Short-Term Stability of Resting Pulse Rates in Chiropractic Students

John Hart DC, MHSc*

Assistant Director of Research, Sherman College of Chiropractic, Spartanburg, SC

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Abstract

Objective: This study assessed the short-term stability of resting pulse rate (RPR) over an approximate 10-minute period in college students.

Methods: Thirty-one students were recruited as a convenience sample. The RPRs were manually measured in the seated position after 1, 3, 5, 7, and 9 minutes of seated rest. The RPRs were compared by rest time in repeated-measures analysis of variance.

Results: Mean RPR increased by 1.9 beats per minute (BPM) from 1 minute of pretest rest to the 3-minute measurement ($P < .05$) and by 1.5 BPM from 3 minutes to 5 minutes ($P > .05$). Among the 5-, 7-, and 9-minute pretest rested readings, a difference of less than or equal to 0.6 BPM was observed. Statistically significant differences were observed for (a) all comparisons involving the 1-minute rested measurement and (b) the 3- and 7-minute rested measurement. Overall, RPRs began to stabilize beginning with the 5-minute rested measurement.

Conclusion: In this sample of participants, RPR measurements could stabilize after a minimum of 5 minutes of pretest rest.

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Introduction

Short-term variability of physiologic findings in practice can be problematic. For example, findings from palpation of the patient's spinal musculature during the first minute of seated (or recumbent) rest may become different in the second or third minute of rest. This may not be a problem from visit to visit if the procedure is performed with the same amount of pretest rest time (eg, 1 minute of rest before the test for all

visits). Unless timing for rest times is performed, it is probably unknown exactly how long the patient rests before examination.

Previous research in chiropractic along these lines has been conducted on paraspinal thermography with the use of a pattern calculator. That study revealed, on average, variability of thermal patterns during approximately the first 15 minutes of acclimation to room temperature (with gown opened in the back).¹ An individual patient's thermographic pattern may show consistency between visits with shorter acclimation times that are consistently used, but this would need to be tested. Short-term stability/repeatability of most physiological assessments performed in chiropractic

* Corresponding author. Sherman College of Chiropractic, PO Box 1452, Spartanburg, SC, 29304. Tel.: +1 864 578 8770x232.
E-mail address: jhart@sherman.edu.

examinations (such as muscle and motion palpation, and leg length inequality tests) within a short (eg, 10 minutes) pretest rest period remains largely unknown. Thus, it is important to test the short-term stability of our neurophysiological measures if these measures are to be compared in a series. Comparing a neurophysiological measure that had a pretest rest period of only 1 minute to a subsequent measure having a 5-minute pretest rest period may not be valid because different rest times likely result in different findings. Controlling for the variable of pretest rest time will help to increase the validity of such comparisons between visits.

Manually derived resting heart (pulse) rate (RPR) is a potentially useful neurophysiological option for assessing the patient's nervous system in chiropractic practice. The theory is that an elevated RPR signals the presence of a neurological disturbance and therefore possibly a need for a spinal adjustment.² Interestingly, RPR (manually derived) shows good agreement with heart rate derived from an electrocardiogram (ECG).^{3,4} The notion that RPR is a measure of neurological function is supported by the following from the scientific literature:

1. "Dysregulation of the autonomic nervous system ...[is] indicated by elevated resting heart rate."⁵
2. "Resting heart rate [is] a low tech and inexpensive measure of autonomic tone...."⁶

Although there are other methods to monitor nervous system function, such as nerve conduction velocity, RPR has an advantage of being sufficiently user-friendly to conveniently allow use on all patient visits (vs only periodically as higher-tech methods are intended). Resting pulse rate is another option that may be of interest to chiropractors looking for an evidence-based neurological assessment that is sufficiently user-friendly to be included on all patient visits.

