

## Deviations in Whole-Body Vibration Training Devices: A Narrative Review

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### Abstract

Research regarding whole body vibration training (WBVT) and its use in practice might be hindered by the fact that WBVT devices generate frequencies and/or amplitudes and/or modes of vibration different to preset adjustments. Considering the to date available research results it can be stated, that significant divergences between the preset frequency and the actual applied frequency in WBVT devices used in practice and scientific research must be expected, whereas divergences regarding the mode of vibration are not to be expected. According to the available published literature, no published research results regarding potential divergences of the actually applied amplitude were identified.

As a result of divergences of more than 10% it will be difficult to identify the most effective range of frequencies for specific intentions in research. In practice, divergences of more than 10% can cause that assumed effective training parameters for WBVT do not result in an improvement of the pathology of a patient or expected training effects in athletes and healthy people. Accordingly, a cause for the lack of effectiveness of an intervention with WBVT can be an inexact applied frequency.

Based on these results it is strongly recommended that user in practice and research should analyse their WBVT devices regarding the applied frequency and mode of vibration. Future research should investigate possible divergences regarding the actually applied amplitude and possible causes for divergences in WBVT devices.

**Keywords:** Whole body vibration training; Frequency; Mode of vibration; Accuracy

### Introduction

Whole body vibration training (WBVT) frequently is subject of scientific research and widespread used in mass sport, competitive sports and therapy [1-4]. The intensity of WBVT mainly is regulated by the duration of each training session, the frequency, the amplitude and the body position as well as by exercises performed on the device [5-7]. One of the most important research questions regarding the use of WBVT is to identify the ideal composition of these parameters and the appropriate mode of vibration for each intention [7-9]. All training parameters and their interaction are resulting in a specific exercise stimulus, influencing the effects of the exercise [10]. Research regarding this question might be considerably hindered by the fact that WBVT devices generate and transmit frequencies and/or amplitudes and/or modes of vibration which are different from preset adjustments [11].

Today it is assumed that regarding preset frequencies a divergence of up to 10% or more appears regularly, and might be increased by loading such devices with users [12-14]. The actually applied frequency and the mode of vibration can easily be quantified using a tri-axial accelerometer. According to Rauch et al., this measurement method is well-established and recommended for this purpose [11].

It is assumed, that such divergences might be due to between manufacturers and device types varying drives, the rigidity of used materials as well as possible software failures [9,11]. According to the available published literature, no published research results regarding potential divergences of the actually applied amplitude were identified. This might be due to the fact, that the amplitude can only be quantified accurately with expensive methods such as photogrammetry.

Only the assumed divergences in the actually applied frequency implicates that identified potentially ideal frequency ranges for specific intentions could not, or only very inaccurately, be applied [11]. Therefore, the knowledge of potential divergences of the preset frequency, amplitude and the mode of vibration between the

manufacturer information and the actually applied signals is of outmost importance for the application of WBVT in practice and future research as well as for the interpretation of results of previous research projects in which devices were used not considering this issue.

This review gives an oversight on the to date available research results regarding possible divergences between the preset frequency as well as the mode of vibration and the actually applied signals and gives recommendations on the handling of potential divergences of WBVT devices in research and practise.

### Review of Literature

Corrie et al. measured a Galileo 2000 device loaded by subjects [12]. They found reduced actually applied frequencies compared to the preset frequencies. The recorded divergences regarding the frequency reached a maximum of 2.4%, whereat the maximum divergence occurred at the lowest measured preset frequency of 5 Hz. The divergence was smaller at higher preset frequencies [12].

