Using basic statistics on the individual patient's own numeric data

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Abstract

Introduction: This theoretical report gives an example for how coefficient of variation (CV) and quartile analysis (QA) to assess outliers might be able to be used to analyze numeric data in practice for an individual patient.

Methods: A patient was examined for 8 visits using infrared instrumentation for measurement of mastoid fossa temperature differential (MFTD) readings. The CV and QA were applied to the readings. The participant also completed the Short Form–12 health perception survey on each visit, and these findings were correlated with CV to determine if CV had outcomes support (clinical significance).

Results: An outlier MFTD reading was observed on the eighth visit according to QA that coincided with the largest CV value for the MFTDs. Correlations between the Short Form–12 and CV were low to negligible, positive, and statistically nonsignificant.

Conclusion: This case provides an example of how basic statistical analyses could possibly be applied to numerical data in chiropractic practice for an individual patient. This might add objectivity to analyzing an individual patient's data in practice, particularly if clinical significance of a clinical numerical finding is unknown.

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Introduction

Pattern analysis has been used in chiropractic since the 1940s.¹ Essentially, this approach is used to assess

the patient's neurological health and is based on the theory that dynamic physiologic measures, such as skin temperature, which is under the control of the autonomic part of the central nervous system,² should be dynamic.³ As with other methods of interpretation, pattern analysis suffers from the problem of subjectivity and the paucity of outcomes research. In such cases, where clinical significance may be unknown, statistical significance may be useful, with the patient being his own control.

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The present report uses coefficient of variation (CV) and quartile analysis (QA) to assess variability and outliers, respectively, of an individual patient's data. Previous reports have used standard deviation (SD) to assess for outliers.^{4,5} However, SD alone for variability assessment has a limitation of not accounting for the mean.⁶ In addition, SD is not resistant to outliers, whereas QA does have such a resistance. In addition, this report shows how CV (for variability) can be used in outcomes research by comparing the CV findings to the outcome (in this case, health perception). The use of mastoid fossa temperature differential (MFTD) is only one example of how numerical data generated in chiropractic practice can be subjected to statistical analysis for the individual patient. Most statistical inferences are based on other people and groups, whereas the application of the individual patient's data to him- or herself is a more relevant application and inference. This in turn represents the purpose of the case study, which is to show how basic statistical analysis can improve the objectivity in analyzing numerical data in chiropractic practice for the individual patient, which in turn can reduce clinical uncertainty.⁷⁻⁹

Although there is plenty of literature on statistical analyses used in clinical studies, no literature was found for statistical analyses for an individual patient under the care of an individual practitioner. To investigate this possibly, the purposes of this report are to (1) to investigate if basic statistical analyses could be performed on an individual patient's own

numeric data and (2) to provide a framework for larger outcomes research to determine if the statistical significance has a corresponding clinical significance.

Methods

A relatively healthy 23-year-old white male chiropractic student consented to have the author take MFTD readings on a weekly basis over a 7-week period. Written consent for publication of this case report was provided by the patient. The 8 MFTD readings were taken 1 week apart using the Tytron C-3000 infrared instrument (Titronics R & D, Oxford, IA) beginning on 4-14-04 and ending on 6-2-04 (Table 1). The issues of reliability and validity of this instrument are discussed elsewhere.⁴ The MFTD readings warmer on the left were given a negative sign, whereas those warmer on the right side remained as positive. The participant did not receive any spinal adjustment during the study period (from 4-14-04 to 6-2-04), and his previous adjustment was approximately 3 months prior, on 1-20-04.

The participant completed the Short Form-12 (SF-12) version 2 health perception survey (1-week recall) on each the 8 visits (1 week apart). The survey provides a physical composite summary (PCS) and a mental composite summary (MCS). A higher score indicates better self-rated health perception than a lower score. The expectation is that these 2 types of health

Table 1 Descriptive statistics

Date	MFTD (neg=L)	Mean of 3	SD of 3	CV of 3	Absolute CV	Absolute CV as percentage	PCS	MCS
4/14/2004	-0.5						64.42	35.59
4/21/2004	-0.23						60.88	46.00
4/28/2004	-0.2	-0.31	0.17	-0.533	0.533	53.30	59.59	46.00
5/5/2004	-0.3	-0.24	0.05	-0.211	0.211	21.09	58.76	50.79
5/12/2004	-0.33	-0.28	0.07	-0.246	0.246	24.60	57.14	51.45
5/19/2004	-0.42	-0.35	0.06	-0.178	0.178	17.84	56.95	48.94
5/25/2004	-0.69	-0.48	0.19	-0.390	0.390	39.03	58.76	50.79
6/2/2004	0.17	-0.31	0.44	-1.404	1.404	140.37	56.08	56.70
Q1	-0.44					21.97	57.09	46.00
Q3	-0.22					49.73	59.91	50.96
IQR	0.22					27.76	2.82	4.96
LF	-0.77					-19.68	52.86	38.56
UF	0.10					91.38	64.14	58.39
Skew	0.63					2.04	1.17	-1.15

Mean of 3 and SD of 3 = mean and SD of 3 consecutive MFTD readings. For example, mean and SD of 3 for 4-28-04 is based on that visit (4-28-04), as well as 4-21-04 and 4-14-04. CV of 3 = CV achieved by dividing the SD of 3 by the mean of 3. Absolute CV = CV of 3 without the negative sign. Absolute CV as percentage = absolute CV * 100 for a percentage of variability of a sliding consecutive 3 MFTD readings. Outliers are in boldface.