Resting pulse rate is supported by outcomes research showing that a lower RPR tends to be associated with improved outcomes compared with a higher RPR.^{7,8} Sensitivity and specificity for a cutoff of 78 beats per minute (BPM) for RPR (less than 78 healthier than 78 or higher) have been reported in a study of Brazilian patients when considering mortality for cardiovascular and all causes.⁹ In addition, a change as small as 1 BPM has been found to be clinically significant in hypertensive patients.¹⁰ In a study of relatively healthy persons, in those whose RPR increased to greater than 85 BPM over an approximate 10-year period from 70 to

85 BPM showed a greater mortality risk compared with those whose RPR was less than 70 BPM.¹¹

There is some evidence that RPR improves (decreases) following chiropractic care,^{12,13} but the reduction is sometimes not statistically significant.¹⁴ In one study, a short-term statistically significant reduction in resting heart rate was observed in an intervention group (thoracic manipulation), but this was also observed in the sham group.¹⁵ In addition, a recent study revealed RPR as having a good (moderate strength) correlation with another, perhaps more well-known neurological assessment in chiropractic—heart rate variability.¹⁶ Still, further research is needed to determine whether improvement in patient-centered outcomes is associated with the lowered RPR following chiropractic care. Further research may also reveal whether RPR decrease following chiropractic care is or is not more beneficial (according to outcomes research) compared with RPR decrease following a fitness approach such as exercise. As an autonomic measure, RPR is hypothesized to be a useful indicator for the neurologically based chiropractor not only for determining when to adjust the patient but also as an outcome measure.

A potential problem in any research on RPR is that different studies using RPR may use different pretest rest times, in which case it would be important to know whether the different times may affect different RPR measurements. As common as the RPR procedure is, its short-term stability appears to be unknown. This is evidenced by the lack of findings in a literature search conducted on January 10, 2014, in Bing, Google Scholar, and PubMed using key words *Short-term stability of resting heart rate*, *short-term stability of resting pulse rate*, and *pulse rate and reliability* (on October 6, 2014). Thus, little is known about the effect of pretest rest times on RPR.

A common pretest rest period in research for measuring RPR is 5 minutes,¹⁷ but in practice, the pretest rest period may not be strictly timed. This is not surprising because standard textbooks on physical examination for practice typically do not include a discussion of pretest rest periods for RPR.^{18,19}

For practitioners who may not strictly time a pretest period for RPR, a reasonable estimation of the pretest rest time may be appropriate and useful to gain confidence that the patient has adequately rested before examination. For example, the practitioner may not know exactly how long the patient has rested but may know that the patient has rested at least a certain amount of time before the examination. If research shows that RPRs tend to stabilize after a certain amount

of rest time, then the clinician would simply note whether this amount of pretest rest time (or longer) was achieved. This would seem to be a more convenient approach in practice compared with exactly timing the pretest rest period for each visit.

Research into the question of short-term RPR stability will help (*a*) provide the clinician with some level of confidence regarding accuracy of the RPR measurements when strict timing of pretest rest times does not routinely occur and (*b*) researchers who might compare RPR studies that use different pretest times (eg, 3 minutes in one study vs 5 minutes in another). If RPR differences occur by different pretest rest times and the practitioner who compares RPR from different visits is not taking this difference (as subtle as it may be) into account, then an inaccurate comparison may occur. For example, an RPR measurement with a pretest rest period of only 1 minute is likely to be different from an RPR measurement with a pretest rest period of 5 or more minutes simply because of the different rest times alone. Attempting to control for this variable (of pretest rest time), at least in knowing whether there can be a difference in RPR when different pretest rest times are used, will help increase the validity of comparing RPR measurements from different visits.

