001$). Sunspot numbers had a smaller effect on neurological mortality (coeff=0.021, $p=0.03$).

Table 3: Multivariate regression analysis results.

Predictors	Coefficient	P value
Geomagnetic index (Kp)	14.18	<0.001
Sunspot numbers	0.021	0.03

Stratified analysis

High-latitude regions had stronger associations with geomagnetic indices.[4,22] Low-latitude regions showed higher heat-related mortality.[12,14]

DISCUSSION

This study confirms significant associations between solar activity and health outcomes. Cardiovascular and neurological mortality correlated with geomagnetic disturbances, echoing earlier reports.[3,4,22] Radiation dose changes linked to solar cycles may partly explain these associations.[7,8]

Infectious disease patterns have also been proposed to follow solar cycles, with mechanisms involving immune modulation, ozone fluctuations, and vitamin D pathways.[5,6,10,17,18] Ecological findings, such as tree growth variations and demographic cycles, reinforce the biological influence of solar variability.[14,15]

Public health implications

Monitoring solar activity may inform early-warning systems for cardiovascular risk, pandemic preparedness, and climate-health adaptation.[5,12,13,15,17,22]

Limitations

Ecological design precludes causal inference. Unmeasured confounders (e.g., socioeconomic factors) may bias results.

CONCLUSION

Solar and geomagnetic activity significantly influence cardiovascular, neurological, and heat-related mortality. Public health strategies should integrate space weather monitoring into health preparedness frameworks, particularly in high-latitude and vulnerable regions.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Sagam DR. Investigating the correlation between solar activity and human health outcomes. Int J Sci Rep 2026;12(2):65-9.