Resting Pulse Rate as a Potentially Useful Autonomic Marker for Neurologically-Based Chiropractic Practice

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Abstract

Many chiropractors focus on improving neurological function with their interventions, e.g., spinal adjustment of chiropractic subluxation. By definition, a chiropractic subluxation includes some type of minor biomechanical dis-relationship, e.g., a slight vertebral misalignment along with some type of neurological disturbance, e.g., an autonomic nervous system (also known as "autonomic") dysfunction. The number of methods for assessing autonomic dysfunction, for the purpose of determining whether or not the patient needs a chiropractic adjustment is currently limited. In this commentary, the author suggests that the manually-palpated resting pulse rate assessment may be a user-friendly option that could be included in the neurologically-based chiropractic practice to help the chiropractor decide when the patient needs a chiropractic adjustment for the purpose of improving autonomic function.

INTRODUCTION

Chiropractors are typically interested in improving neurological function with their interventions, e.g., spinal adjustment (now referred to as "adjustment") of chiropractic subluxation (now referred to as "subluxation"). One aspect of subluxation pertains to a neurological component.[1] If a neurological disturbance is found, along with a slight biomechanical fault such as a slight vertebral misalignment, then the patient would be considered to have a subluxation in need of an adjustment. The neurological aspect of subluxation may involve an autonomic nervous system (also known as "autonomic") component. Currently, the number of assessments available to chiropractors for analysis of autonomic function, such as paraspinal thermography and heart rate variability, is limited. In this commentary, the author suggests that the manually-palpated resting pulse rate assessment may be a user-friendly option that could be included in the neurologically-based chiropractic practice to help the chiropractor decide when the patient needs an adjustment for the purpose of improving autonomic function.

Briefly, heart rate, also known as pulse rate [2] is primarily controlled by autonomic centers in the medulla oblongata.[3] Furthermore, use of the resting pulse rate (RPR) in health care is considered a marker for autonomic function.[4-8] Here are some relevant extractions from the research literature showing RPR is an indicator for autonomic function:

1."The resting heart rate is also a marker of haemodynamic **and autonomic nervous system states**…"[4] (Emphasis added)

2."Dysregulation of the autonomic nervous system…[is] indicated by elevated resting heart rate."[6]

3."Resting heart rate [is] a low tech and inexpensive measure of autonomic tone…"[7]

4."Heart rate not only reflects the status of the cardiovascular system, but also **serves as an indicator of autonomic nervous (sympathetic and parasympathetic/vagal) system activity** and metabolic rate."[8]8 (Emphasis added)

RPR assessment in health care is also supported by outcomes research, which in general shows that a slower RPR is healthier than a faster RPR.[4-18] A sampling of resting heart rate literature reveals that: a) a reduction in RPR from 70 to 60 beats per minute (BPM), presumably in the general population, would be expected to increase expectancy of life from 80 to 93.3 years of age;[13] b) a 5 BPM increase in RPR is associated with an 8% increase in cardiovascular deaths in patients with left ventricular dysfunction and stable coronary artery disease; and c) a change in RPR as small as 1 BPM is associated with a 1% change in risk for cardiovascular, ischemic heart disease, and all cause mortality in patients with hypertension.[11]

As visual examples of the relationship between RPR and outcomes, Figures 1[18] and 2[14] show relationships between RPR and outcomes of mortality, where increasing RPR is related to increasing relative risk of death (Figure 1) and decreasing survival rates over time (Figure 2). Arnold et al[15] sum-up the outcomes research on resting heart rate in their 2008 paper as follows:

"Over the past 30 years, at least 38 studies have looked at the connection between heart rate and cardiovascular or all-cause mortality [cited in original paper here: Palatini et al, Drugs 2006; 66:133-144]. These studies have covered a wide variety of populations: men and women, black and white, healthy and diseased, and younger and older. After adjusting for risk factors and lifestyle, at least 32 studies show that an elevated heart rate is an independent risk factor for mortality and morbidity in healthy people with and without hypertension; it is also an independent risk factor in patients with coronary artery disease, myocardial infarction, and heart failure [cited in original paper here: Palatini et al, 2006; Hjalmarson, Eur Heart J 2007; 9:F3-7]."[15]

Thus, RPR assessment appears to have a strong outcomes evidence-base.