Likewise, Pel et al. measured the accelerations and their transmission to the lower extremities of two professional WBVT devices, a Galileo Fitness device and a PowerPlate device and therefore recorded the respective applied frequencies with and without an external load, and identified the mode of vibration as well [13]. A divergence between the preset and the actually applied frequency within 1% up to a preset

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frequency of 30 Hz but in the range of 30 up to 40 Hz a divergence, in this case a reduction, of within 5% appeared in the Galileo Fitness device in unloaded condition [13]. The PowerPlate showed raised actually applied frequencies between 25 and 40 Hz in the range of 3% in unloaded condition. Between 45 and 50 Hz no detectable divergences occurred. Besides, both devices applied nearly perfect sinusoidal signals and did not show impaired applied frequencies under loaded condition [13].

Donaldson and Ross measured a PowerPlate Next Generation under loaded condition by a subject with a body weight of approximately 80 kg and found a divergence between the applied frequency and the preset frequency of 15-20% between 30 and 50 Hertz which corresponds to a reduction of the occurring acceleration of about 30-35% [15].

In an own recent research project we measured nine professional devices for WBV training (two Galileo 2000, a Galileo Sport, two Board 3000, a PowerPlate Next Generation, a Vibrafit Classic, a Zeptor med pro and a srt medical PRO) with a tri-axial accelerometer regarding the preset frequency and the actually applied frequency as well as the mode of vibration [16]. Besides the measurement of different combinations of preset frequency and amplitude, the repeatability across 3 successive measurements with the same preset conditions and one measurement under loaded condition were carried out at each device. We found no noteworthy divergences regarding the mode of vibration. With three exceptions (both Board 3000 devices and the srt medical PRO) we also did not find noteworthy divergences between preset and actually applied frequencies [16]. In these three devices we found divergences up to -25%. Loading all devices did not affect their applied frequency or their mode of vibration. There were no important divergences detectable for the applied frequency and mode of vibration regarding the repeatability in all devices [16].

## Discussion

Considering the to date available research results it can be stated that significant divergences between the preset frequency and the actual applied frequency in WBVT devices used in practice and scientific research must be expected. Particularly by using a WBVT device with intensive movements and/or exercises and/or large additional weights, the existing divergence could be increased much more [11].

Whereas a divergence up to 10% between the preset and the actual applied frequency can be accepted in practice and hardly in research, a divergence of more than 10% cannot be accepted neither in practice nor in research, because a different stimulus might result in different effects [6]. As a result of divergences of more than 10% it will be difficult to identify the most effective range of frequencies for specific intentions. Besides, under these preconditions, research results are hardly to replicate in practice and research projects under similar settings. In practice, divergences of more than 10% can cause that assumed effective training parameters for WBVT do not result in an improvement of the pathology of a patient or expected training effects in athletes and healthy people. Accordingly, a cause for the lack of effectiveness of an intervention with WBVT can be an inexact applied frequency. Besides, a divergence of more than 10% cannot be accepted from a technical point of view. To date, it is easily realisable to provide much less than a divergence of 10% by using appropriate materials, power units, mechanics and software.

As Rauch et al. already formulated, the to date available research results underline the need for an adequate evaluation of WBVT devices in preparation of a research project and the use in practice [11].

Based on these results it is strongly recommended that user in practice and research should analyse their WBVT devices regarding the applied frequency and mode of vibration. The recommendations of the International Society of Musculoskeletal and Neuronal Interactions for the reporting of whole-body vibration intervention studies is recommended for further information regarding the assessment of WBVT devices and the reporting of whole-body vibration intervention studies [11]. Future research should investigate possible divergences regarding the actually applied amplitude and possible causes for divergences in WBVT devices.

## Conclusion

Based on the in this narrative review reviewed papers, the need for an adequate evaluation of WBVT devices is supported by previous research results and should call attention of scientists and researchers as well as users in practice. This might induce more considerable results of future research projects and/or make the use of WBVT in practice more effective and safe. It is strongly recommended, that user in practice and research should analyse their WBVT devices before using them.

However, manufacturers of devices for WBVT should check every device before delivery regarding their accuracy. Also, they should take care of possible influencing conditions of the interface between the floor and the device, maybe with an on-site inspection and specific individual measures, although such factors seemed not to be of outstanding importance.

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