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In-home virtual reality program for chronic low back pain: durability of a randomized, placebo-controlled clinical trial to 18 months post-treatment

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INTRODUCTION

Chronic low back pain (CLBP) impacts approximately one-third of adults globally.¹ Efficacious non-pharmacological and behavioral treatments for CLBP are needed, but barriers impede broad implementation, such as the need for therapists, treatment duration, insurance coverage, and copay requirements.² At-home, immersive virtual reality (VR) therapies might address these barriers. A recent double-blind, randomized, placebo-controlled trial compared 8-week self-administered proprietary Skills-Based VR for Chronic Pain to Sham VR in adults with CLBP. The proprietary VR was statistically superior to sham VR (and showed clinically meaningful reductions) at end-of-treatment for pain intensity, pain interference with activity, sleep, and mood, pain-related stress, physical function, and sleep disturbance³ that was durable at 1, 2, 3 and 6 months post-treatment.^{4 5} This study extended these results by examining durability at 18 months post-treatment.

METHODS

Full methods are available (online supplemental file 1).³ Individuals with self-reported CLBP (≥ 6 months and average pain intensity of >4 for the past month on a 0–10 Pain Rating Scale) were recruited nationally through chronic pain organizations, healthcare professionals, and online advertisements. In short, the proprietary Skills-Based VR for Chronic Pain therapy (RelieVRx; AppliedVR; Los Angeles, California, USA) is an 8-week sequential multimodal self-administered immersive therapeutics for in-home use that incorporates evidence-based self-regulatory skills used in cognitive-behavioral therapy for chronic pain (diaphragmatic breathing, biofeedback elements, cognition, and emotion regulation), mindfulness principles, and pain education. The standardized 56-day program delivers VR content through a prescribed sequence of daily immersive experiences that range from 2 to 16 min. Sham VR is an active and rigorous placebo of non-immersive, two-dimensional visual content displayed in a VR headset. Content included 20 rotating nature videos overlaid with music that was not relaxing, aversive, or distracting; content was devoid of pain education or pain management skills training. Eighteen-month post-treatment data

were collected during March–April 2022. Participants who completed the 18-month post-treatment surveys (Defense and Veteran's Pain Rating Scale (DVPRS), DVPRS-II, Patient-Reported Outcomes Measurement Information System (PROMIS) Physical Function and Sleep Disturbance) were compensated US\$75.

Results

The 18-month surveys were completed by 136 of 188 participants. **Figure 1** displays the results for the five primary endpoints.

Skills-based VR for chronic pain versus sham VR

At 18 months post-treatment, the average pain reduction for skills-based VR for chronic pain was significantly larger than that for sham VR for pain intensity ($p=0.003$; effect size=0.65, skills-based VR SD=2.21; Sham VR SD=1.99), pain-related stress ($p=0.043$; effect size=0.32, skills-based VR SD=2.90; Sham VR SD=2.57), and pain interference with activity ($p=0.020$; effect size=0.54, skills-based VR SD=2.65; sham VR SD=2.50) and sleep ($p=0.015$; effect size=0.36, skills-based VR SD=2.85; sham VR SD=2.74), but not mood ($p=0.47$; effect size=0.35, skills-based VR SD=2.45; sham VR SD=2.63).

Baseline versus 18 months post-treatment for skills-based VR for chronic pain

The average pain reduction at 18 months post-treatment relative to baseline was statistically significant for pain intensity (-20.1% ; $p=0.0003$; effect size=0.56, baseline SD=1.20; 18 months SD=2.21), pain-related stress (-32.6% ; $p=0.0003$; effect size=0.58, baseline SD=2.20; 18 months SD=2.90), and pain interference with activity (-35.1% ; $p<0.0001$; effect size=0.82, baseline SD=1.80; 18 month SD=2.65) and sleep (-32.0% ; $p<0.0001$; effect size=0.56, baseline SD=2.60; 18 month SD=2.85), but not mood (-35.6% ; $p=0.46$; effect size=0.68, baseline SD=2.20; 18 month SD=2.45).