RPR IN CHIROPRACTIC PRACTICE

RPR assessment in chiropractic is not new, but it is typically used only as a routine vital sign. A suggestion has been made by other authors that pulse oximetry could be used in chiropractic practice.[19] The emphasis in this suggestion pertained to the oximetry aspect. Here, these authors[19] seem to suggest that indications for adjustment do not depend on heart rate. For example, in their paper, where they discuss percent of hemoglobin in oxygen in the blood (SpO2) being between 94% and 97%, they say that adjustment may be indicated while noting that heart rate could be "normal, increased, or decreased."[19]

What appears to be new in chiropractic is the suggestion made in this commentary that manually-palpated RPR analysis could be included in the neurologically-based chiropractic practice to help the chiropractor decide whether the patient is displaying a neurological disturbance as evidenced by an increasing RPR. If RPR analysis indicates that an autonomic disturbance is present, and the patient also has a minor biomechanical fault in the spine, then an assumption could be made that subluxation is present and the patient needs an adjustment. RPR could also be used as an outcome measure over periods of time that are longer from visit-to-visit, as is done in chiropractic research (discussed later in more detail). Advantages of using the manually-palpated RPR assessment in chiropractic practice are that it is: a) an autonomic assessment, b) supported by outcomes research, c) user-friendly (no special equipment needed), and d) an objective measure (in the form of a number) which is easily understood by both doctor and patient.

Patients who see chiropractors may also have a disease which is associated with elevated RPR (such hypertension). Therefore, a reduction in RPR in these patients may be associated with amelioration of the disease symptoms or outcomes according to the literature on RPR reduction, though this literature does not specifically include chiropractic care.[4-18] Conversely, patients who see chiropractors may not have a disease, and may be asymptomatic. Asymptomatic patients would also seem to receive a clinical benefit from a reduced RPR that might follow chiropractic care. In a study on asymptomatic men, a higher resting heart rate (of 80 BPM or more) was associated with an increased risk of all-cause mortality and sudden death compared to a lower resting heart rate (of less than 65 BPM).[16] Similar findings were revealed in a study on resting heart rate in a general population (women and men), without known cardiovascular disease.[17] Here, a decrease in resting heart rate to less than 70 BPM was associated with a 40% lower risk of death compared to those whose resting heart rate remained between 70 and 85 BPM.[17] Also from this study,[17] compared to participants with resting heart rates below 70 BPM at two measurements approximately 10 years apart, participants whose resting heart rate increased from less than 70 BPM at the first reading to greater than 85 BPM at the second reading were observed to have a 90% higher risk of death from ischemic heart disease and a 50% higher risk of death from all causes. In another study on asymptomatic men, a general trend of increasing relative risk of death was observed as RPR increased from a lower RPR category (e.g., 60-64 BPM) to a higher RPR category (e.g., 65-69 BPM).[18]

In addition to outcomes such as mortality rates, autonomic function itself, indicated by RPR could be considered as an outcome. Since an elevated RPR signals the presence of autonomic dysfunction,[6] then improvement of autonomic function, evidenced by a decrease in RPR would seem to be an important step toward improved health and well-being of the patient.

RPR in chiropractic research

In chiropractic research, RPR is typically used as an outcome measure rather than for determining when the patient needs an adjustment. Some outcomes-based studies have shown reductions in RPR following chiropractic care.[20-24] One of these studies showed a statistically significant reduction in RPR in the short term but this was also observed in the study's sham group.[23] Two of these studies reported effect sizes that were either negligible[20] or small.[22] A multi-clinic study revealed a statistically significant reduction in heart rate over time following chiropractic care.[24] Consequently, there appears to be evidence that: a) RPR may decrease (improve) following chiropractic care and b) further research is warranted regarding RPR and chiropractic care.

Other factors can reduce heart rate

In addition to adjustment of subluxation, another type of manual intervention, massage, has been followed by a statistically significant reduction in RPR.[25] A limitation to this study,[25] as with some of the aforementioned chiropractic studies, is that there was no comparison group. Obviously there are other factors that can also reduce RPR, such as excellent level of physical fitness and certain medications. However, if massage, physical fitness, and certain medications can reduce RPR, then it would seem that chiropractic care, which in principle typically seeks to improve neurological function, should also be associated with RPR reduction. If RPR does not decrease following chiropractic care, then this would be an indication that autonomic improvement would not have occurred. Perhaps future research will find that some types of interventions are more effective than others regarding RPR reduction.