Minor changes in neurophysiological findings such as RPR frequently occur and are the reason why the study was done—to see how much change occurs with (rest) time alone. Clinical relevance is not assessed in this study, but knowing variation according to rest times is important so that next steps (such as determining clinical relevance of the minor RPR changes) can be more accurately assessed. Physiological properties of RPR include its rate (could be palpated, in BPM), rhythm (as measured typically by ECG), and force (weak vs strong, as felt with palpation). Rate is assessed in the present study, whereas assessment of rhythm and force is beyond the scope of this study. Although there are many factors that can change RPR from visit to visit, this study seeks to address the variable of different pretest rest times. Thus, the purpose of the study is to determine how stable RPRs are in the short term in a sample of relatively healthy college-aged students. From a position of standing, where RPR is higher than it is in the seated position, the expectation is that initial RPR measurements in the seated position will have lingering effects from standing and therefore will have higher RPR values than subsequent RPR values (that have longer rest times).

Methods

This observational study was approved by the Institutional Review Board at Sherman College of Chiropractic. Study participants gave consent and consisted of 31 students (18 female and 13 male) at Sherman recruited by the primary investigator as a convenience sample. Thus, inclusion criteria consisted of participants being Sherman students, whereas no exclusion criteria were applied. Their ages ranged from 21 to 54 (mean age, 28.4; standard deviation, 8.4), and body mass indexes (BMI) ranged from 18.9 to 40.9 (mean, 27.3; standard deviation, 5.6). In appreciation, the students were paid \$5 for their participation.

Willing participants arrived in the examination area and were instructed to remain standing for the paper work, which included signing a consent form. The room was kept at a comfortable temperature, and participants were instructed to remain still and quiet. Upon being seated, a digital timer was started. Count times for manual pulse derivation typically are 15,¹¹ 30,²⁰ or 60 seconds.²¹ Good agreement with ECG is achieved with 15-, 30-, and 60-second count times when the count begins with a “1” rather than zero.²² For the present study, 30-second count times were used because this was the time used in a study on reference data for the United States.²⁰ Counts were taken at the radial artery by the primary investigator, using the pads of the first 2 or 3 fingers, at the 1-, 3-, 5-, 7-, and 9-minute marks, with the first count for all measurements beginning with a 1. Participants were not instructed to restrict or limit their routine in areas such as diet of caffeine so as to represent a sample commonly encountered in practice.

Analysis

No previous study on the topic of short-term changes in RPR was found, thereby preventing sample size/power analyses based on previous data. A minimum of 30 participants was selected because this is the minimum number suggested for *t* test–type procedures.²³ The 30-second counts were multiplied by 2 to obtain a BPM value. Resting pulse rates by pretest rest time (minutes 1, 3, 5, 7, and 9) were compared in an unblinded manner in (*a*) analysis of variance (ANOVA) for repeated measures with Tukey-Kramer multiple-comparison posttest and (*b*) effect size, using a pooled standard deviation. Resting pulse rate stability was assessed by comparing all RPR averages to each other in ANOVA. The program used for the ANOVA

Table 1 Descriptive Statistics for RPR (BPM)

Pretest Rest (min)	n	Mean	SD	CV	SE	Minimum	Maximum
1	31	73.4	11.4	0.15	2.0	52	106
3	31	75.3	11.0	0.15	2.0	52	110
5	31	76.8	10.1	0.13	1.8	56	106
7	31	76.9	10.6	0.14	1.9	56	108
9	31	76.3	9.8	0.13	1.8	58	104

CV, coefficient of variation. SD, standard deviation; SE, standard error.

analysis was InStat 3.10 (GraphPad Software, San Diego, CA), and Excel 2010 (Microsoft Corp, Redmond, WA) was used for effect size calculation. Stability for RPR according to pretest rest time was determined by noting whether a given RPR by pretest rest time revealed statistically nonsignificant differences and relatively low effect size when comparing with the other RPRs by pretest rest time. In addition, participants' RPR variability, represented by their individual RPR standard deviation, was compared with their (a) age and (b) BMI to see if these factors influenced the RPR. This comparison was done using Pearson correlation in Stata. Given the rather quick pace of the taking and recording of the RPR measurements (30-second measurements every 2 minutes), blinding of RPR data collection was considered unfeasible.

P values less than or equal to the conventional α level of .05 were considered statistically significant.