Fig 1. Mastoid fossa temperature differential readings by visit. Top and bottom lines = upper and lower limits (fences), respectively, according to quartile analysis. The last MFTD reading is outside of one of the fences and thus is considered as an outlier.

perception (PCS and MCS) are inversely related (correspondence to author from science staff at Qualitymetric.com on 2 November 2010) as observed in the case study (Fig 1). The summaries (PCS and MCS) are also referred to here as *outcomes*, and a larger score is considered as an improved score in each of these outcomes.

Data analysis was performed in Excel (Microsoft Corp, Redmond, WA) and SAS 9.2 (SAS Institute, Cary, NC). The QA and CV were calculated in Excel, whereas the correlations (between CV and outcomes) were performed in SAS. For QA, Quartiles (Q) 1 and 3 are derived from the Excel function QUARTILE. Afterward, the interquartile range (IQR) is calculated by subtracting Q1 from Q3. The lower fence is calculated with the following:

$$Q1 - (1.5 * IQR),$$

whereas the upper fence is calculated with the following:

$$Q3 + (1.5 * IQR).$$

The CV is calculated by dividing the SD of the sample by the mean of the sample. This resulted in a value with decimal points and some with negative signs (due to warm on the left given a negative sign). Thus, 3 steps were taken to arrive at a percentage of variation: (1) CV (SD/mean), (2) absolute CV (removes the negative sign), and (3) percentage CV (absolute CV * 100) (Table 1).

The skew values suggested significant departures from normal distribution, so the nonparametric correlation (Spearman) test was used. Variation was calculated by a sliding set of consecutive MFTD

readings; that is, readings 1, 2, and 3 provided the first CV value; and readings 2, 3, and 4 provided the second CV value and so on. The CV values were correlated with corresponding PCS and MCS outcomes scores (Table 1).

Results

One MFTD outlier was observed—for the last visit (6-2-04, Table 1, = visit #8 in Fig 2). This visit (6-2-04), which the CV was based on along with the 2 previous MFTD readings (as described in “Methods”), revealed the largest CV percentage (of

Fig 2. Correlation of CV and SF-12 (PCS and MCS) where low strength, statistically insignificant correlations are observed. On the visit with the highest MFTD variability, that is, the highest (best) CV value (visit #8), the PCS was the lowest (worst), whereas the MCS was the highest (best). (Color version of figure is available online.)

Table 2 Inferential statistics for correlation between MFTD variation and health perception using the PCS and MCS

	PCS	MCS
r	0.029	0.319
P	.9	.5

r = Spearman correlation coefficient. P = P value for the correlation coefficient.

143.37; Table 1, Figs 1-2). Correlations between the sliding CVs and SF-12 scores (PCS and MCS) revealed low, positive, and statistically insignificant correlations (Table 2, Fig 2).

Discussion

Increased variability of the MFTD readings was directly related to MCS improvement (increased variability → improved mental health perception), although this correlation was weak and statistically insignificant in the case of MCS and negligible for PCS.

The purpose of this report was 2-fold: (1) to investigate if statistical analysis could be used in practice to help the practitioner use basic statistics to analyze the patient's own data (vs inferring from data from research where different patients were studied), particularly when clinical significance of a numeric finding is lacking, and (2) to provide a framework for outcomes research on a larger scale in an attempt to determine if there is clinical significance in regard to the statistical methods. In this study, variation of the physiological findings was the focus because the theoretical framework was based on the idea that variability of skin temperature is a sign of a healthy, dynamic nervous system. Obviously, variability is only one of many possible statistics that could be studied, just as health perception is only one of many outcomes that could be studied. Larger-scale outcomes research is needed to determine if the CV method used in this study has clinical significance.

Limitations

This study focused on the feasibility of using statistical methods for an individual patient with an individual practitioner. The findings of this study do not imply clinical relevance; however, they suggest that more research should be performed to determine

clinical relevance. This study was hypothetical, and more assessment needs to be done to evaluate if statistics used in this manner are appropriate for single participants. Outcomes research is required to determine if the statistical methods used in this case study have clinical significance.

Conclusion

This case report provides an example of how basic statistical analyses can be applied to numerical data in chiropractic practice for the individual patient (vs inferring from other studies). This in turn might be able to add objectivity, at least from a statistical standpoint, in analyzing the individual patient's data in practice when clinical significance of data may be unknown.

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