applied sciences

MDPI

Editorial

Special Issue on "Research on Circadian Rhythms in Health and Disease"

Denis Gubin [1,2,3,*], Germaine Cornelissen [4,*], Oliver Stefani [5] and Dietmar Weinert [6]

[1] Department of Biology, Medical University, 625023 Tyumen, Russia
[2] Tyumen Cardiology Research Center, Tomsk National Research Medical Center, Russian Academy of Science, 634009 Tomsk, Russia
[3] Laboratory for Chronobiology and Chronomedicine, Research Institute of Biomedicine and Biomedical Technologies, Medical University, 625023 Tyumen, Russia
[4] Halberg Chronobiology Center, University of Minnesota, Minneapolis, MN 55455, USA
[5] Lucerne University of Applied Sciences and Arts, 6048 Horw, Switzerland; oliver.stefani@hslu.ch
[6] Institute of Biology/Zoology, Martin Luther University Halle-Wittenberg, 06108 Halle (Saale), Germany; dietmar.weinert@zoologie.uni-halle.de
* Correspondence: dgubin@mal.ru (D.G.); corne001@umn.edu (G.C.)

Despite rigorous investigation of circadian rhythms in humans and animal models in the past, basic chronobiologic principles have not yet entered clinical practice. Advances in animal models and in human physiological monitoring as well as recent developments of applied techniques in biomedical research, including unobtrusive wearables, now facilitate the incorporation of chronobiologic principles and their transfer into clinical practice for timed screening, diagnosis, and treatment. While technological advances focus primarily on data collection, less attention has been devoted to the processing and analysis of the new large databases thus acquired. It is imperative that measures be taken at this stage to include all information needed to foster the development of true precision chronomedicine. For this purpose, it is crucial to establish universal standards for the collection, analysis, and interpretation of time series data to help discern rhythms in health from their altered characteristics in disease. It is equally important that data banks and repositories suitable for time series analysis also specify age and gender, as well as genetic information whenever possible.

This Special Issue includes six original research papers and two reviews discussing various aspects of applied research on circadian rhythms in health and disease. As a major signal that modulates circadian rhythms in mammals, light holds a prominent place in this issue. Arguments are provided to illustrate that tools are needed for studying and evaluating real environments from both visual and nonvisual perspectives to improve lighting conditions in accordance with current standards. Sanchez-Cano et al. emphasize the need to personalize optimal lighting specifications [1]. They suggest a personalized method to calculate melanopic light reaching the retina depending on the optical density of the crystalline lens. Its importance lies in the fact that aging affects the lens structure and modifies light wavelength absorption, causing significant variation in the level of daylight equivalent melanopic illuminance in the retina. Otsuka et al. [2] derive rules of heliogeomagnetic coordination of circadian rhythms in blood pressure and heart rate, with illustrations based on data collected above the Arctic Circle. They show that mild, moderate, or extreme geomagnetic activity induce differential changes in circadian parameters (amplitude, acrophase, and period) according to a bell-shaped windowed dose–response curve depending on the intensity of geomagnetic disturbances and on the circadian phase when geomagnetic stimulation occurs. Putilov et al. [3] suggest a modeling technology for the correction of accumulated sleep loss during weekly workdays. The model takes into account individual differences between morning and evening chronotypes (M-types and

check for updates

Citation: Gubin, D.; Cornelissen, G.; Stefani, O.; Weinert, D. Special Issue on "Research on Circadian Rhythms in Health and Disease". *Appl. Sci.* **2023**, *13*, 10728. https://doi.org/10.3390/app131910728

Received: 21 September 2023
Accepted: 25 September 2023
Published: 27 September 2023

E-types), suggesting that a larger-than-2-hour difference between M- and E-types in weekday waking times is necessary to equalize losses between these types. Borisenkov et al. [4] perform a comparative analysis of actigraphic parametric and non-parametric indices regarding their agreement with the MCTQ (Munich ChronoType Questionnaire) and the PSQI (Pittsburgh Sleep Quality Index) questionnaire. They determine that non-parametric indices are better predictors than parametric ones, but find the acrophase of activity to be a useful index to predict sleep efficacy. Gubin et al. [5] document that compromised light perception, due to retinal ganglion cell loss, is associated with altered serum lipid profiles, showing uneven alterations in the morning or evening values, also dependent on CLOCK gene polymorphism. Their discovery underlines a putative link between light signaling and lipid metabolism, and highlights the importance of analyzing evening as well as morning values, suggesting the morning–evening gradient as a novel biomarker. The association of sleep disturbances with co-morbid psychological mental problems is investigated by Rahafar et al. [6], who provide insight into the interaction between sleep habits of individuals regarding their Dark Triad traits (Machiavellianism, psychopathy, and narcissism). Weinert and Gubin [7] review the effect of physical activity on the circadian system, and outline its benefits for health, well-being and performance. The authors propagate practical implications of circadian activity rhythms for diagnosis and highlight the advantages of scheduled motor activity. Finally, Danilenko et al. [8] provide a comparative review of seventeen currently available light-and-motion wearables for their appearance, dimensions, weight, mounting, battery, sensors, features, communication interface, and software. This review is a useful guide helping researchers to make a proper choice to suit their needs for a particular research protocol.