Results

Descriptive statistics are provided in Table 1. Low-strength, statistically nonsignificant correlations were

observed between RPR standard deviation and (a) age ($r = -0.231$, $P = .212$) and (b) BMI ($r = -0.107$, $P = .567$). Coefficients of variation and standard errors of the mean were slightly larger for pretest rest times of 1 and 3 minutes (Table 1). Coefficients of variation were largest for pretest rest times of 1 and 3 minutes (Table 1). The 3 smallest effect sizes were revealed for comparisons involving 5 or more minutes of rest times (Table 2).

Mean RPRs were lower for minutes 1 and 3 rest times compared with the other counts (having longer resting times). Statistically significant differences were observed when comparing each rest time to all others for (a) all comparisons involving the 1-minute rested reading and (b) the 3- and 7-minute rested measurement comparison. The largest difference for all comparisons was between the 1- and 7-minute rested measurements, a difference of 3.5 BPM, followed by the 1- and 5-minute rested measurement which revealed a difference of 3.4 BPM. The only pair of consecutive RPR measurements that revealed a statistically significant difference was for the 1- vs the 3-minute RPR measurement. Stability (defined under "Analysis" above) for RPR began with the 5-minute pretest rest reading, with a slight decrease observed for the 9-minute measurement (Tables 1 and 2; Fig 1).

Table 2 Resting Pulse Rate Differences by Pretest Rest Time

Comparison	Difference	<i>P</i>	95% CI	Effect Size
1:3	-1.9	<.01	-3.4 to -0.4	0.17
1:5	-3.4	<.001	-4.9 to -1.9	0.32
1:7	-3.5	<.001	-5.1 to -2.0	0.32
1:9	-3.0	<.001	-4.5 to -1.5	0.27
3:5	-1.5	NS, >.05	-3.0 to 0.0	0.14
3:7	-1.6	<.05	-3.1 to -0.1	0.15
3:9	-1.0	NS, >.05	-2.5 to 0.5	0.10
5:7	-0.1	NS, >.05	-1.6 to 1.4	0.01
5:9	0.5	NS, >.05	-1.1 to 2.0	0.05
7:9	0.6	NS, >.05	-0.9 to 2.1	0.06

CI, confidence interval. Comparison = pretest rest times compared (eg, the first row consists of the 1- and 3-minute rest counts being compared in ANOVA for repeated measures). Difference = mean difference of pulse counts between rest times, subtracting the later measurement from the earlier measurement (eg, 1-minute measure - 3-minute measure). NS, not statistically significant; CI, confidence interval for the difference.

Fig 1. Resting pulse rate (in BPM) by pretest rest time with standard error bars. Stability of the pulse rate was achieved beginning with the 5-minute pretest rest time. *BPM*, beats per minute.

Tachycardia, defined as an RPR that exceeds 100 BPM,¹⁸ was observed in 2 of the 31 participants (7%). In one of these participants, the tachycardia was observed in only 1 of the pretest rest times, whereas in the other participant, the tachycardia was observed for all 5 measurements. The tachycardia observed in one of the participants may be due to the presence of pain. An explanation for tachycardia is lacking for the other participant, other than the possibility that it represents neurological stress that may be alleviated with a chiropractic adjustment. *Bradycardia*, defined as an RPR less than 60 BPM,¹⁸ was observed in one participant for all 5 measurements, another participant in 2 of the measurements, and a third participant in 1 of the measurements. The bradycardia in these young healthy participants is viewed as a sign of neurological fitness, as commonly seen with athletes. One of these participants exercised regularly using moderate exertion, whereas the other exercises also regularly with a high level of exertion.

Discussion

Resting pulse rates for these participants stabilized, on average, beginning with the 5-minute pretest rest period. Only the 1- and 3-minute pretest rest times showed statistically significant differences, with larger effect sizes when compared with the other pretest rest times. The overlapping error bars (in Fig 1) suggest that RPRs are not different according to pretest rest time, even though some of the *P* values for comparing the differences are statistically significant (eg, when comparisons include the 1-minute pretest rest RPRs). This conundrum is similar to the case of overlapping

confidence intervals that sometimes accompany differences that are actually statistically significant.

