**Supplementary File 2.** Comprehensive details of included studies evaluating clinical populations

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| Author, Study design | Population, sample size | Comparison treatment/group | Outcomes measured | Key exercise finding | Primary findings |
| Aims: Use of immersion on exercise outcomes (clinical populations) | | | | | |
| Baños, 2016 ‡  Within subject study design.  VR: 150cm x150cm screen | Healthy and overweight children aged 10-15 years (n=109). Overweight (n=33)  47 males, 62 females | 6 minutes of treadmill walking. First three minutes at 4.6 kph, second three minutes at 5.7 kph.  A. No VR and instructions to concentrate on bodily sensations and feeling.  B. VR condition | 1. Affect  a. Attentional strategies assessment (ad hoc assessment)  b. FS  2. Enjoyment  Enjoyment and preference (ad hoc assessment) | 1. Affect  a.  VR vs no VR  Overweight children   * + **Focus on bodily sensations: MD -2.00 [-2.78, -1.22]**   + Thoughts about performance: MD -0.20 [-0.73, 0.33]   + Thoughts of encouragement: MD 0.10 [-0.53, 0.73]   + Thoughts about the task: MD 0.10 [-0.53, 0.73]   + Distraction by thoughts: MD -0.20 [-0.88, 0.48]   + **Distraction by the environment: MD 1.90 [1.00, 2.80]**   Normal weight children   * + **Focus on bodily sensations: MD -0.60 [-1.02, -0.18]**   + Thoughts about performance: MD 0.30 [-0.13, 0.73]   + Thoughts of encouragement: MD 0.00 [-0.32, 0.32]   + Thoughts about the task: MD 0.40 [-0.08, 0.88]   + Distraction by thoughts: MD -0.50 [-1.06, 0.06]   + Distraction by the environment: MD 0.30 [-0.31, 0.91]   b.  Overweight children   * MD -0.48 [-1.39, 0.43]   Normal weight children   * MD 0.35 [-0.06, 0.76]   2. Enjoyment  Data not provided: (participants enjoyed  the VR more [F(1, 86) = 3.893, p > 0.05, g2 partial  = 0.04), but there were no differences between groups, and the group · condition interaction was not significant | 1a. VR condition for overweight children = ↓ focus on bodily sensations, and ↑ distraction.  VR condition for normal weight children = ↓ focus on bodily sensations.  b. No difference between VR and no VR conditions in the feeling scale.  2. Authors report no difference between groups. |
| Bryanton, 2006 ‡  Within subject study design.  VR: Interactive rehabilitation exercise system (IREX) that consists of screen and camera that films participant. | Children with cerebral palsy (n=10)  4 males, 6 females  And healthy children (n=6)  2 males, 4 females  Age range: 7-17 years | Participants sat in chair seated position or long sit. Participants were required to use ankle dorsiflexion to interact with the environment.  Each condition spanned 10 minutes 2 x 2 minutes of conventional exercise and 2x2minutes of VR exercise  A. VR exercise  B. Conventional Exercise  For  1. healthy control group  2. cerebral palsy group | 1. Engagement  Dorsiflexion hold times and ROM measure | 1. Engagement   Insufficient data provided | Author reported VR condition to have ↑ dorsiflexion hold times over conventional condition in both populations. |
| Finkelstein, 2013 ‡  Within subject study design.  VR: Projected graphics onto wall/s. | Children with autism (n=10)  Sex not specified  Mean age = 12.6 years | 15 minutes of exercise, playing ‘astrojumper’ game.  A) One screen projected  B) three screens projected (more immersive) | 1. Engagement  MET’s  2. Enjoyment  Post experiment survey. Varying questions with 7-point scales.  3. Motivation  Post experiment survey. Varying questions with 7-point scales. | 1. NS 2. Enjoyment question for astrojumper in general (1 = low enjoyment, 7 = high enjoyment) (M = 6.63, SD = 1.06)   Question regarding whether they’d use it more if they could play whenever they wanted (1 = no, 7 = yes) (M = 6.00, SD = 1.00).  Question: Was it a good work out? (1 = no, 7 = yes) (M = 5.38, SD = 1.16),  Question: Did they prefer the single screen or the three screens?  3.  Question: would they play Astrojumper if they could play it whenever they want? (1 =no, 7=yes)  (M = 6.00, SD = 1.00)  Question: how likely was it that they would get bored of Astrojumper eventually? (1=low chance, 7 = high chance)  (M = 2.18, SD = 1.65) | 1. Not significant  2. Post- experiment survey questions suggest that participants enjoyed Astrojumper, would like to use it more to exercise, and preferred the more immersive three screens over one. |