Is an increasing RPR definitely related to an existing slight biomechanical fault in the spine? The same question could be asked regarding any test that purports to identify a neurological component of subluxation. If RPR is reduced following adjustment, then it is reasonable to assume that a slight biomechanical fault, if present, was a factor in the elevated RPR, and adjustment contributed to the reduction, particularly if baseline readings showed a persistent elevated RPR prior to the adjustment.

Measurement methods

Some studies that report on resting heart rate use technology such as ECG,[26] or home units[27] to obtain the resting heart rates, while others use palpation of a peripheral pulse such as the radial artery.[11] Some studies have the patient in the seated position[28] while others have the patient in the supine position.[11] For the palpation method, typically, the pulse is taken for 15, 30, or 60 seconds.[29] Furthermore, the manually-palpated RPR has a strong correlation with RPR from ECG findings.[17]

In addition to the traditional manually-palpated RPR reading suggested in this commentary, the author has researched a modified method of taking and interpreting the RPR readings.[30]The method attempts to capture not only the RPR readings but also its variability over an approximate two minute period.[30] This method involves four manually-palpated radial pulse readings, calculating their mean, and then subtracting from the mean, the difference between the maximum and minimum readings. The method is re-stated here as follows: pulse mean – (maximum – minimum pulse rates).[30] The method, pulse mean – (maximum – minimum pulse rates), as well as pulse rate mean itself, was found to have a good association with the standard deviation of normal-to-normal beats (SDNN) using heart rate variability technology.[30]

This commentary suggests that chiropractors interested in including a user-friendly method for analyzing a neurological (autonomic) component for subluxation care could consider using the manually-palpated resting pulse rate of the radial artery, also referred to here as manual resting pulse rate (MRPR). It is recommended that the following protocol be included for obtaining MRPR measurements:

a) Rest the patient for at least 5 minutes prior to the MRPR measurement. Patient position could be seated or supine but the position should be the same for resting and measurement (e.g., either seated for resting and measurement or supine for resting and measurement) and consistent between visits. The reason for consistency of body position for the patient is that RPR tends to change with changing body positions (e.g., seated versus supine);[31]

b) Take MRPR for at least 15 seconds, keeping in mind that 30 or 60 second time frames appear to be more common in practice and in research. Multiplied numbers for 15 or 30 second readings, to achieve an estimate for a full minute (e.g., 15*4 or 30*2) are limited to the extent that they result only even numbers. A greater "resolution," that includes odd numbers as well, thereby allowing detection of as little as 1 BPM change is achievable by taking the pulse for a full minute. Un-multiplied RPR readings obtained in shorter times (e.g., leaving the 15 second reading un-multiplied) would also include odd numbers but the difference between such readings would be smaller than it would be for an RPR taken for a longer period of time. For example, a 1 beat difference with 15 second readings would probably show a difference of 4 beats if the RPR was taken for a full minute.

c) Count initially from 1 instead of 0, since the former shows stronger agreement with ECG than the latter.[32]

d) For type of timepiece, there may be a potential pitfall for obtaining an accurate MRPR if a sweep second hand type timepiece is used. Sweep second hands on wrist watches and computer clocks typically "jump" from one second to the next. On computer clocks it seems rather clear which number on the clock the second hand is "jumping" to, as the jump appears to typically "land" exactly on a definitive number (e.g., the 12). This is important since the examiner must have a target number on the timepiece marking the beginning of the time period to be used, be it 15 seconds, 30 seconds, or 60 seconds. On wrist watches however, it seems less clear which number the sweep second hand lands on. As an example, if the examiner's beginning target number is 12 on the wrist watch with a sweep second hand, it (the sweep second hand) may jump to a point slightly before or after the 12. For this reason, the author recommends a digital timer (which produces actual numbers for each passing second). A digital timer is typically available on computer clocks, as well as on certain wrist watches and stopwatches. In using a digital timer, there would be no question as to when the targeted time period begins.