Age and BMI did not appear to influence the amount of RPR variability in this sample, evidenced by their weak and statistically nonsignificant correlations with RPR standard deviations.

The RPR findings in this study may indicate what can be expected for other college students' RPRs at various short-term rest periods. Thus, RPR measurements for college-aged students are likely to stabilize with at least a 5-minute pretest rest period. This stability is assumed to persist beyond the 9-minute pretest rest period used in this study, but further research using longer times would be needed to test this assumption.

The expectation was that the initial (1-minute rested) RPR measurement would be *higher* than the subsequent measurements due to the fact that it (the initial reading) was temporally closer to the time when the participant was standing. Surprisingly, the initial RPR measurements (1- and 3-minute acclimated RPR measurements) were, on average, *lower* than the subsequent measurements that had longer rest times. This may be due to the body's adaptive processes that may exhibit an exaggerated adaptive response from standing to sitting, governed by heart centers in the medulla oblongata, where a lower RPR is produced compared with standing. The possible exaggerated response is akin to the exaggerated response in blood pressure increase that typically occurs from sitting to standing.²⁴ Apparently, the effects of standing, which involve a higher heart rate compared with sitting, not only wear off in these participants after 1 minute of sitting but result in a lower RPR compared with subsequent RPRs having longer pretest rest times.

Practical Significance of the Findings

The findings of this study may be of interest to those who wish to compare RPRs among multiple visits in the ambulatory setting. An RPR measurement taken with only 1 minute of pretest rest time on one visit can be expected to be different from another RPR measurement taken with 5 or more minutes of pretest rest. However, an RPR measurement taken with 5 minutes of pretest rest can be expected to essentially represent the same pretest rest condition of 7 or more minutes of pretest rest used on other comparison visits. Future research could address the reliability of RPR on different days (vs addressing different minutes on the same visit as this study did). Here, the findings of this study could be considered in future studies that seek to

determine what a *minimal clinical meaningful difference* following chiropractic care might be. Knowing the probability of when RPR becomes stable in any given visit will help the chiropractor more accurately know whether an increase (typically viewed as a worsening) or a decrease (typically viewed as an improvement) has actually occurred.

Clinical Implications of RPR

Resting pulse rate in neurologically based (eg, subluxation-centered) chiropractic is a novel application of a routine vital sign. Briefly, its use in daily visits for determining when the patient needs an adjustment is based on long-term studies that show that increasing RPR is not a healthy occurrence. Thus, when the chiropractic patient is observed to have an increasing RPR on consecutive visits, the clinician may theorize that the patient's nervous system is exhibiting stress possibly as a component of chiropractic subluxation. If RPR decreases following an adjustment, the clinician might attribute the improvement to the adjustment.

The findings of the present study suggest that pretest rest time needs to be accounted for from visit to visit. In particular, the clinician does not necessarily have to time the pretest rest period but simply know whether a minimum time was observed. That minimum time, based on this study's findings, is 5 minutes. This rest time is consistent with rest times observed in other research, although rest time in practice is not particularly addressed in the literature. Here is an example where research and practice may form a bridge, where the research finding of at least 5 minutes of pretest rest should be observed in practice before obtaining an RPR measurement.

Limitations of the Study

The study is limited in that (a) the author was not blinded as to which group of RPRs he was analyzing (eg, pretest rest times were known during analysis); (b) the findings have limited external validity because the participants consisted of a convenience sample; (c) only 9 minutes of pretest rest time was observed; (d) only 1 position (seated) was tested (another common position for RPR measurement is the supine position); (e) data collection and analysis were conducted in an unblinded manner; and (f) participants remained on their normal schedule regarding dietary intake. It would be feasible in future studies to address many of these limitations.

Conclusion

In this sample of participants, RPR began to stabilize after 5 minutes of pretest rest.

Funding Sources and Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

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