SCRIPTA MEDICA (BRNO) – 74 (2): 97–102, *March 2001*

NATURAL NEAR-WEEKS OF BIOLOGY AND GEOPHYSICS DIFFER FROM THE MAN - MADE WEEK: TRANSDISCIPLINARY META-ANALYTIC HINTS

UEZONO K.[1], HALBERG F.[2], CORNELISSEN G.[2], WATANABE Y.[3], SIEGELOVÁ J.[4], SCHWARTZKOPFF O.[2]

[1]Kyushu University, Fukuoka, Japan
[2]University of Minnesota, Minneapolis, Minnesota, USA
[3]Tokyo Women's Medical College, Daini Hospital, Tokyo, Japan
[4] Department of Functional Diagnostics and Rehabilitation, Faculty of Medicine, Masaryk University, Brno

A b s t r a c t

Biometric methods, building on those used earlier by physicists, validate an anthropogenic weekly component in geophysical time series, analyzed by stacking the data for an idealized week. An attempt is made at mapping sequences of events following solar and biologic extrema, all in keeping with important solar effects in the biosphere. Natural near-weeks of biology and geophysics differ from the man – made week.

K e y w o r d s

Circaseptan rhythm, Chronobiology

INTRODUCTION

In the footsteps of William Gilberd, the physician who distinguished electricity from magnetism, and Samuel Heinrich Schwabe, the pharmacist who discovered the sunspot cycle, biologists strive to reciprocate the debt they owe to physics *(1,2).* We do so for the case of those periodicities that may have, with a putative anthropogenic-technogenic cultural source, also a natural physical and/or a built-in biological counterpart of similar (circa) but not of exactly the same length as the cycle in society. Siegelova in Brno demonstrated that the amplitude of the about-half-weekly (circasemi septan) component of neonatal blood pressure and heart rate is larger than the about 24-hour or circadian amplitude, and that the amplitude of the about-weekly (circa septan) component is larger than that of the circasemiseptan amplitude *(3).*

The atavistic biological week had prompted the search for and discovery of an environmental, not precise weekly but near-weekly 6.75-day counterpart in the planetary geomagnetic disturbance index, Kp, as an external match for periods

arising within the organism in response to internal integrative needs as well as to needs for integration in the broader organism-environment system, commonly viewed as adaptations.

MATERIALS AND METHODS

Inferential statistical procedures used include, with the demonstration of statistically significant spectral peaks, weightier evidence from cross-spectral coherence, superposed epochs and remove-and-replace approaches. Specifically, longitudinal series of blood pressure and heart rate measured around the clock, mostly at 30-minute intervals for 11 years, or by self-measurements about 5 times a day during waking time for 30 years, were analyzed by cosinor, along with Wolf numbers during the same spans. These series are complemented by data of mortality statistics in Minnesota from myocardial infarction (MI) spanning 29 years, and by a 15-year record of urinary 17-ketosteroid excretion. Each data series was analyzed by linear-nonlinear least squares to resolve the about 10-5-year component characteristic of the solar activity cycle. Phase relations between the biological data and Wolf numbers are mapped in each case, relying on solar maxima when the relation between the two variables is positive or on solar minima when dealing with an inverse relation.

In data taken of the published graphs for the least squares fitting of cosine curves with a period of 7 days, we find for the geomagnetic disturbance indices Ap and aa and for their SDs, whether the raw data or the normalized values are used, a statistically significant 7-day component ($P<0.05$ in each case, whereas the SD of an after-normalization is associated with a $P=0.056$). The phase of the maximum is very similar among all these endpoints, the scatter being only 47 degrees. A statistically significant 7-day component is also found for the total Pc 1 variations ($P=0.019$), with only a slightly later phase (although in one of the 2 subspans of Pc 1 variations, no 7-day component was detected).

RESULTS

Some of the biological phenomena are interrelated physiologically, and they may be mechanisms contributing to mortality from MI in Moscow *(4)* and Minnesota, USA *(5,6).* Only a very small lag of 0.08 or 0.28 years is observed between the physiologic extrema of blood pressure, heart rate, and the heart rate variability (gauged by the standard deviation) and Wolf numbers. A slightly longer lag of 1.56 years is found for bacterial sectoring, followed by a lag of 1.72 years of mortality from MI vs. Wolf numbers. This makes biological sense, since a decreased heart rate variability is a known risk factor for MI *(2),* and since an association of infections with MI has been noted *(3).* It is hence not surprising that the lag of MI vs. Wolf numbers occurs after that of bacterial sectoring and after that of heart rate variability in the sequence of events, along the scale of the solar cycle. Last comes a lag of 2.09 years of 17-ketosteroids vs. Wolf numbers, reflecting perhaps a mechanism of organism defense coming into play last.