e) Note the patient's activities during the hours prior to the MRPR reading, particularly in regard to exercise and ingestion of caffeine, alcohol, nicotine, or medications that can affect RPR.[29] If the patient is under physical exertion, a 20 minute rest is advised. If activities that affect RPR, such as ingestion of caffeine have occurred, view RPR findings with caution. Two possible approaches are available for the patient who, for example typically drinks coffee prior to the MRPR examination. One approach would be to ask the patient questions such as whether the coffee was caffeinated or decaffeinated, how many cups were ingested, and approximate time (in minutes) since the coffee was ingested. Correlations could then be performed between these variables with, say, 10 visits worth of data. Amount of coffee would be expected to directly correlate with MRPR (increased MRPR with increased number of cups of coffee). If this direct correlation is observed in a particular patient, and a lower MRPR is observed on a subsequent visit that had the same or more cups of coffee compared to previous visits, then the MRPR decrease would seem to be an actual decrease for this patient. A second approach could be to simply ask the patient to refrain from coffee drinking and other similar activities that can affect RPR in the hours (e.g., 3-4 hours) prior to MRPR examination. In either approach, the patient should still be asked about activities that can affect the RPR reading.

f)Measurements should be taken at the same time of day as RPR could vary with time of day.

g) Additional details on protocols, including other factors affecting MRPR are available elsewhere.[33]

It may be worthwhile noting here that if certain activities, including time of day can affect MRPR, then these same activities may also affect other physiological measures commonly performed in chiropractic practice, such as motion palpation and contractured leg length inequality assessments.

Figure 1

Figure 1. Resting heart rate and relative risk of death. From Jouven et al. 2005; 352:1951-1958. (Reference # 18 above). Reprinted with permission from the Massachusetts Medical Society. As resting heart rate increases, relative risk of death also tends to increase. Text below figure is in original paper.

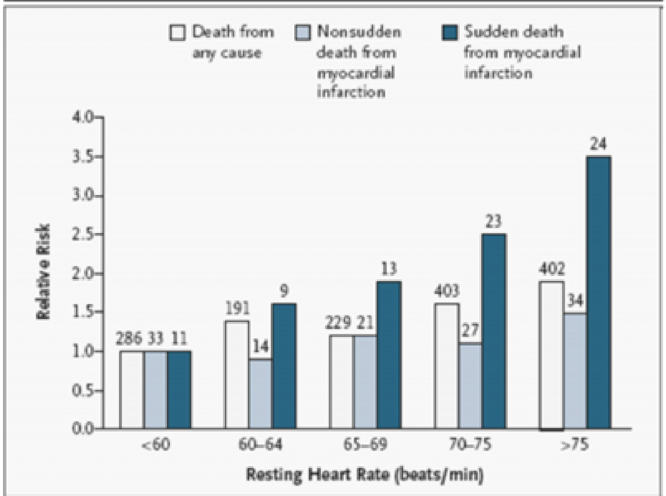


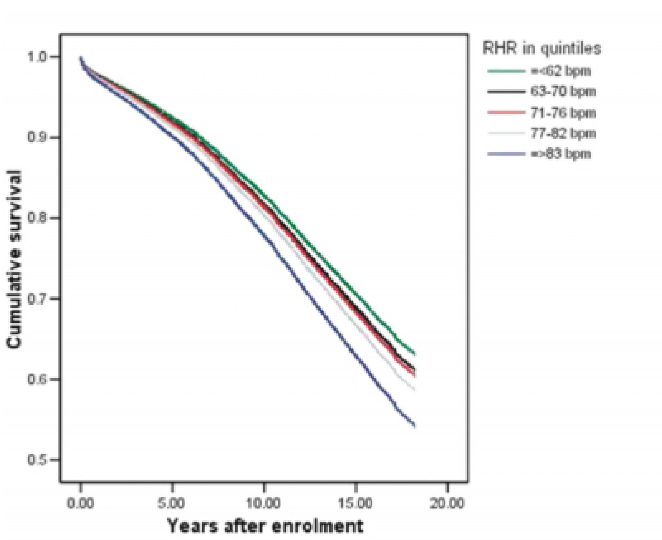
Figure 1. Relative Risks of Death from Any Cause and of Nonsudden and Sudden Death from Myocardial Infarction, According to the Quintile of Resting Heart Rate.

