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Advancements and Critical Steps for Statistical Analyses in Blood Pressure Response to Resistance Training in Hypertensive Older Women: A Methodological Approach

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ABSTRACT

This document represents a supplemental appendix material for a better understanding of preprocessing steps of all statistical analysis used in the study **"Advancements and Critical Steps for Statistical Analyses in Blood Pressure Response to Resistance Training in Hypertensive Older Women: A Methodological Approach".**

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Advancements and Critical Steps for Statistical Analyses in Blood Pressure Response to Resistance Training in Hypertensive Older Women: A Methodological Approach

Criteria for establishing blood pressure responsiveness:

Responsiveness were defined on the basis of SBP decline between pre-training (Mesocycle 1) and post-training (change score) (Mesocycle 4). This variable can be calculated as the post-training (Mesocycle 4) score minus pre-training (Mesocycle 1) score for

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each participant (Dankel & Loenneke, 2018).

High responders in the hypertensive group were classified as a percent BP decline in the 50th percentile for the SBP mean change score, which corresponded to a decline ≥ -2.75 mmHg for high responders, and a decline < -2.75 mmHg for low responders. This threshold-based dichotomous classification was based on the decline of ≥ 2.00 mmHg, which according to a previous study (Hardy et al., 2015; Stamler et al., 1989) has a substantial impact on cardiovascular disease incidence.

Reference:
Hardy ST, Loehr LR, Butler KR, et al. Reducing the Blood Pressure-Related Burden of Cardiovascular Disease: Impact of Achievable Improvements in Blood Pressure Prevention and Control. *Journal of the American Heart Association* 2015; 4(10): e002276.
Stamler J, Rose G, Stamler R, Elliott P, Dyer A, Marmot M. INTERSALT study findings. Public health and medical care implications. *Hypertension* 1989; 14(5): 570-7.
Dankel SJ, Loenneke JP. Effect Sizes for Paired Data Should Use the Change Score Variability Rather Than the Pre-test Variability. *Journal of strength and conditioning research* 2018.

All procedures from repeated measures ANOVA and two-way mixed ANOVA used the following references:
Laerd Statistics (2015). Two-way mixed ANOVA using SPSS Statistics. *Statistical tutorials and software guides*. Retrieved from https://statistics.laerd.com/
Field, A. (2017). *Discovering statistics using IBM SPSS statistics: North American edition*. sage..

Procedures during two-way mixed ANOVA

For SBP, there was one outlier in the data, assessed by inspection of boxplot. The outlier is a genuinely unusual value and the statistician responsible decided to include the outlier in the analysis anyway because was verified that the result was not substantially affected (compared the result of two-way mixed ANOVA with and without the outlier).

Determination of normality

SBP values from morning training group was not normally distributed during detraining period. However, we considered to carry on regardless, because ANOVAs are considered to be fairly robust to deviations from normality.

Outliers cheking based on residuals

There were no outliers, as assessed by examination of studentized residuals for values greater than ±3.

Assumption of homogeneity of variances

There was homogeneity of variances, as assessed by Levene's test of homogeneity of variance ($p > .05$).
There was no homogeneity of covariances, as assessed by Box's test of equality of covariance matrices ($p = .034$).

Interpreting the assumption of sphericity

Mauchly's test of sphericity indicated that the assumption of sphericity was not met for the two-way interaction, $\chi2(15) = 40.46$, $p = .001$. However, **Greenhouse-Geisser or Huynh-Feldt,** was used as adjustment estimates. The *Standard error of measurement* (SEM) was estimated as the square root of the mean square error term from the two-way mixed ANOVA (Weir, 2005; Vincent & Weir, 2012) output from SPSS **(Huynh-Feldt)** (Weir., 2005; Vincent & Weir, 2012). The use of **Huynh-Feldt** was based on the proximity of the smallest real difference (SRD) to others SRD based on pre and post-design, and anchor based approach method displayed on Figure 01.