In the 1960s, the foregoing suggestion by a biologist to a physicist was implemented by the biologist at the circaseptan rather than the circadian frequency in a biological time series revealing another circa-period. After 10 years of a 7-day synchronized circaseptan rhythm in the excretion of urinary breakdown products of steroidal hormones (17-ketosteroids), following the self-administration of a massive dose of testosterone suppositories, the circa septan

phase of the excreted steroids during several years scanned the week, advancing in a way corresponding to a slightly shorter than 7-day period. It differed from precisely 7 and also from 6.75 days. Indeed, many more examples of about 7-day rhythms in organisms prompted a look and the discovery of their counterpart of 1 cycle in 6.75 days in the spectrum of 59 years of data on Kp as subsequently tested, confirmed and extended to the aa index by physicists.

DISCUSSION

Our results stem from a procedure elaborated from that introduced to physicians and other biologists as a harmonic dial in 1953 by physicist Julius Bartels. At the same 1953 meeting where Bartels introduced his method, one of the authors reported data on blinded mice revealing (built-in) periods that deviated from precisely 24 hours, and suggested to Bartels that: 1. it might be worthwhile to extend his harmonic dial method to non- but near-24-hour periodicities, 2. if and only if deviations can be anticipated, and 3. more generally to extend the approach to the study of periods close to anticipated environmental periods, but not exactly of their length, with the prediction of the circa-range tested based on prior information, the latter contributing to the scientific (beyond any statistical) significance of the outcome.

Biometric methods, building on those used earlier by physicists, validate an anthropogenic weekly component in geophysical time series, analyzed by stacking the data for an idealized week. Any man-made contribution is in turn dwarfed by a near-weekly component detected when biological findings prompted focus upon circa-rhythms, in this case circaseptans in physics. The recognition of circadian rhythms with built-in periods of about (but not precisely) 24 hours is followed by the detection of near-weekly geophysical rhythms built into both purely physical and biological nature. Even more broadly, the detection of a circaseptan component in biology leads to the detection of a physical counterpart, in the case of the week, and vice versa to a biological half-year, in the case of the geomagnetic counterpart. The probability that the natural physical near-weekly component in Kp is a harmonic of the sun rotation period of 27 days and of some sun/moon/earth interactions qualifies, but does not disqualify, these results.

An increase in the incidence of MI after magnetic storms in Moscow *(4),* in St. Petersburg *(7),* Russia *(8)* and Mexico *(9),* among other associations of magnetic storms, e.g., with stroke *(8,10),* of interest to space life science, was validated and added to the evidence reviewed by Dubrov (*11*) and Gamburtsev *(12).* Heart rate itself, measured automatically around the clock at about 30-min intervals over 11 years, is much less consistent than heart rate variability in the same data. Heart rate was positively correlated with Wolf relative sunspot number during the ascending solar cycle stage ($r = 0.535$; $P = 0.001$) but not during the descending stage ($r = 0.078$; $P = 0.556$). Heart rate, self-measured up to 6 times a day on most

days for 31 years, was positively correlated with Wolf numbers during the descending stage of one solar cycle (Jan 1970-Dec 1975: r = 0.398; P = 0.001) and negatively during the next 2 descending stages (Jan 1982-Dec 1985: r = -0.427; P = 0.002 and Aug 1991-Jul 1996: r = -0.450; P<0.001). Dense and/or long biological time series show that the solar cycle number and stage may lead to different associations, a finding which is hardly surprising in view of the great instability, e.g., in length, of the solar cycle itself.A remove-or-replace approach (with 7-day components in solar wind present or absent) reveals, in this case, a consistent solar amplification of about 7-day cycles in heart rate, a result in keeping with more prominent about-weekly variations in mortality from MI in Tbilisi, Georgia, during high vs. low solar activity. For each biological rhythm, notably when desynchronized from the obvious socio-ecologic light-dark and temperature cycles of the habitat niche, a more remote as well as proximal natural physical match or near-match should be sought and, vice versa, solar and/or galactic cycles may be associated with changes in the biosphere. Thus, the biological week prompted the search and the finding in a biological center for a 6.75-day component in Kp, whereas the geophysical half-year led to the scrutiny of this component in epilepsy. Both disciplines benefit from transdisciplinary communication. Consistent relations found over several solar activity cycles in heart rate variability, mood and blood pressure, vs. Wolf numbers or the geomagnetic disturbance index, Kp, support the inference of a lowering of heart rate variability by magnetic storms triggered by solar activity *(13).* On the basis of the available evidence, a coordinated systematic monitoring of physiological and natural physical phenomena, with planning for centuries, is advocated.