The reference group was subjects with a resting heart rate of less than 60 beats per minute (lowest quintile). The numbers over the bars indicate the numbers of subjects. Comparisons were performed with the Mantel–Haenszel chi-square test for trend. The test for trend showed a significant difference among quintiles with respect to the risk of death from any cause (P<0.001), nonsudden death from cardiac causes (P=0.02), and sudden death from cardiac causes (P<0.001). Adjustments were made for age, use or nonuse of tobacco, level of physical activity, presence or absence of diabetes, body-mass index, basal systolic blood pressure, cholesterol level, presence or absence of a parental history of sudden death or myocardial infarction, and exercise duration. Data are missing for five subjects who died of any cause, including one who died suddenly from myocardial infarction.

Figure 2

Figure 2. Resting pulse rates, years after enrolment in study, and survival curves. From Diaz A et al. 2005; 26:967-974 (reference #14 above). Reprinted with permission from Oxford University Press. Survival curves show a trend where increasing resting heart rates are associated with decreasing survival rates. As examples, the blue line, which is the lower line, represents resting pulse rates of 83 BPM or more and shows the lowest survival rates at various years after enrolment. By comparison, the green line, which is the upper line, represents resting pulse rates of 62 BPM or less and shows the highest survival rates at various years after enrolment. Text below figure is in original paper.

Adjusted survival curves for overall mortality by RHR quintiles



Adjusted for age, gender, hypertension, diabetes mellitus, cigarette smoking, clinically significant coronary vessel disease, EF, recreational activity, treatment with antiplatelets, diuretics, beta-blockers, and lipid-lowering drugs.

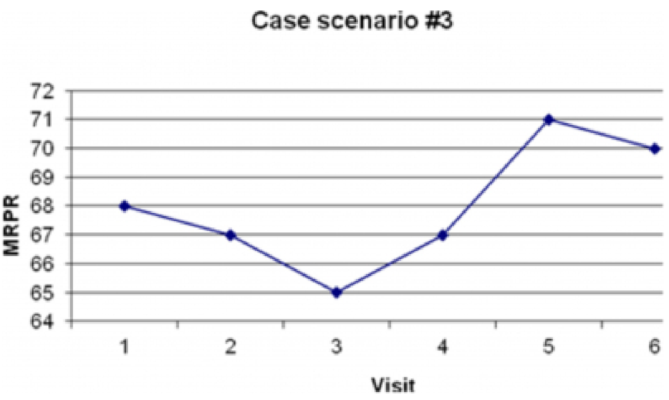
Figure 3

Table 1. Case scenario #3. Trend inspection of three consecutive visits and outlier detection using quartile analysis of five consecutive visits. MRPR = manual resting pulse rate. Q1 = quartile 1. Q3 = quartile 3. IQR = inter-quartile range, calculated with Q3Â–Q1. LF = lower fence, calculated with Q1Â– (1.5*IQR). UF = upper fence, calculated with Q3+ (1.5*IQR). Trend inspection indicates MRPR is moving in the right direction (decreasing) for visits 2 and 3 compared to Visit 1 but moving in the wrong direction (increasing) for Visits 4 and 5 compared to Visit 3. Visit 6 decreased (improved) slightly compared to Visit 5. Of the two analyses for outliers (Visits 5 and 6), only Visit 5 shows an outlier, where the 71 BPM is above the upper fence of 69.5 for that visit.

Visit	MRPR	Visits analysed	Q1	Q3	IQR	LF	UF
1.	68						
2.	67						
3.	65						
4.	67						
5.	71	1-5	67	68	1	65.50	69.50
6.	70	2-6	67	70	3	62.50	74.50

Figure 4

Chart for case scenario #3 (same data as in Table 1).



POSSIBLE METHODS OF INTERPRETATION

One possible method of interpreting RPR readings could be to simply inspect the trend of several consecutive visits. For example, the 60-second RPR that increases on consecutive visits, e.g., 71, 72, and 73 BPM could be considered as heading in the wrong direction (increasing RPR) from an autonomic standpoint. Thus, a worsening RPR may indicate that the patient needs an adjustment, assuming some type of slight biomechanical fault is also present. The chiropractor could theorize that a slight biomechanical fault in the spine, if present, could be interfering with neurological communication between the medulla oblongata and the heart. This neurological interference, essentially occurring between the brain and the body, would be evidenced by the increasing (worsening) RPR readings. Conversely, if RPR is decreasing (improving), even in the presence of a slight biomechanical “fault” (that the body may have adapted to), adjustment would not be indicated, at least according to RPR analysis.

