Let's Get It Clear No. 74
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By Dr Barend ter Haar

I'm picking up good vibrations

For all of us, wheelchair occupants included, some vibrations are good, but there's also some that are bad and need to be dampened down.

Good vibrations include those that carry sounds to our ears, light to our eyes, or signals to our phones. There are some vibration frequencies that are used by the medical profession to our advantage - for example, in treatment of osteoporosis or around therapeutic ultrasound. However, there are also 'bad' vibrations, such as those that lead to spasms, cause pain, tire us out, deafen us, or blind us. 'Bad' vibrations can be detrimental to our equipment and to our health. In this article we will look at the benefits of good vibrations, and, for wheelchairs and their occupants, how we can moderate the bad vibrations.

Sound

Our ears are important organs – obviously for hearing, in the first place, but also for our sense of balance and for spatial awareness. The sound that we hear is a combination of vibrations which our brains interpret into information from our environment, music, words, etc. There are times when the noises are too large, and are painful. Other times they are too quiet and indistinct, and as we get older this challenge increases, and we combat this with hearing aids to amplify the frequencies we have problems with.

But how do our ears provide spatial awareness? This is accomplished by the pinnae, or ear flaps. The corrugations in these distort the sound waves as they arrive at the ears by varying amounts depending on the angles at which the sound waves arrive. We get to learn what these distortions mean, to convert the distortions into information as to the directions from which the sound has arrived. Therefore, we should be aware of the importance of the pinnae with anything that we may place on a person's head, and ensure that they do not interfere with them, either by pinning them back or covering them up.

Ultrasound

Sound wavelengths outside our auditory range can also be beneficial. Therapeutic ultrasound devices use a handheld probe that can emit sound waves into the body in a continuous or pulsed mode. Continuous ultrasound creates a heating effect in the tissues, which can help to increase blood flow and flexibility. Pulsed ultrasound, on the other hand, is used to promote tissue healing without significantly increasing the temperature.

Elsewhere, ultrasound is being used for the treatment of cancer of soft tissues: high-intensity focused ultrasound (HIFU) uses high-frequency sound waves to generate heat at a specific focal point within the body to heat and destroy it, while minimizing damage to surrounding healthy tissue. It's a non-invasive procedure, meaning it doesn't involve incisions or needles, and can be used to treat various types of cancer, including prostate, liver, or brain tumours, and other conditions like uterine fibroids.

Low frequency vibrations

At the Victoria and Albert Museum there is currently an exhibition called Design and Disability that is open until February 2026, and is well worth visiting. This is both a celebration and a call to action that showcases the radical contributions of Disabled, Deaf, and Neurodivergent people and communities to design history and contemporary culture, from the 1940s to now.

Figure 1. From the Living section of the V&A Design and Disability exhibition

In the section on Living one can watch a film from Canada where a blind person is guided by a brass band, where the music gives him clues as to where to turn and what obstacles might be in his way. While sitting on the bench to watch this film, the seat provides regular vibrations – this and other means of providing 'haptic feedback' are tools to help neurodivergent individuals keep 'grounded' while carrying out an activity that needs concentration, such as watching a film.

Haptic feedback

The term haptic is derived from the Greek word ἁπτικός (haptikos) meaning 'pertaining to the sense of touch'. In essence, haptikos refers to anything related to the tactile senses, including the perception, sensation, and manipulation of objects through touch. This concept is relevant to both the biological sense of touch and the technological application of haptic feedback in devices and systems.

The mechanisms behind haptic feedback vary, but typically involve a combination of motors or piezoelectric actuators to create pressure or vibration. Tactile feedback can also be triggered by surface textures or changes in temperature.

Figure 2. An adapted Woojer jacket on show at the V&A Design and Disability exhibition

In the same section in the V&A exhibition is a Woojer jacket (Figure 2) – this jacket, originally designed for gamers to get additional sensory inputs while playing video games, has found a wider application for deaf people giving them 'haptic feedback' from the music at an event, even if they cannot hear it.

Low frequency physical vibrations have been used for well-being benefits for some time. Back in the 1950s and '60s, magazines promoted vibrating bands to stretch across the stomach, buttocks, legs or arms, where the vibrations were claimed to help improve muscle tone and lose weight.

Similar technologies are available today in vibration plates, which can offer several potential benefits, including increased muscle activation, improved circulation, and enhanced flexibility. They may also aid in weight loss, improve balance and coordination, and boost bone density. Furthermore, vibration plates can help with muscle recovery after exercise by reducing soreness and stiffness.

Bad vibrations

While vibration plates may convey benefits to some users, excessive use can cause both acute and chronic injury to a range of physiological systems, including musculoskeletal, circulatory and nervous systems.

For wheelchair occupants, the vibrations transmitted through their wheelchairs to their bodies can increase fatigue, and accentuate pain. As one occupant pointed out at a symposium at this year's International Seating Symposium (ISS) in Pittsburgh, even a sharp jolt from a caster hitting an object could make him go into a spasm.

'Bad' vibrations can also cause wheelchair components to work loose or break. So what is currently available that we can apply to a chair to reduce vibrations? We'll look briefly at different elements of a chair: its casters, wheels, frame materials, and seating.

Casters

Frog Legs have had their shock-absorbing caster mounts around for a number of years – their new Whisper casters additionally offer energy-absorbent tyres (Figure 3).

Figure 3. Frog Legs' Whisper caster and mounting system

Energy-absorbent tyres for the main wheels are also important: in the early days of cycling and motoring pneumatic tyres made a world of difference to the operators, but punctures to these have always presented problems. These days, different infills have got around this challenge, while still offering some degree of shock-absorption.

