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Topical Review

# Whole-Body Vibration Exercise on Hematology and Serum Biochemistry in Healthy Dogs

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The present study aimed to evaluate the influence of whole-body vibration (WBV) exercise on hematology and serum biochemistry in healthy dogs. Ten intact beagle dogs, 3 females, and 7 males, with a mean age of 3 years, and mean body mass of 14.3 kg, body condition score between 4.0/9 and 4.5/9 were evaluated. The WBV sessions were done with the dog standing up on all 4 feet on a vibrating platform. Daily session of 30 Hz for 5 minutes, followed by 50 Hz for 5 minutes and finishing with 30 Hz for 5 minutes was accomplished for 5 days. The velocity and amplitude of the vibrating platform were 12-40 m/s$^2$ and 1.7-2.5 mm, respectively. Blood samples were collected, before and immediately after the WBV platform exercise session, and 1 and 6 hours after the end of each session for 5 days. In addition, blood samples were collected 24 hours and 48 hours after the last WBV platform exercise session. Complete blood count and serum biochemistry (alanine aminotransferase, aspartate aminotransferase, creatine kinase, blood urea nitrogen, creatinine, and serum total protein) were the data analyzed. The erythrocytes, hemoglobin, and packet cell volume values decreased, whereas the leukocytes, neutrophils, and eosinophils values increased after WBV platform exercise sessions; however, all values were within the reference range. Other hematological and serum biochemical parameters did not show important variations. In conclusion, the WBV exercise sessions attended for 5 consecutive days did not adversely affect the hematology and serum biochemistry of adult healthy dogs.


## Introduction

Vibrating platforms are machines that produce sinusoidal oscillations (vertical or reciprocating) that result in vibrations indirectly transmitted through the legs to the patient' body.[1,2] These platforms have been used by humans in sports training and rehabilitation, as well as to improve different conditions such as bone mineral density and leg muscle strength.[1–5]

Whole-body vibration (WBV) exercises may be influenced by several factors including vibration platform type, vibration amplitude and frequency, number and duration of sessions, and body position on the vibrating platform.[2,3] Although, a large number of protocols can be used, and the inadequate combination of the aforementioned factors may cause deleterious effects on the cardiovascular and nervous systems.[1,2] On the other hand, the comparison among studies in this research field is sometimes difficult, because they address different treatment protocols.[1,2,5]

Besides the neuromuscular and bone effects from WBV,[1,2,4] few studies have also investigated its influence on blood chemistry measurements and on bone markers.[6–9] Accordingly, experimental studies have assessed the short-period WBV training influence on the concentration of blood biomarkers in rats,[9] on the biochemical response after 4-week low-intensity WBV training in middle-aged mice,[7] as well as the effects of short-term WBV on horses' blood values.[10] The plasma levels of muscle enzymes were assessed in a study involving sedentary human patients subjected to one bout of high-intensity WBV.[6] Another study investigated the influence of acute and chronic WBV exercises on health-related parameters in human patients.[8]

However, very few studies related to effects of WBV on dogs were conducted.[11] Thus, the evolved neurophysiological mechanisms must be further studied in order to help developing WBV exercise programs.[1,3] Therefore, the aim of the present study was to assess the effects of WBV exercises on the hematology and serum biochemistry of adult healthy dogs based on a single protocol. It was hypothesized that the exposure to acute and short-period WBV exercise protocols is unable to induce negative effects on hematological and biochemical parameters.

## Material and Methods

This study had the approval of the Ethics Committee of the School of Veterinary Medicine and Animal Science, São Paulo State University (Unesp), Botucatu (no. 075/2014-CEUA), and the owners of all animals participating in the study gave written consent.

Ten healthy intact Beagle dogs, 3 females and 7 males, with a mean age of 3 years (range from 2 years to 4 years), and mean body mass of 14.3 kg (range from 10.1 to 17.9 kg), BCS between 4.0/9 and 4.5/9 were evaluated. Dogs considered overweight (BCS ≥ 6) were not included.

Dogs were judged healthy by the absence of disease clinical signs or abnormalities at physical and orthopedic examination, as well by complete blood cell count (CBC), serum biochemistry, and urinalysis. Exclusion criteria included previous surgical procedure or use of medications. In addition, the dog's forelimb length was measured from the dorsal scapular border to the ground; the body length was measured from the cranial aspect of the

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scapulohumeral joint to the caudal aspect of the ischial tuberosity by using a tape-measure.

The dogs were subjected to 2-hour acclimatization and rest prior to the WBV sessions. The WBV sessions were done with the dog standing up on all 4 feet on a vibrating platform[11] with approximately length 92 cm, width 62 cm, height 16 cm, and frequency range from 0-100 Hz.[12] Dogs were assisted by a trained person during the training session in order to avoid locomotion. Daily session of 30 Hz for 5 minutes, followed by 50 Hz for 5 minutes and finishing with 30 Hz for 5 minutes was accomplished for 5 days. The velocity and amplitude of the vibrating platform were 12-40 m/s$^2$ and 1.7-2.5 mm, respectively.