Reference:
Weir, J. P. (2005). Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *The Journal of Strength & Conditioning Research*,*19*(1), 231-240.
Vincent, W. J., & Weir, J. P. (2012). *Statistics in kinesiology*. Human Kinetics.

The data of one-way repeated measures and two-way repeated measures design is available in the file:
"TWO-WAY MIXED ANOVA - Paper Nascimento et al -2020.sav."
TWO-WAY MIXED ANOVA - Paper Nascimento et al -2020.sav
"OUTPUT FOR TWO-WAY MIXED ANOVA - Paper Nascimento et al -2020.spv"
OUTPUT FOR TWO-WAY MIXED ANOVA - Paper Nascimento et al -2020.spv
"OUTPUT FOR REPEATED MEASURES ANOVA - Paper Nascimento et al -2020.spv"
OUTPUT FOR REPEATED MEASURES ANOVA - Paper Nascimento et al -2020.spv

The calculation of TE, SRD, and magnitude based inference for SBP is available in the file:
"TE - CI - SBP - Paper Nascimento et al-2020.xlsx"

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TE - CI - SBP - Paper Nascimento et al-2020.xlsx

Short-term and long-term reliability for SEM

To accurately analyze the hemodynamic data, identical methodology should ideally be used for all hypertensive participants to obtain a larger reliability coefficient (i.e. ICC of 0.96-0.97) (Williamson et al., 2017) to establish adequate short-term reproducibility (Williamson et al., 2017). However, reproducibility needs to be assessed over a longer-period (Williamson et al., 2017; Bonafiglia et al., 2018).

The measure of reliability considering the change in the mean value between 2 trials (test-retest baseline tests) estimates the random change and a systematic change. The simplest example of a systematic change is when the participant presents a lower SBP in the second measurement (all participants had triplicate measurements of BP obtained and the average of those readings were used to represent the participant's BP).

However, pre-post changes (between T1 and T4 mesocycles) in SBP estimates standard error of measurement and the within-subject variability caused by changes in behavioral (i.e. medication use)/environmental (i.e. time of training) factors across an intervention (Williamson et al., 2017; Bonafiglia et al., 2018).

It is important to emphasize that a study with such statistical approach for responsiveness, also used the SEM to calculate the smallest real difference (Bonafiglia et al., 2018). For this several reasons cited, we considered the calculation of SEM for pre-post changes and repeated measures design.

Another important information is that standard error of measurement value can vary markedly depending on the magnitude of the intraclass correlation coefficient (Vincent & Weir, 2012). However, the large differences between standard error of measurement estimates depending on which intraclass correlation coefficient values is used are a bit unsatisfactory (Vincent & Weir, 2012). Because of this, the alternative approach to estimate the standard error of measure using the mean square error from repeated measure ANOVA is substantially recommended (Vincent & Weir, 2012; Weir, 2005).

This standard error of measurement value does not vary depending on the intraclass correlation coefficient model used because the mean square error from ANOVA is constant for a given set of data (Vincent & Weir, 2012). Furthermore, considering that all participants had triplicate measurements of BP and the average of those readings were used to represent the participant's BP baseline (Vincent & Weir, 2012). Each measurement was considered as a trial (repeated administration of a test or assay) (Hopkins, 2000) and the SEM was also calculated to represent the short-term reproducibility to accurately analyze the hemodynamic data.

References:

Vincent, W. J., & Weir, J. P. (2012). *Statistics in kinesiology*. Human Kinetics.
Williamson, P. J., Atkinson, G., & Batterham, A. M. (2017). Inter-individual responses of maximal oxygen uptake to exercise training: a critical review. *Sports Medicine*, *47*(8), 1501-1513.
Hopkins, W. G. (2000). Measures of reliability in sports medicine and science. *Sports medicine*, *30*(1), 1-15.
Bonafiglia, J. T., Nelms, M. W., Preobrazenski, N., LeBlanc, C., Robins, L., Lu, S., ... & Gurd, B. J. (2018). Moving beyond threshold-based dichotomous classification to improve the accuracy in classifying non responders. *Physiological reports*, *6*(22), e13928.
Weir, J. P. (2005). Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *The Journal of Strength & Conditioning Research*, *19*(1), 231-240.