| Hossain, 2013 ‡  Cross sectional, design.  VR: Nintendo Wii with motion tracking with television or projector | Participants with obesity (n=12)  3 children aged 8 to 15 (sex not specified)  4 men aged 16 to 24  3 men aged 25 to 34  2 men aged 35 to 44 | Intensity and length of intervention not reported.  Participants to play game called ‘Treasure Hunting’.  No control or comparison group | 1. Enjoyment  A 22 question, 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5) was used to determine enjoyment, helpfulness, engagement.  2. Engagement  (See 1) | 1. & 2.  No data reported in study. | Insufficient data provided. Authors suggest that participants enjoyed playing the game. |
| Jones, 2019  Within subject study design  VR: High immersive: HMD & headset audio  Low immersive: screen & speakers | Overweight and inactive population (n=21)  5 males, 16 females  Mean age = 34.7 years | 15 minutes of exercise at ventilatory threshold (VT) on stationary recumbent bike,  A) High immersion (HI) VR (HMD and audio)  B) Low immersion (LI) VR (Television screen and speakers)  C) Control (no VR) | 1. Affect  a. IEQ  b. FS  2. Enjoyment  PACES | 1. Affect  a. Dissociation   * **LI vs control (favours LI) (p = 0.000, d = 1.76)** * **HI vs control (favours HI) (p = 0.000, d = 2.36)** * **HI vs LI (favours HI) (p = 0.025, d = 0.54)**   b. Feeling Scale   * **HI vs control (favours HI) (at 15 minutes) (p = 0.000, d = 2.57)** * **HI vs LI (Favours HI) (at 15 minutes) (p = 0.014, d = 0.65)**   2. Enjoyment   * **LI vs control (favours LI) (p = 0.000, d = 1.17)** * **HI vs control (favours HI) (p = 0.000, d = 2.36)** * HI vs LI: no difference | 1a. HI = ↑ dissociation than control and LI. LI = ↑ dissociation than control.  b. HI = ↑ FS than control and LI  2. HI & LI = ↑ enjoyment than control. No difference between LI and HI. |
| Meyer, 2008 ‡  Longitudinal, cohort study design  VR: TV Screen | Females with obesity who had previously attended weight loss program and identified as non-adherers (<5000 steps per day) (n=3)  Mean age = 47.6 years | 21 weeks of treadmill walking exercise (one-week was pre-baseline, up to six weeks for the baseline phase, eight weeks for the intervention phase, and up to six weeks for the post-intervention phase) | 1. Motivation:  IMI  2. Enjoyment  Qualitative assessment of enjoyment  3. Engagement  Step pedometer | 1. Motivation (total IMI scores)   * Baseline vs intervention phase: MD 1.33 [-4.35, 7.01] * Baseline vs post intervention: MD -2.67 [-9.07, 3.73] * Intervention phase vs post intervention: MD --4.00 [-9.68, 1.68]   2. Enjoyment   * Qualitative data suggested the participants enjoyed the VR walking.   3. Engagement   * Baseline vs intervention phase: MD 0.97 [-0.89, 2.82] | 1. No significant differences between phases  2. qualitatively participants enjoyed VR walking.  3. No significant difference between phases |
| Törnbom, 2018 ‡  Within subject study design.  VR: 92x50 cm screen | 10 participants,  Stroke (n=8), traumatic brain injury (n=1), encephalitis (n=1).  7 males, 3 females  Aged 38-64  Mean age = 51 | Treadmill walking 13-30 minutes  A. With VR  B. Without VR | 1. Enjoyment  Qualitative interview | Many of the participants found the VR to be more enjoyable but more tiring and challenging due to the increased auditory and visual sensory information, and concentration on balancing. | Authors report ↑ enjoyment in VR condition. |