Blood samples were collected from the jugular vein using a 21-gauge needle and Vacutainer tube (BD Vacutainer®, Vacuette Brasil Ltda, São Paulo, Brazil), before and immediately after the WBV platform exercise session, and 1 and 6 hours after the end of each session for 5 days. In addition, blood samples were collected 24 hours and 48 hours after the last WBV platform exercise session. Blood for hematology was collected using K2-EDTA as an anticoagulant; blood for serum biochemistry analysis was collected in tubes without an anticoagulant. Hematology samples were analyzed within 30 minutes of collection. CBC and serum biochemistry (alanine aminotransferase—ALT, aspartate aminotransferase—AST, creatine kinase—CK, creatinine—CR, and serum total protein—STP) were the data analyzed. Leukocyte and erythrocyte counts, hemoglobin ,and packet volume cell were estimated using the Ebram 18 Hematology Analyzer (Ebram 18 Hemascreen®, Ebram Produtos Laboratoriais Ltda, Belenzinho, Brazil). Whole blood smears were stained with Wright Giemsa hematologic stain (Sigma-Aldrich Brasil Ltda, São Paulo, Brazil). Differential leukocyte counts were performed manually. The whole blood was allowed to clot at room temperature, and the tubes were centrifuged at 1500 rpm for 15 minutes. The sera were placed into Eppendorf tubes and frozen at −20 °C, and analyzed using commercial kits (Labtest®, Labtest Diagnóstica, Minas Gerais, Brazil). The creatinine was analyzed using a colorimetric method (Spectronic 21®, Analítica, São Paulo, Brazil).

The variability of the CBC and serum biochemical measurements among the moments in each day was evaluated by ANOVA repeated measures, followed by the Tukey post hoc test. The values were expressed as Mean ± Standard Deviation (SD). The statistical analysis was performed using GraphPad Instat-test program (DataSet1.ISD). Results were considered significant at $P < .05$.

## Results

The forelimb length ranged from 33.2 to 35.6 cm (mean 34.4 ± 1.2 SD) and the body length ranged from 38.1 to 44.7 cm (mean 41.4 ± 3.3 SD). Data of CBC are shown in Tables 1 and 2, and serum biochemistry in Table 3. The erythrocytes, hemoglobin, and packet cell volume values decreased, whereas the leukocytes, neutrophils, and eosinophils values increased after the WBV platform exercise sessions; however, all values were within the reference range. Other hematological and serum biochemical (ALT, AST, CK, CR, and STP) parameters did not show important variations.

Significant differences were observed in the mean values of erythrocytes: before the WBV session, between days 1 and 5, days 1 and 6, and days 1 and 7 ($P = .0001$); immediately after the WBV session, between days 1 and 4, days 1 and 5, and days 2 and 5 ($P = .0003$); 6 hours after the end of WBV session, between days 1 and 5 ($P = .0192$). Significant differences were observed in the mean hemoglobin values immediately after the WBV session, between days 1 and 5, days 2 and 4, days 2 and 5, and days 3 and 5 ($P < .0001$). Significant differences were observed in the mean packet cell volume values immediately after the WBV session, between days 1 and 5, and days 2 and 5 ($P = .0039$). Significant differences were observed in the mean eosinophil values before the WBV session, between days 1 and 3, and days 1 and 4 ($P = .0034$).

The values of erythrocytes showed significant differences on day 1, before and immediately after the WBV session, before and 1 hour after the WBV session, and before and 6 hours after the WBV session ($P = .0021$). On day 2, significant differences were

**Table 1**
Values of Erythrocytes, Hemoglobin, Packet Cell Volume, and Platelets Obtained From 10 Healthy Adult Beagles, Before (PRE), Immediately After (IP), 1 and 6 Hours After the End of Each Daily Whole-Body Vibration (WBV) Exercise Session, Performed From Day 1 to Day 5, and 24 Hours (Day 6) and 48 Hours (Day 7) After the Last WBV Session