Clinically meaningful pain reductions

Table 1 displays the percentage of participants achieving moderate ($\geq 30\%$) and substantial ($\geq 50\%$) clinically

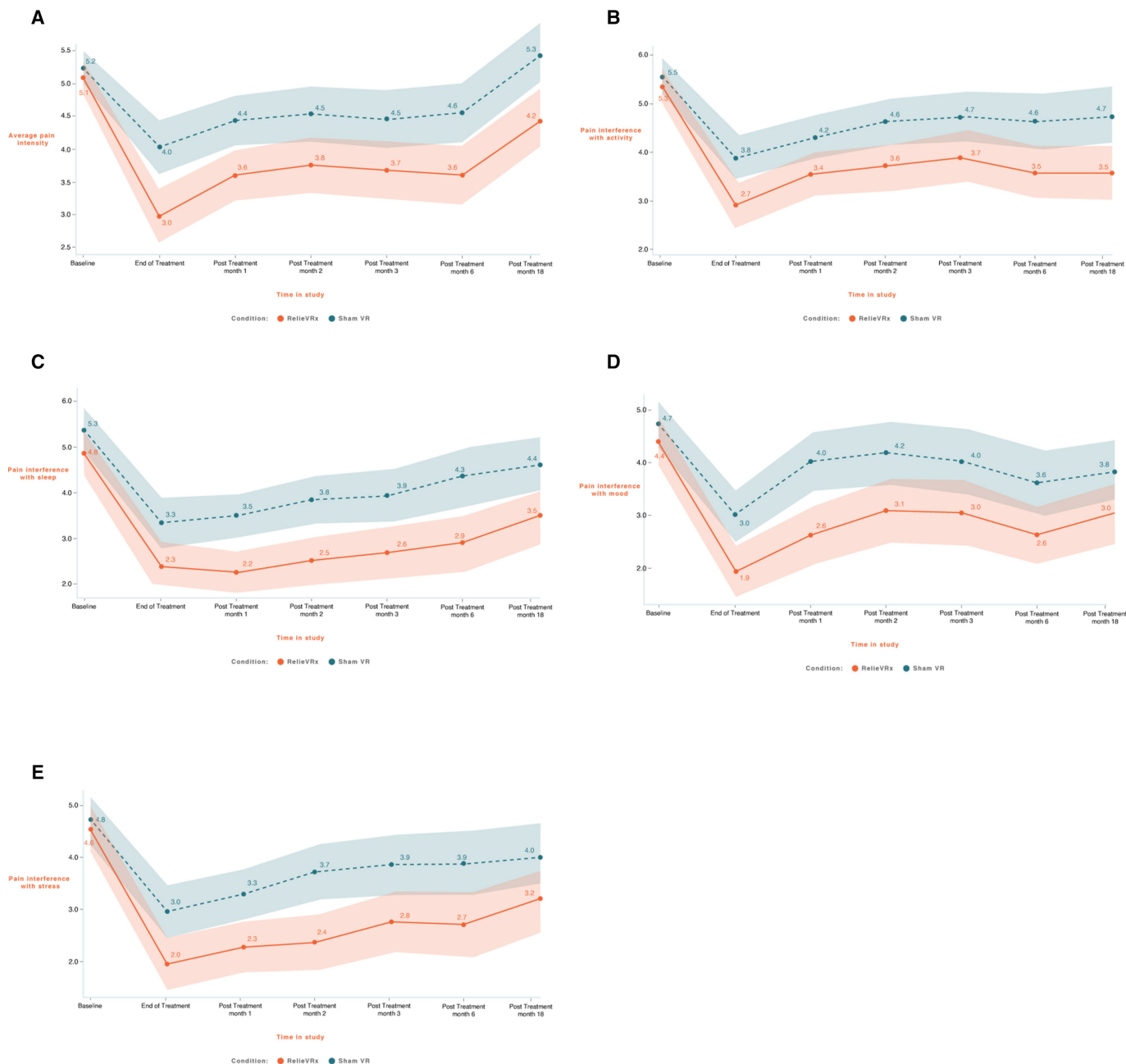


Figure 1 Skills-based VR for chronic pain and sham VR groups from baseline to 18 months post-treatment for (A) average pain intensity, (B) pain interference with activity, (C) pain interference with sleep, (D) pain interference with mood, and (E) pain-related stress. The x-axis represents time and the color bands represent 95% CIs for the mean after correcting for multiple comparisons (all p values are Tukey-Kramer corrected). VR, virtual reality.

meaningful reductions in pain intensity and interference. More than half of skills-based VR for chronic pain participants retained clinically meaningful reductions in pain interference at 18 months.