Wheels

For the main wheels, Loopwheels provide a great solution. Wheelchair users are exposed to levels of Whole Body Vibration (WBV) (vibration and shock) which are likely to be detrimental to their health: in particular the evidence links to increased back pain, neck pain and fatigue. 60 % of manual wheelchair users report neck and/or back pain and 40 % modify daily activities as a result.

Research carried out at the University of Pittsburgh, presented at ISS, studying a group of 24 manual wheelchair users trialling Loopwheels that they reported reduced neck pain, a decrease in pain interference in daily life, and fewer overall pain problems. Vibrations from daily wheelchair use were reduced by 35 %, while shock exposure dropped by 50 % compared with previous community-based studies. Participants propelled on average about two hours a day, which is twice as long using Loopwheels than other community based studies. WBV levels fell to levels below hazardous thresholds defined in the ISO 2631 series of international standards focused on evaluating human exposure to mechanical vibration and shock - manual wheelchair users using Loopwheels should be able to propel up to 14-16 hours per day before being exposed to a harmful amount of vibration and shock (WBV).

Figure 4. Loopwheel Urban

Loopwheel springs are made from a composite of layers of different materials, including carbon, developed with the help of specialist bow-makers KG Archery. The rim remains rigid, while the hub 'floats' within the rim, adjusting constantly as shocks from an uneven road hit the rim of the wheel. The system has been developed and tested to give optimum compression and lateral stability as well as strength and durability.

Wheelchair Frame

There's many areas where investment in technological improvements in bicycle design and materials have

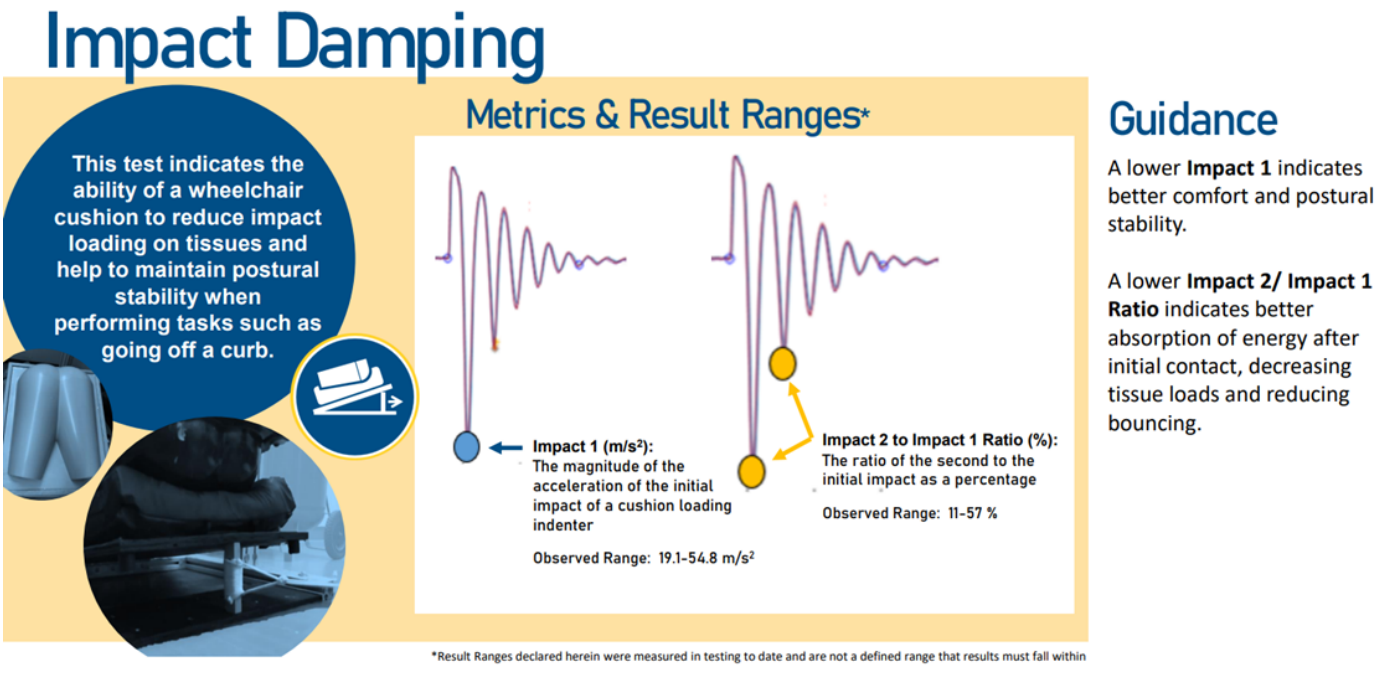

Figure 5. Test for Impact Damping by cushions

benefitted wheelchair occupants. One example is the use of carbon fibre which can absorb vibrations due to its unique material properties. Its ability to deform and recover under stress, combined with its viscoelastic behaviour (where it dissipates energy through internal friction), allows it to dampen vibrations effectively, particularly those of higher frequencies. Carbon fibre also has the benefit of being light weight.

Cushions

The materials from which a seat cushion or back support can make a difference with regard to vibration absorption. Air-filled cushioning can be very absorptive, but another study from the University of Pittsburgh showed that the air-foam mix used in Varilite cushions gave the best results.

Current cushion testing for impact damping is carried out as detailed in Clause 9 of ISO 16840-2 – see Figure 5 and reference 1.

Conclusion

Vibrations are all around us at a wide range of frequencies and amplitudes: most are good or useful, while others are detrimental and should be avoided where possible. Our sensitivities and our reactions to all the different types of vibration vary from person to person, and so, as ever, there's not going to be one right answer that suits everyone equally.

1. https://www.wheelchairstandards.pitt.edu/sites/default/files/extended_infographic_pdf_-_sept_2022.pdf