| Parameters | Day 1 ($n = 10$) (Mean ± SD) | Day 2 ($n = 10$) (Mean ± SD) | Day 3 ($n = 10$) (Mean ± SD) | Day 4 ($n = 10$) (Mean ± SD) | Day 5 ($n = 10$) (Mean ± SD) | Day 6 ($n = 10$) (Mean ± SD) | Day 7 ($n = 10$) (Mean ± SD) |
|---|---|---|---|---|---|---|---|
| Erythrocytes (×10$^6$/μL) (Normal range:5.6-8.7) | | | | | | | |
| PRE | 7.10 ± 0.71$^{Aa}$ | 6.85 ± 0.60$^{ABa}$ | 6.84 ± 0.70$^{ABa}$ | 6.54 ± 0.57$^{ABa}$ | 6.28 ± 0.83$^{Ba}$ | 6.33 ± 0.69$^{B}$ | 6.37 ± 0.64$^{B}$ |
| IP | 6.60 ± 0.74$^{Ab}$ | 6.48 ± 0.67$^{ABbc}$ | 6.35 ± 0.71$^{ABCb}$ | 6.23 ± 0.67$^{BCa}$ | 6.04 ± 0.78$^{Ca}$ | - | - |
| 1 h | 6.51 ± 0.85$^{Ab}$ | 6.56 ± 0.61$^{Aab}$ | 6.23 ± 0.62$^{AB}$ | 6.25 ± 0.83$^{Aa}$ | 6.16 ± 0.90$^{Aa}$ | - | - |
| 6 h | 6.62 ± 0.50$^{Ab}$ | 6.44 ± 0.77$^{ABb}$ | 6.46 ± 0.54$^{ABab}$ | 6.22 ± 0.83$^{Ba}$ | 6.02 ± 0.72$^{Ba}$ | - | - |
| Hemoglobin (g/dL) (Normal range:14-20) | | | | | | | |
| PRE | 16.15 ± 1.59$^{Aa}$ | 15.58 ± 1.73$^{Aa}$ | 15.58 ± 1.64$^{Aa}$ | 15.12 ± 1.70$^{Aa}$ | 14.92 ± 1.62$^{Aa}$ | 14.98 ± 4.10$^{A}$ | 14.79 ± 1.41$^{A}$ |
| IP | 15.13 ± 1.55$^{ABb}$ | 15.28 ± 1.66$^{Aa}$ | 14.69 ± 1.87$^{ABb}$ | 14.31 ± 2.02$^{Ba}$ | 13.64 ± 1.77$^{Cb}$ | - | - |
| 1 h | 14.77 ± 2.20$^{Ab}$ | 14.59 ± 2.27$^{Aa}$ | 14.21 ± 1.78$^{Ab}$ | 14.10 ± 2.17$^{Aa}$ | 14.12 ± 1.73$^{Ab}$ | - | - |
| 6 h | 14.97 ± 1.57$^{Ab}$ | 14.53 ± 2.13$^{Aa}$ | 14.53 ± 1.76$^{Ab}$ | 14.07 ± 2.20$^{Aa}$ | 14.010 ± 1.39$^{Ab}$ | - | - |
| Packet Cell Volume (%) (Normal range:40-59) | | | | | | | |
| PRE | 45.60 ± 4.27$^{Aa}$ | 45.10 ± 5.53$^{Aa}$ | 44.80 ± 5.67$^{Aa}$ | 43.90 ± 4.70$^{Aa}$ | 43.10 ± 4.36$^{Aa}$ | 42.60 ± 3.66$^{A}$ | 43.40 ± 3.81$^{A}$ |
| IP | 44.10 ± 4.33$^{Aa}$ | 43.70 ± 4.74$^{Aab}$ | 42.80 ± 5.92$^{ABa}$ | 41.60 ± 5.08$^{ABab}$ | 40.50 ± 4.65$^{Bb}$ | - | - |
| 1 h | 43.40 ± 5.26$^{Aa}$ | 42.80 ± 3.58$^{Aab}$ | 40.40 ± 5.66$^{Aa}$ | 42.30 ± 6.21$^{Aab}$ | 41.60 ± 5.56$^{Aab}$ | - | - |
| 6 h | 43.10 ± 4.58$^{Aa}$ | 42.30 ± 5.08$^{Ab}$ | 42.10 ± 4.68$^{Aa}$ | 40.70 ± 5.29$^{Ab}$ | 41.00 ± 4.00$^{Aab}$ | - | - |
| Platelets (/μL) (Normal range:145-440) | | | | | | | |
| PRE | 296 ± 70.00$^{Aa}$ | 303 ± 53.06$^{Aa}$ | 314 ± 63.50$^{Aa}$ | 286 ± 61.71$^{Aa}$ | 292 ± 89.00$^{Aa}$ | 283 ± 67.94$^{A}$ | 277 ± 65.20$^{A}$ |
| IP | 287 ± 73.42$^{Aa}$ | 291 ± 65.39$^{Aa}$ | 286 ± 53.97$^{Aa}$ | 292 ± 76.83$^{Aa}$ | 278 ± 91.26$^{Aa}$ | - | - |
| 1 h | 281 ± 80.23$^{Aa}$ | 289 ± 62.38$^{Aa}$ | 285 ± 63.91$^{Aa}$ | 291 ± 92.32$^{Aa}$ | 288 ± 93.17$^{Aa}$ | - | - |
| 6 h | 283 ± 64.01$^{Aa}$ | 284 ± 63.01$^{Aa}$ | 294 ± 69.97$^{Aa}$ | 276 ± 90.67$^{Aa}$ | 278 ± 88.21$^{Aa}$ | - | - |

Means followed by different uppercase letters in same line were different by Tukey test ($P < .05$). Means followed by different uppercase letters in column were different by Tukey test ($P < .05$).