Procedures during Linear Mixed Model

All procedures from Mixed effect modeling technique used the following references:

- Field, A. (2017). Discovering statistics using IBM SPSS statistics: North American edition. sage. Chapter: Multilevel linear models.
- Kreft, I. G., & De Leeuw, J. (1998). Introducing multilevel modeling. Sage.
- Landau, S. (2004). A handbook of statistical analyses using SPSS. CRC. Chapter: Analysis of Repeated Measures II: Linear Mixed Effects Models; Computer Delivery of Cognitive Behavioral Therapy
- WEST, Brady T.; WELCH, Kathleen B.; GALECKI, Andrzej T. Linear mixed models: a practical guide using statistical software. CRC Press, 2014.

Description of Data

Measurements of SBP and DBP were made in six occasions. For convenience, we centered the variables (new variable time_c) and the baseline SBP scores (new variable SBP_c) by subtracting the respective sample means. Centered was also used for DBP.

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For SBP the Wald test (Wald Z = 1.90, p = 0.057) demonstrated that the variance of the random slope effects was not significantly different from zero. The simpler random intercep model provided an adequate description of the data. For DBP the Wald test (Wald Z = 3.27, p = 0.001) demonstrated that the variance of the random slope effects was significantly different from zero. Thus, random slope effects provided an adequate description of the data.
The inclusion of time of training, baseline SBP and medications to predict post SBP is based on previous research findings cited in the references below.

Reference:

Jones H, Atkinson G, Leary A, George K, Murphy M, Waterhouse J. Reactivity of ambulatory blood pressure to physical activity varies with time of day. Hypertension. 2006;47(4):778–784.
Pocock SJ, Bakris G, Bhatt DL, Brar S, Fahy M, Gersh BJ. Regression to the mean in SYMPLICITY HTN-3: Implications for design and reporting of future trials. J Am Coll Cardiol 2016;68(18):2016-2025.
Ketelhut, R. G., Franz, I. W., & Scholze, J. (1997). Efficacy and position of endurance training as a non-drug therapy in the treatment of arterial hypertension. *Journal of human hypertension*, *11*(10), 651-655.

The data of Mixed effect modeling technique is available in the files:
“RESPONDER BLOOD PRESSURE PREDICTORS Paper Nascimento et al-2020.sav”
RESPONDER BLOOD PRESSURE PREDICTORS Paper Nascimento et al-2020.sav
“MEM FOR SBP BASE Paper Nascimento et al-2020.sav”
MEM FOR SBP BASE Paper Nascimento et al-2020.sav
“Output for MEM - SBP Paper Nascimento et al-2020.spv”
OUTPUT FOR MEM - SBP Paper Nascimento et al-2020.spv
“MEM FOR DBP BASE Paper Nascimento et al-2020.sav”
MEM FOR DBP BASE Paper Nascimento et al-2020.sav
“OUTPUT FOR MEM - DBP Paper Nascimento et al-2020.spv”
OUTPUT FOR MEM - DBP Paper Nascimento et al-2020.spv

To have access of how power calculation for the Mixed effect modelling technique was conducted, download the file cited below and upload to GLIMMPSE software https://v3.glimmpse.samplesizeshop.org/:
"POWER FOR MEM - - Paper Nascimento et al -2020.json"
POWER FOR MEM - - Paper Nascimento et al -2020.json

Mean values for each group for power calculation is displayed in the file below:
"OUTPUT FOR MEM - SBP AVERAGE FOR CALCULATING POWER - Paper Nascimento et al -2020"
OUT PUT FOR MEM - SBP AVERAGE FOR CALCULATING POWER - Paper Nascimento et al -2020.spv

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