

Yoga in Virtual Reality

Yoga is well-documented in the literature as being an effective intervention for improving the physical function and health-related quality of life in adults, as well as wellness and wellbeing (Cartwright et al., 2020). For example, a recent meta-analysis of 12 randomized controlled trials of yoga revealed that an association exists between yoga and improvements in health-related-quality of life (HRQOFL) and mental wellbeing (MWB) in older adults (Kelley & Kelley, 2019). Specifically, reports indicated a standardized mean difference effect size improvement of 0.51 for HRQOFL and 0.38 for MWB.

While historically yoga has been taught in classes attended in person, with the Covid-19 pandemic and the implementation of Covid-19 restrictions, alongside many other wellness activities, yoga studios were mandated to move their classes into virtual formats. Further, even with the lifting of Covid-19 restrictions, yoga studios are continuing to offer members online classes or the option to join classes virtually via online video conferencing.

To update the prior Kelley and Kelley (2019) meta-analysis, we undertook a systematic review using keyword searchers for “physical activity,” “adult,” “personal satisfaction,” “yoga,” “quality of life,” “health-related quality of life,” and “productive aging” and identified three recent studies that met search criteria. First, a study conducted by Yuce and Muz (2020) sought to investigate the effect of yoga on perceived stress, anxiety and quality of life in students at the University of Turkey. The intervention group consisted of 60 students who practiced yoga for four weeks at 60 minutes each week, whereas the control group were 50 students at the same university who did not receive any yoga intervention (Erdoğan Yüce & Muz, 2020). The results indicated that the participants who received the intervention had decreased perceived stress levels and state anxiety levels but there was no effect on the participants' trait anxiety levels or

quality of life (Erdoğan Yüce & Muz, 2020). A second study explored health-related-quality of life using yoga as therapy for patients with chemotherapy-induced peripheral neuropathy (CIPN) (Zhi et al., 2021). The results from the study indicated that yoga may reduce anxiety in patients with CIPN (Zhi et al., 2021). The third recent study investigated the effects of yoga on job satisfaction and burnout on nurse academicians (Kavurmaci et al., 2021). The experimental group practiced yoga in-person twice a week for 60-90 minutes across eight weeks and were asked to complete the Maslach Burnout Inventory (MBI) and the Minnesota Job Satisfaction Scale (MSQ) at both pre-test and post-test (Kavurmaci et al., 2021). The results showed that those in the experimental group reported significantly increased job satisfaction and less burnout at post-test compared to those in the control group (Kavurmaci et al., 2021).

In addition to the keyword search adopted from the work of Kelley and Kelley's (2019) meta-analysis, topics such as "online," "virtual," "pandemic," "telehealth" and "mental well-being" were also included for additional analysis. As a recent example of yoga's efficacy as a wellness intervention delivered virtually, Pandya (2021) provided a yoga intervention to a group of older adult women who participated in daily 30-minute online yoga classes for 30 days. After the 30-day intervention was complete, compared to the control group who received no such intervention, the participants reported lower scores on fear of Covid-19 and geriatric anxiety measures and higher scores on resilience and wellness measures (Pandya, 2021). The next study utilized a multinational cross-sectional study design with 3164 participants to determine the health-related-quality of life outcomes of participants who completed a 100 day-virtual yoga and meditation program (Thimmapuram et al., 2022). Practicing yoga and meditation frequently were found to promote health and well-being (Thimmapuram et al., 2022). Another study investigated 181 yoga instructors' self-reported advantages and disadvantages to teaching yoga online in

