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LETTER TO THE EDITOR Open Access

Pain scores and statistical analysis—the conundrum

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To the Editor,

Documenting pain scores followed by its subsequent comparison and analysis is an essential part of research articles in regional anaesthesia (RA) and pain medicine. Commonly used pain scores are the visual analogue scale (VAS), numerical rating scale (NRS) and verbal rating scale (VRS) (Swift 2015). In paediatric patients, the Face Legs Activity Cry Consolability (FLACC) scale, Wong-Baker's FACES scale, and Children's Hospital of Eastern Ontario Pain Scale (CHEOPS) are used (Srouji et al. 2010). For research purposes, pain scores are noted at predetermined intervals and subsequently compared to know if a medication or RA technique in question is better than an established standard of care.

There is skepticism regarding the correct statistical used in the analysis of pain scores. Conventionally, pain scores are considered ordinal data, i.e. categorical data in order. In statistics, ordinal data is considered non-parametric, i.e. data with skewed distribution (Manikandan 2011). For a non-parametric data, median with interquartile range is the preferred central tendency used. Thus, for data which is not normally distributed, i.e. skewed, non-parametric statistical tests are used for statistical analysis. On many occasions, researchers use parametric statistics to analyse and compare non-parametric data, i.e. data which is not distributed normally (Yim et al. 2010). However, researchers are of the opinion that if pain scores are distributed normally, it can be analysed using parametric tests. This can be explained if pain scores are scattered in a narrow range, i.e. between 2 and 4 for the entire duration of analysis as per methodology. Therefore, it is important to analyse data using tests like the Kolmogorov-Smirnov test or Shapiro-Wilk test to determine the distribution of data (Kim 2017). Based on the type of distribution, researchers can apply indicated tests for the analysis of pain scores. This important piece of information is missing in many papers which is very important. Authors should mention in the methods section what kind of data they have gathered (nominal, ordinal, interval, ratio, discrete, continuous). The distribution of data (normal or skewed) should be mentioned along with the name of the test that was used to determine the distribution of data. Based on this, the statistical tests should be employed and should be specifically mentioned what test was used for a particular type of data. If pain scores are parametric in distribution, the *t* test or analysis of variation (ANOVA) can be used. For skewed distribution tests like Kruskal-Wallis, Wilcoxon rank sum test or Mann-Whitney could be used. Another school of thought mentions that pain scores should be considered as a ratio (Ghasemi and Zahediasl 2012). When used as a ratio, i.e. scores are reduced with an analgesic, this would make the data linear in nature. In such situations, statistical tests should be used based on the distribution of data.

When there are repeated measurements of pain scores, i.e. a high score is noted to begin with, rescue analgesic administered as per protocol and pain score is noted, the premise becomes complicated. For such situations, a repeated measure of analysis of variation (RMANOVA) is used. RMANOVA is a non-parametric test which is based on the additional assumption in which the variance differences between repeated measurements are equal over the whole (Lee 2015).

Authors use generalized statements to describe the type of data collected and the tests used for analysis. It is a known fact that clinicians find statistical analysis cumbersome and complicated. The statistical test used should be decided based on how pain scores are defined by the researchers. The researcher also needs to assess if the pain scores are distributed normally or are skewed. Based on this, an appropriate central tendency (mean or median) has to be used. This will decide what statistical test needs to be employed to analyse pain scores in 2 or more groups (Table 1).

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Table 1 The statistical tests that could be used based on the type of data, i.e. nominal or ordinal, distribution of data and number of groups for comparison (reproduced after permission from the Editor in Chief of the *Korean Journal of Pain* and is from the published paper by Tae Kyun Kim: Kim 2017)

Level of scale	Nominal	Ordinal	Interval or ratio	
			Normality assumed	Normality not assumed
Two independent groups	Chi-square or Fisher's exact test	Wilcoxon rank sum test Mann-Whitney test	t-test	Wilcoxon rank sum test Mann-Whitney test
Three or more independent groups	Chi-square or Fisher's exact test	Kruskal-Wallis test	One-way ANOVA	Kruskal-Wallis test
Two correlated samples	McNemar test	Wilcoxon sign rank test Mann-Whitney test	Paired t-test	Wilcoxon sign rank test Mann-Whitney test
Three or more correlated samples	Cochran Q test Mixed effects logistic regression	Friedman's test Mixed effects ordinal logistic regression	RMANOVA	Friedman's test Mixed effects linear regression

To conclude, a biostatistician should be consulted from the beginning for planning and analysing the research so as to avoid the use of incorrect tests leading to flaws in the final draft.

Abbreviations

RA: Regional anaesthesia; VAS: Visual analogue scale; NRS: Numerical rating scale; VRS: Verbal rating scale; FLACC: Face Legs Activity Cry Consolability; CHEOPS: Children's Hospital of Eastern Ontario Pain Scale; ANOVA: Analysis of variation; RMANOVA: Repeated measures of analysis of variation

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