Contributions in this Special Issue of Applied Sciences cover important developments in the field of chronobiology and offer a vision for the future of the field. They will interest students in life sciences as well as seasoned researchers and all those involved in the development of wearable sensors and devices, including the software architecture needed for the analysis and interpretation of the serial data. A concerted collaborative effort between chronobiologists and engineers should lead the way toward a true precision chronomedicine that urgently needs entering everyday clinical practice.

Author Contributions: Conceptualization, D.G. and G.C.; methodology, D.G, G.C., O.S. and D.W.; software, not applicable.; validation, D.G., G.C., O.S. and D.W.; formal analysis, D.G, G.C., O.S. and D.W.; investigation, D.G, G.C., O.S. and D.W.; resources, D.G, G.C., O.S. and D.W.; data curation, D.G, G.C., O.S. and D.W.; writing—original draft preparation, D.G.; writing—review and editing, G.C.; visualization, D.G, D.W. and G.C.; supervision, D.G, G.C., O.S. and D.W.; project administration, D.G.; funding acquisition, D.G. All authors have read and agreed to the published version of the manuscript.

Funding: Publication of four papers in these Special Issue was supported by West-Siberian Science and Education Center, Government of Tyumen District, Decree of 20 November 2020, No. 928-rp.

Acknowledgments: We are grateful to all the authors and peer reviewers for their valuable contributions to this Special Issue "Research on Circadian Rhythms in Health and Disease". We would also like to express our gratitude to all the staff and people involved in this Special Issue. Finally, special thanks to Leezy Li.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Sanchez-Cano, A.; Orduna-Hospital, E.; Fernández-Espinosa, G.; Aporta, J. Method to Calculate Melanopic Light Reaching the Retina Depending on the Optical Density of an Aging Crystalline Lens. *Appl. Sci.* **2023**, *13*, 2569. [CrossRef]
2. Otsuka, K.; Cornelissen, G.; Weydahl, A.; Gubin, D.; Beaty, L.A.; Murase, M. Rules of Heliogeomagnetics Diversely Coordinating Biological Rhythms and Promoting Human Health. *Appl. Sci.* **2023**, *13*, 951. [CrossRef]
3. Putilov, A.A.; Sveshnikov, D.S.; Bakaeva, Z.V.; Yakunina, E.B.; Starshinov, Y.P.; Torshin, V.I.; Trutneva, E.A.; Lapkin, M.M.; Lopatskaya, Z.N.; Budkevich, R.O.; et al. The Irrecoverable Loss in Sleep on Weekdays of Two Distinct Chronotypes Can Be Equalized by Permitting a >2 h Difference in Waking Time. *Appl. Sci.* **2022**, *12*, 8092. [CrossRef]
4. Borisenkov, M.; Tserne, T.; Bakutova, L.; Gubin, D. Actimetry-Derived 24 h Rest–Activity Rhythm Indices Applied to Predict MCTQ and PSQI. *Appl. Sci.* **2022**, *12*, 6888. [CrossRef]

5. Gubin, D.; Neroev, V.; Malishevskaya, T.; Kolomeichuk, S.; Weinert, D.; Yuzhakova, N.; Nelaeva, A.; Filippova, Y.; Cornelissen, G. Daytime Lipid Metabolism Modulated by *CLOCK* Gene Is Linked to Retinal Ganglion Cells Damage in Glaucoma. *Appl. Sci.* **2022**, *12*, 6374. [CrossRef]
6. Rahafar, A.; Kalbacher, L.S.; Randler, C. A Closer Look at the Sleep/Wake Habits and Dark Triad Traits. *Appl. Sci.* **2022**, *12*, 5963. [CrossRef]
7. Weinert, D.; Gubin, D. The Impact of Physical Activity on the Circadian System: Benefits for Health, Performance and Wellbeing. *Appl. Sci.* **2022**, *12*, 9220. [CrossRef]
8. Danilenko, K.V.; Stefani, O.; Voronin, K.A.; Mezhakova, M.S.; Petrov, I.M.; Borisenkov, M.F.; Markov, A.A.; Gubin, D.G. Wearable Light-and-Motion Dataloggers for Sleep/Wake Research: A Review. *Appl. Sci.* **2022**, *12*, 11794. [CrossRef]