

Consumer by Design, Medical by Choice (A Wearable Transitioning)

Jeff Hiserman*

Independent Practice Physical Therapist, Spectrum Ergonomics and Occupational Health Services, USA

***Corresponding Author:** Jeff Hiserman, Independent Practice Physical Therapist, Spectrum Ergonomics and Occupational Health Services, USA.

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The tsunami of medical wearables is not too far off the shore. With the proliferation of laboratory designs, for example, arterial pulse wave monitoring, continuous stress monitoring, and a sensor bracelet for impaired hand control [1-3], nearing completion in the lab but not yet ready for the medical market, there is a large void currently for consumer wearables to occupy.

A fine example of this intentional crossover is Wearable X. In May 2017 Wearable X launched its first direct to consumer product, Nadi X, a line of activated yoga apparel [4]. Its patented technology with integrated sensors and haptic feedback (vibration) allows the user to literally “feel” how to move into each pose & posture verification at the end of each sequence.

The sensors utilize accelerometers found in many current products, such as mobile phones, heart rate measuring devices, and Fitbit devices. Accelerometers measure the proper acceleration of a particular body, in the case of Nadi X, the lower limbs. Acceleration is the rate of change of speed with respect to time. In physics terms, $s=d/t$, with d being distance [5].

As for the haptic feedback in the Nadi X, it consists of vibrations through 10 haptic motors located in the hips, knees, and ankles; this is powered by the battery pack that clips in behind the left knee. A typical example of this is the slight vibrations from a smartphone that is given to the user when a button on the touchscreen is tapped [6]. Yet haptics is far more than just feeling a vibration. It is a myriad of sensations interpreted by the user [7]. The stimulation of Pacinian corpuscles, which are the mechanoreceptors that lie deep within the skin, is responsible for giving the sensation of vibration, specifically, high-frequency (20 - 1000 Hz) vibrations [8].

In the case of the Nadi X, it guides the wearer where to focus. i.e. “ground down through the back of your calves” this is paired with further audio instructions i.e. “Lift up through the back of your hips”, which in a one on one class, is sometimes paired with physical adjustments. For each user, there is probably a different feeling evoked, quite possibly a different emotion surfacing. Yes, haptic feedback is far more than just a vibration.

It is the combination of these sensors and the haptic feedback during the performance of a yoga pose that is key to the Nadi X pants potentially crossing into the medical wearable realm. So why would this fact matter with regards to the medical realm? An excellent question indeed, and a question asked by Wearable X CEO, Billie Whitehouse, that lead to her collaboration with this author in a pilot study just recently concluded and currently undergoing data analysis. This pilot study examined if the Nadi X can help the user reduce low back pain using a yoga pose. The particular post utilized was the Chair Pose (Utkatasana) and is demonstrated in figure 1.

In our discussions prior to commencing the study, Ms. Whitehouse shared her rationale for wanting to understand the landscape in order to move Nadi X into the medical wearables market, “We see an opportunity for Nadi X in the physical therapy space specifically because of the work we have done with Yoga. The long term goal is to collaborate across the country with medical professionals to ensure that Nadi X can support the efforts for reducing lower back pain. We engaged in this pilot study with Spectrum Ergonomics to test our hypothesis about how Nadi X can be effective as a physical therapy tool and potentially (in the future) a medical wearable technology platform”.



Figure 1: Courtesy of Wearable X.

So, with Wearable X's smart textile wearable technology platform and strong drive for adventure, coupled with physiological truths as the backbone of the pilot study, this crossover journey began.

Since we have an idea of how the pants operate with the user interface (UI), let us examine the physiological truths as they relate to orthopaedics and kinesiology of the low back, and just how a consumer wearable such as the Nadi X, can so easily manage this journey into medical territory.

It is well known that core muscle strengthening is beneficial for treating low back pain [9,10]. As a Physical Therapist, I have utilized this type of strengthening for over three decades with low back pain patients with good success. The mechanisms involved in lumbar stabilization are varied and involve both fast and slow twitch fiber core muscles and their actions on the osseous structures of the lumbo-pelvic region [11,12]. It is maintaining the yoga pose through the guidance of the Nadi X app and inbuilt technology that can strengthen the core muscles.

In the core muscles providing structural support to these osseous structures, the body's center of gravity (COG) is positively affected. During static standing the COG is approximately at the second sacral body, although it can be more precisely defined [13]. Strengthening the core muscles in a static fashion can have significant effects on postural stability by keeping more normal vertebral alignment in the lumbar spine. This more normal alignment reduces torque moments on the lower lumbar vertebrae and their associated intervertebral discs. This also reduces torque moments on the sacrum. In conjunction with this lowering of torque moments is reduced sway in the body during static standing. The smaller the amplitude of body sway, the closer the COG stays to the second sacral body and reduces the need for lower extremity muscles to assist with maintaining balance. This leads to decreasing the potential for loss of balance and possibly falls [14,15].

So, in the final analysis, one can see that a consumer wearable, such as the Nadi X, has great potential to cross over into the medical wearable market. The advanced technology in this product, as with other consumer wearables, such as sensors and electronics, coupled with savvy styling, making it a clinically sound and user compliant choice.

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