| Zimmerli, 2013 ‡  Within subject study design.  VR: Projected onto a screen | Spinal cord injury (SCI) participants (n=12)  9 males, 3 females  Mean age = 46.3 years  Healthy control participants (n=10)  6 males, 4 females  Mean age = 25.9 years | 4 minutes for each condition with a 3-minute break between each. Participants instructed to “try to walk actively” or “modulate your speed using your activity”  A start and end baseline condition was also included, with the four other conditions pseudo randomised.  A. Steady: walking in virtual world, speed wasn’t interactive with environment  B. Speed: the activity within the subject’s orthoses was measured and was congruent to the speed within the virtual environment.  C. Sprint: Same as Speed condition but added information regarding their average speed was provided. An audio cue was also used to draw attention to this information.  D. Race: a virtual competitor that was programmed from the current speed of the participant was used to create competition. | 1. Engagement  a. HR  b. EMG of bicep femoris  c. EMG of gastrocnemius,  d. EMG of rectus femoris | 1.  a.  SCI group   * **Steady and the Speed (favours speed) (P=0.003)** * **Steady and the Sprint (favours sprint) (P=.0006)**   Healthy group   * **Steady and Race (favours race) (P=0.007)** * **Speed and the Sprint (favours sprint) (P=0.009)**   b.  SCI group   * **Steady vs Speed (favours speed) (during swing phase) (P=0.013)** * **Steady vs Sprint (favours sprint) (during swing phase) (P=0.003)** * **Steady vs Race (favours race) (during swing phase) (P=0.004)** * **Speed and the Sprint (favours sprint) (during swing phase) (P=0.006)**   Healthy Group   * **Steady and the Race (favours race) (P=0.007)**   c.  SCI group   * No differences (data not provided)   Healthy group   * **Steady and the Race (favours race) (during stance & swing phase) (P=<0.008)**   d.  SCI group   * **Steady and the Speed (favours speed) (during stance phase) (P=0.003)** * **Steady and the Sprint (favours sprint) (during stance phase) (P=0.005)** * **Steady and the Speed (favours speed) (during swing phase) (P=0.002),** * **Steady and the Sprint (favours sprint) (during swing phase) (P=0.006)** * **Steady and the Race) (favours race) (during swing phase) (P=0.005)**   Healthy group   * **Steady and the Speed (favours speed) (during swing phase) (P<.008),** * **Steady and the Sprint (favours sprint) (during swing phase) (P<.008)** * **Steady and the Race (favours race) (during swing phase) (P<.008)** * **Steady and the Speed (favours speed) (during stance phase) (P<.008)** | 1.  a. In SCI group, speed and sprint condition = ↑ HR than steady condition  In healthy controls, Race = ↑ HR than steady, and sprint = ↑ HR speed condition.  b. In SCI, speed, sprint, and race conditions = ↑ biceps femoris EMG in swing phase of gait than steady condition. Sprint = ↑ EMG than speed condition.  In healthy controls, Race condition = ↑ EMG than steady.  c. In healthy controls, Race = ↑ gastrocnemius EMG during both phases than steady condition.  d. In SCI, speed and sprint conditions = ↑ rectus femoris EMG during stance phase than steady condition.  Speed, race, and sprint conditions = ↑ EMG during swing phase than steady condition.  In healthy control, Speed, sprint, and race = ↑ EMG than steady condition during swing phase. Speed condition = ↑ EMG than steady during stance phase. |

**Table S2.** Comprehensive details of studies (clinical populations)

**Legend:** n = sample size; M = Male; F = Female; VR = Virtual Reality; LI = Low immersive; HI = High immersive; HMD = Head mounted display; NS = Not significant; ↑ = increase; ↓ = decrease; ‡ denotes studies that don’t meet requirements for place and plausibility illusion (Slater, 2009). Bold text signifies statistically significant findings. Results provided in Mean Difference (MD) and 95% Confidence Intervals (CI) when data was available.

**Measures:** FS = Feeling Scale; HR = Heart rate; cm = Centimetre; ROM = Range of motion; MET’s = Metabolic equivalent of task; EMG = Electromyography; IMI = Intrinsic motivation inventory: five subscales that assess interest/enjoyment, perceived competence, effort/importance, pressure/tension, and value/usefulness; PACES = Physical activity enjoyment scale (18 item questionnaire, higher results = greater enjoyment); Attentional strategies assessment (ad hoc assessment) = assesses attentional focus in 6 categories, focus on bodily sensations, thoughts about performance, thoughts of encouragement, thoughts about the task, distraction by thoughts, and distraction by the environment; Enjoyment and preference (ad hoc assessment) = 1-7 scale on perceived enjoyment, and question after both conditions which one they’d prefer to repeat; IEQ = the Immersive Experience Questionnaire: 7-items, specific to dissociation.