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LETTER TO THE EDITOR

Reproducibility and Repeatability

P. SLEZÁK[1], I. WACZULÍKOVÁ[2]

[1]Institute of Normal and Pathological Physiology, Slovak Academy of Sciences, Bratislava, Slovak Republic, [2]Division of Biomedical Physics, Faculty of Mathematics, Physics and Informatics, Comenius University, Bratislava, Slovak Republic

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Comment on: JÍRA M, ZÁVODNÁ E, NOVÁKOVÁ Z, FIŠER B, HONZÍKOVÁ N: Reproducibility of blood pressure and inter-beat interval variability in man. *Physiol Res* **59** (Suppl 1): S113-S121, 2010.

Corresponding author

Peter Slezák, Institute of Normal and Pathological Physiology, Slovak Academy of Sciences, Sienkiewiczova 1, 813 71 Bratislava, Slovak Republic. Fax: +421-2-52968516. E-mail: peter.slezak5@gmail.com

Apart from that the topic of the study is interesting and important, the paper contains some terminological inconsistencies which seriously undermine implications of research and thus, credibility of the conclusions made by the Authors. It is not uncommon to find studies with inconsistent terminology and definitions, with some terms being defined differently but then used interchangeably. Inconsistency in the use of terminology makes it difficult to determine what methodology, both, experimental and analytical, is being used in the research.

The terms "reproducibility" and "repeatability" are both strictly defined, each with its own, unique meaning, and scientists should distinguish between them. **Reproducibility** of a method/test can be defined as the closeness of the agreement between independent results obtained with the same method on the identical subject(s) (or object, or test material) but **under different conditions** (different observers, laboratories etc.). In a specific situation, it can be defined as the variability of the measurement system caused by differences in the observer's behavior. In mathematical terms, it is the variability of the average values obtained by several observers while measuring the same item (interobserver variability). On the other hand, **repeatability** denotes the closeness of the agreement between independent results obtained with the same method on the identical subject(s) (or object or test material), **under the same conditions**. Or, it is the variability of the measurements obtained by one person while measuring the same item repeatedly (intraobserver variability). This is also known as the inherent precision of a measurement equipment (BS ISO 5725 part 1 and part 2, IUPAC 1997, Engineered Software 1999). Among the statistical methods for determination of repeatability and reproducibility, the most frequently used procedure is that proposed by Bland and Altman (1986).

From the presented paper, it is not clear whether the Authors have been distinguishing between the discussed terms and whether they used appropriate statistical methods to answer the aim of the study addressed in the title. From the data acquisition and analysis described in the Methods section, it can be inferred that they rather assessed repeatability of the measurements than determined reproducibility. As mentioned above, the term reproducibility is associated with the method, observer, laboratory etc., and not with the measured variable itself as it is indicated in the title. This apparent misunderstanding and confusion of the terms "repeatability" and "reproducibility" has raised problems of interpretation of the results, which cannot help to answer the aim of the study. A simple amendment would have been to re-state the aim of the study.

Further, it is questionable whether the authors employed proper statistical methods and correctly checked the assumptions underlying their use. From figures 1 and 2 it is clear that the homoscedasticity, one

of the assumptions for using Pearson's correlation coefficient, was violated. Moreover, using the correlation coefficient should be avoided when assessing reproducibility (Hulley *et al.* 2001). Thus, the Authors do not supply a convincing proof that would justify the conclusive statement that *blood pressure and inter-beat interval variability is an individually characteristic feature*.

If the Authors had intended to characterize the amount of variation of the variables under consideration, the coefficient of variation (at least) should have been used. This coefficient is useful because the standard deviation of data must always be understood in the context of the magnitude of mean. Based on this measure, the conclusion that *blood pressure and inter-beat interval variability is an individually characteristic feature* might be drawn.

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Answer to Slezák and Waczulíková

M. JÍRA[1], E. ZÁVODNÁ[1], Z. NOVÁKOVÁ[1], B. FIŠER[1], N. HONZÍKOVÁ[1]

[1]Department of Physiology, Faculty of Medicine, Masaryk University, Brno, Czech Republic

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Corresponding author

Miroslav Jíra, Fyziologický ústav LF MU Brno, Kamenice 5, CZ-625 00 Brno, Czech Republic. E-mail: jiramir@centrum.cz

Reproducibility, which refers to the ability of a test to be accurately reproduced by someone else, is different from repeatability, which measures the success rate in successive experiments conducted by the same experimenters, as authors of the letter correctly stated. However, this definition assumes constant measured values and an imperfect method of measurement. This is not the case in blood pressure indices, where the method of measurement is reliable in all laboratories for all experimenters, but the indices are changing from minute to minute. We have used the term usual in similar papers (e.g. Palatini *et al.* 2000). The authors of the letter are also correct in the statement that heteroscedasticity violates the correct use of Pearson's correlation coefficient as a measure of linear dependence. Thus, the calculation of the proposition of variance Y explained by a linear function of X is unreliable, but we did not perform this

estimation in our paper. On the other hand, if our conclusion that blood pressure and inter-beat interval variability is an individually characteristic feature is wrong, then the correlation coefficients should be near zero regardless of the heteroscedasticity of our data. The coefficient of variation is probably similar at low and high values of variability and yields nothing to the physician who wants to use the blood pressure variability for clinical purposes.

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