A c k n o w l e d g e m e n t

The authors are grateful to Ms. Angie Sechler of the Minnesota State Department of Health for providing data on mortality due to myocardial infarctions in Minnesota.

Support: U.S. Public Health Service (GM-13981) (FH), National Heart, Lung, and Blood Institute, National Institutes of Health (HL-40650) (FH, GC); University of Minnesota Supercomputing Institute, Dr. h.c. Dr. h.c. Earl Bakken Fund, and Mr. Lynn Peterson, United Business Machines, Fridley, MN, CEZ J037/98:100004.

PŘÍRODNÍ CIRKASEPTÁNNÍ BIOLOGICKÉ A GEOFYZIKÁLNÍ CYKLY SE LIŠÍ OD CIVILIZAČNÍHO TÝDNE: METAANALÝZA

S o u h r n

Biometrické metody, založené na metodách používaných dříve ve fyzice, nám dovolují analyzovat týdenní komponentu v geofyzikálních a biologických časových sériích. Je učiněn pokus o mapování sledu událostí následujících po slunečních a biologických extrémech, což je v souladu s významnými slunečními vlivy v biosféře. Naše výsledky potvrdily výskyt biologických rytmů podobných přirozené fyzikální týdenní komponentě.

REFERENCES

1. *Farrell SM.* Dictionary of Scientific Biography. New York: Scribners, 1975, vol. 12, pp. 239–240.
2. *Harris WH, Levey JS, eds.* The New Columbia Encyclopedia. New York: Columbia University Press, 1975;1176.
3. *Siegelova J, Dušek J, Fišer B et al.* Circaseptan rhythm in blood pressure and heart rate in newborns. Scripta medica 1996;67(Suppl. 2): 63–70.
4. *Halberg F, Breus TK, Cornelissen G et al.* International Womb-to-Tomb Chronome Initiative Group: Chronobiology in space. Keynote, 37th Ann. Mtg. Japan Soc. for Aerospace and Environmental Medicine, Nagoya, Japan, 1991. University of Minnesota/Medtronic Chronobiology Seminar Series, #1, 1991:21.
5. *Cornelissen G, Halberg F, Schwartzkopff O et al.* Chronomes, time structures, for chronobioengineering for „a full life". Biomedical Instrumentation & Technology 1999;33:152–87.
6. *Schussheim AE, Fuster V.* Antibiotics for myocardial infarction? A possible role of infection in atherogenesis and acute coronary syndromes. Drugs 1999;57:283–91.
7. *Villoresi G, Breus TK, Iucci N, Dorman LI, Rapoport SI.* The influence of geophysical and social effects on the incidences of clinically important pathologies. Physica Medica 1994;10:79–91.
8. *Villoresi G, Kopytenko YA, Ptitsyna NG et al.* The influence of geomagnetic storms and man-made magnetic field disturbances on the incidence of myocardial infarction in St. Petersburg (Russia). Physica Medica 1994;10:107–17.
9. *Mendoza B, Diaz-Sandoval R.* A preliminary study of the relationship between solar activity and myocardial infarctions in Mexico City. Geofisica Internacional 1999, in press.
10. *Feigin VL, Nikitin YuP, Vinogradova TE.* Solar and geomagnetic activities: are there associations with stroke occurrence? Cerebrovasc Dis 1997;7: 345–48.
11. *Dubrov AP.* The geomagnetic field and life: geomagnetobiology. (Translated by F.L. Sinclair; translation edited by F.A. Brown Jr.) New York: Plenum Press, 1978:318.
12. *Gamburtsev AG, Alexandrov SI., Belyakov AS et al*. Atlas of Natural Processes: Order and chaos in lithosphere and other spheres. Moscow: Rossiiskaya akademia nauk, 1994:176.
13. *Baevsky RM, Breus TK, Nikulina GA, Petrov VM, Chernikova AG.* Effects of geomagnetic disturbances on humans: functional state in space flight. Moscow: Russian Academy of Sciences Space Research Institute, 1999:32.