Secondary endpoints: PROMIS physical function and sleep disturbance

At 18 months post-treatment, the skills-based VR for chronic pain group had statistically significant reductions for sleep disturbance compared with baseline (p=0.004; effect size=0.43, baseline SD=5.20; 18 month SD=10.34) and also compared with sham VR (p=0.036; effect size=0.26, skills-based VR SD=10.34; sham VR SD=9.08). Skills-based VR for chronic pain was also statistically significant for improving physical function compared with baseline (p=0.009; effect size=0.35,

Table 1 Percentage of participants achieving moderate (≥30%) and substantial (≥50%) clinically meaningful reductions in pain intensity and interference by treatment group

	Pain intensity	Pain interference with			
		Activity	Sleep	Mood	Stress
Moderate					
Skills-based VR for chronic pain	36.4	56.1	51.5	56.1	56.1
Sham VR	20.6	34.9	42.9	42.9	36.5
Substantial					
Skills-based VR for chronic pain	25.8	42.4	37.9	47.0	48.4
Sham VR	6.4	22.2	28.6	28.6	27.0

VR, virtual reality.

baseline SD=5.10; 18 month SD=7.60) but not compared with sham VR ($p=0.431$; effect size=0.37, skills-based VR SD=7.60; sham VR SD=6.47).

DISCUSSION

We report the 18 month post-treatment results comparing skills-based VR for chronic pain with sham VR in adults with CLBP. Despite attenuated effects across all variables from end-of-treatment to 18 months post-treatment, the skills-based VR for chronic pain versus sham VR effect sizes remained moderate (0.32–0.65) and moderate to substantial, and clinically meaningful effect sizes for skills-based VR for chronic pain at 18 months relative to baseline were maintained (0.35–0.82).

These extended results are important for at least two reasons. First, the fact that more than 50% of participants maintaining clinically meaningful reductions in pain interference 18 months post-treatment provides evidence of long-term efficacy of skills-based VR for chronic pain and suggests the device helps people durably manage and reduce the impact of pain in daily life. Second, national calls for improved access to non-pharmacological pain care^{6–9} may be realized by skills-based VR for chronic pain. Such a VR treatment is non-pharmacological, efficacious, durable, requires only 6 min per day, has high usability,³ and may better equalize access to pain care in underserved populations.

Despite these strengths, limitations include low levels of depressive symptoms and a bias toward Caucasian women as study participants. The study also relied on participant-reported data with no objective data on concurrent health conditions or receipt of additional pain treatments. Finally, this was a post hoc analysis with a 28% attrition rate, although this rate was similar between treatment groups and its effects were mitigated by the intention-to-treat analytic approach.

Correction notice This article has been corrected since it published Online First. The author's name, Beth Darnall, has been corrected.

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Contributors TM was involved in study design, data analysis and manuscript preparation. HG, KF, and AO were involved in data collection. RM was involved in data collection, data presentation, and manuscript preparation. LG was involved in study design, participant management and data interpretation. PK was involved in data analysis, interpretation, and manuscript preparation. DO, CS, and LO were involved in data interpretation and manuscript preparation. BB was involved in study design. JS was involved in project management. IM was involved in participant management. RL was involved in study design. VS was involved in medication analysis. BD was involved in study design, data interpretation and manuscript preparation. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

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Competing interests AppliedVR financially supported this study. TM, HG, KF, RM, LG, DO, CS, LO, and AO are employees of AppliedVR. JS is president of AppliedVR. BB, PK, and VS are consultants for AppliedVR. IM is a former contractor and employee of AppliedVR. BD is chief science advisor for AppliedVR. BD has authored or coauthored

five pain treatment books for patients and clinicians and receives royalties for four. BD is the principal investigator for pain research grants and awards from the NIH and the Patient-Centered Research Outcomes Research Institute (non-specific to the current work). BD is a coinvestigator on two NIH research grants investigating virtual reality analgesia; neither of these grants is specific to the current work. BD serves on the Board of Directors for the American Academy of Pain Medicine and is on the Board of Directors for the Institute for Brain Potential. BD is a scientific member of the NIH Interagency Pain Research Coordinating Committee, the Centers for Disease Control and Prevention (CDC) Opioid Workgroup (2020–2021), and the Pain Advisory Group of the American Psychological Association.

Patient consent for publication Not applicable.

Ethics approval The WCG Institutional Review Board (Puyallup, WA) approved the study protocol in July 2020. International Registered Report Identifier RR2-10.2196/25291. Participants gave informed consent to participate in the study before taking part.

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