response to the Covid-19 pandemic (Sharma et al., 2022). The findings suggested that the three most reported advantages were a sense of safety from Covid-19 exposure, cost-saving and wider access to trainees in India, while the three most reported disadvantages were missing in-person contact, technical difficulties, and concern that online instruction could potentially lead to injuries (Sharma et al., 2022). Another study also looked at satisfaction with online compared to in-person yoga during the Covid-19 pandemic (Brinsley et al., 2021). It was found that in-person yoga scored the highest for providing mental health/mood benefits, physical satisfaction and feeling energized (Brinsley et al., 2021). Whereas online yoga scored highest for convenience, mental health/mood benefits and affordability (Brinsley et al., 2021). Schulz-Heik and colleagues (2017) evaluated the feasibility, acceptability and effectiveness of yoga delivered through telehealth compared to in person instruction to patients from the Veterans Affairs Medical Centre. The results indicated that participants were highly satisfied with the program and 80% of participants reported improvement in pain, energy level, depression, and anxiety (Schulz-Heik et al., 2017). There were no differences observed between those who participated through telehealth compared to the in-person instruction (Schulz-Heik et al., 2017). Chang et al (2022) also used an online Isha Upa yoga intervention delivered to university students during the Covid-19 pandemic to investigate the effects of yoga on mental health and well-being. Those assigned to the intervention group were found to have a reduction in stress and an overall increase in wellbeing as a result of practicing Isha Upa yoga over a 12-week period (Chang et al., 2022). Moreover, there was some evidence to suggest that the intervention alleviated depression after two weeks and maintained positive effects for four weeks (Chang et al., 2022).

Yoga has clearly been demonstrated in the literature as an effective intervention for increasing overall well-being, health-related-quality of life and other significant benefits

highlighted in the literature, including when delivered virtually. However, there is a gap that warrants attention with regard to how the different virtual delivery formats affect the nature and received benefits of this ancient practice. In particular, novel technology such as the use of immersive virtual reality (VR) to instruct virtual yoga practice sessions has received little attention, even though VR yoga applications using a head-mounted display (HMD) have become available. Previous studies have shown that when compared to viewing a guided meditation on a standard laptop, VR guided meditations using HMD can increase positive emotions and elicit more desirable states described in Buddhist psychology (e.g., Mistry et al., 2020). It has also been found that compared to a traditional workout, exercising with the use of a HMD can lead to a higher heart rate, more calories being burned and reports of participants being able to remove themselves from their bodily sensations allowing them to workout longer (McClure & Schofield, 2019). Thus, the present study proposes to investigate the use of VR in a guided yoga practice in the virtual, online format. Another question of interest to the current research is whether the live delivery of online instruction is preferred over pre-recorded instruction. For example, participants may feel a greater sense of temporal and interpersonal presence knowing that the instructor is also engaged in the practice with them at that moment.

Methods

The present study would include five different yoga practice instruction conditions: 1) traditional in-person; 2) pre-recorded 360° videos viewed by HMD; 3) pre-recorded 360° videos viewed without HMD (i.e., on standard flatscreen such as laptop or smartphone); 4) live streamed 360° videos viewed with HMD; and 5) live streamed 360° videos viewed without

HMD. All participants would complete the in-person yoga class and also be randomly assigned to participate in two of the remaining four additional delivery format conditions. The order of delivery format would also be randomly assigned.

Participants will be recruited from local yoga studios in London through a flyer that will be made available to the members of the studios. The purpose of including participants who have already practiced yoga is to minimize the novelty of yoga practice as a whole in order to obtain a more accurate reflection of using VR and a HMD in their yoga practice. A certified yoga instructor will be consulted to create three separate 10 minute yoga classes with the same number of positions and difficulty/enjoyableness level. The purpose of having three separate classes is to ensure that participants are not influenced by the repetition of the same yoga class across the three different delivery format conditions; viewing format will be randomly assigned to the three yoga classes.

Prior to the experiment, participants will be asked to complete a short questionnaire asking about how often they practice yoga and their experience level with yoga. Following each yoga class, participants will be asked to complete short questionnaires assessing their experience of presence and satisfaction with each class. We hypothesize that the yoga classes instructed with VR using a HMD in both the pre-recorded and livestream conditions will be associated with greater spatial presence in comparison to the classes instructed online viewed without the use of a HMD. It is also hypothesized that participants will report greater temporal presence for both live stream conditions compared to the pre-recorded conditions. Further, we hypothesize that the greater sense of interpersonal presence that may also be granted by immersive VR technology and livestreaming could further increase participants' satisfaction with online instruction (e.g., Mistry et al., 2020), making it more comparable to in-person instruction.

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