Is there a small amount of MRPR fluctuation that is clinically insignificant, at least from one visit to the next? A small change of, say 1 BPM (using the full minute measurement) from one visit to the next should be viewed with caution, as this could be due to measurement variability. Case scenario #1 is provided here as an example of potential measurement variability accounting for a 1 BPM difference between readings using the 60-second MRPR: In one reading, the first beat could occur toward the beginning of the first timed second while a subsequent reading could have the first beat occur toward the end of the first timed second.

It may be that a change of, say, 3 BPM (from readings taken for a full minute) in MRPR could be the minimum change needed for clinical significance regarding subluxation analysis from visit-to-visit. Future research might help to clarify the minimum BPM change needed from visit-to-visit for clinical significance to be present. From a practice standpoint, it would seem that establishing a baseline prior to adjustment would be helpful in addressing the question of small MRPR changes. Case scenario #2 is provided here in an attempt to address this question (of small MRPR changes from visit-to-visit) using 60-second readings:

Establishing a baseline would also seem to help in determining whether a white coat effect is present. If this effect appears to be present, the MRPR procedure can be taught to the patient to obtain MRPR measurements at home. The patient could then report the home MRPR readings to the chiropractor, at least until a time when the white coat effect is determined to have subsided. The home RPR measurement appears to be valid to the extent that it (home RPR readings) has been shown to be a strong predictor of cardiovascular disease mortality risk in the general population.[27]

Another option for dealing with uncertainty in small MRPR changes consists of outlier detection using quartile analysis.[34]This statistic is easily performed in Excel (Microsoft Corp. Redmond, WA) and can be applied to the MRPR numbers (e.g., five consecutive MRPR numbers). The quartile analysis formula is outlined here:

Step 1: Quartiles 1 and 3 are calculated

Step 2: Interquartile range calculated with: Quartile 3 – Quartile 1

Step 3: Lower fence calculated with: Quartile 1 – (1.5 * Interquartile range)

Step 4: Upper fence calculated with: Quartile 3 + (1.5* Interquartile range)

An MRPR reading outside the fences would be considered at least a moderate outlier. Case scenario #3 is provided in Table 1 and Figure 3, showing this application, where a statistical outlier, above the upper fence, is present on Visit 5. Thus, the patient in this scenario would most likely need an adjustment on Visit 5, not only according to trend inspection (of three consecutive MRPR measurements of 65, 67, and 71 BPM) but also according to outlier analysis (where the 71 is above the upper fence of 69.5 for that visit).

Another scenario regarding interpretation could pertain to the MRPR that has no clear upward trend but seems relatively elevated on average. Comparative survey data may help reveal whether MRPR readings are "relatively elevated." Average pulse rates for relatively healthy people in the U.S. for years 1999-2008 are available.[35] These pulses were taken: a) after about 4 minutes of rest in the seated position followed by measurement also in the seated position; and b) for 30 seconds and multiplied by 2 to get the full minute rate. Five age groups for black and white males in the U.S. are provided below from these data:[35]

Figure 5

Age	Mean pulse black males (BPM)	Mean pulse white males (BPM)
16-19	67	73
20-39:	69	71
40-59:	70	71
60-79:	72	69
80 and older:	68	71

These particular data reveal average pulse rate differences between races with increasing age groups. Case scenario #4 is provided here for a 25 year old black male in the U.S. who has relatively high 60-second MRPR readings:

Future research may help to establish which interpretations have stronger validity than others regarding adjustment of subluxation. Nonetheless, one interpretation seems clear: A slower RPR tends to be healthier than a faster RPR.

CONCLUSION

This commentary presents the manual resting pulse rate (MRPR) as an assessment that is: a) evidenced-based, b) user-friendly, c) quantifiable, and d) easily interpreted by doctor and patient. Consequently, the manual resting pulse rate assessment may be a useful procedure to be included in the neurologically-based chiropractic practice.

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