

Horse Riding Simulator with Virtual Reality for Rehabilitation of Children with Cerebral Palsy

Samsung Changwon Hospital

Department of Physical Medicine & Rehabilitation

Hyun Jung Chang



Cerebral palsy (CP)

- The most common physical disability of childhood
- A group of disorder of movement and posture, causing activity limitation, due to nonprogressive insult or anomaly of the developing brain
- Muscle weakness, abnormal muscle tone, impaired motor control, and dysequilibrium, which cause abnormal posturing and poor balance control

Equine-assisted activities and therapy (EAAT)

- A broad term that includes any activities or therapies that incorporate equines (horses)
Hippotherapy & therapeutic horseback riding
- Hippotherapy in CP
 - Significant improvements on gross motor function
 - Positive effects on balance recovery and muscle spasticity reduction

EFFECTIVE

DO IT **S+**

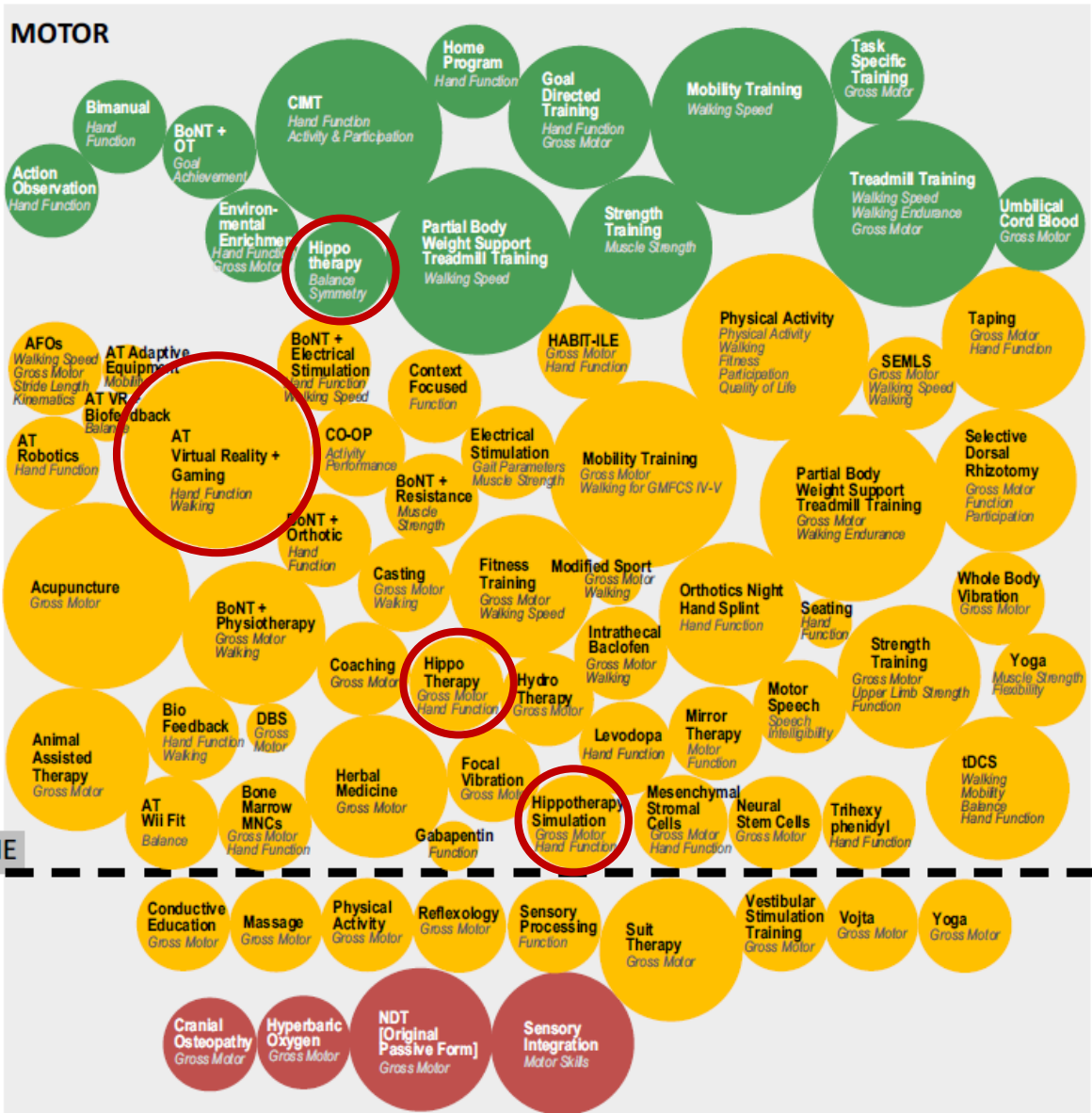
PROBABLY DO IT **W+**

WORTH IT LINE

PROBABLY DON'T DO IT **W-**

DON'T DO IT **S-**

INEFFECTIVE



LEGEND: AFOs= Ankle Foot Orthoses; AT= Assistive Technology; BoNT= Botulinum Toxin; CIMT= Constraint Induced Movement Therapy; CO-OP= Cognitive Orientation to Occupational Performance; COP-CAR= Coping with and Caring for infants with special needs - a family centered program; DBS= Deep Brain Stimulation; GAME= Goals Activity Motor Enrichment; NDI= Neurodevelopmental Therapy; OT= Occupational Therapy; SEMLS= Single Event Multi Level Surgery; tDCS= Transcranial Direct Current Stimulation



Horse-riding simulator (HRS)

- Robotic device with a dynamic saddle that imitates the movement of a horse
→ producing three-dimensional movements similar to the horse walking pattern
- Positive effect on postural balance in children with CP



Horse-riding simulator (HRS) – Mechanism

- Astride sitting on a moving saddle → improvement of reactive sitting control
- Protective mechanism while sitting on HRS
 - Development of strategy to prevent falling off and for maintenance of posture
 - Facilitation of body awareness in space
- Body Weight shift in response to rhythmic movement
 - Multiple sensory inputs and efferent motor outputs from the CNS
 - Improvement in postural stability, equilibrium reaction, upright alignment correction

Horse-riding simulator (HRS)

- It is reported that HRS is less effective than hippotherapy.
- One possible reason is the different quality of sensory system stimulation, besides just using the actual horse.
- If HRS is combined with various postural challenges that can increase somatosensory stimulation, it is expected that similar effects to EAAT will be elicited

Virtual reality (VR)

“Simulated experience that can be similar to or completely different from the real world.

Application of VR include entertainment, education and business.”

From Wikipedia



- Technology that provides a sense of presence in a real environment with the help of 3D pictures and animations formed in a computer and enables the person to interact with the objects in that environment.

Virtual reality (VR)



International Journal of
*Environmental Research
and Public Health*

Review

The Effect of Virtual Reality Games on the Gross Motor Skills of Children with Cerebral Palsy: A Meta-Analysis of Randomized Controlled Trials



International Journal of
*Environmental Research
and Public Health*

Review

The Rehabilitative Effects of Virtual Reality Games on Balance Performance among Children with Cerebral Palsy: A Meta-Analysis of Randomized Controlled Trials



VR games have positive effect on the improvement of gross motor skills and balance of children with CP

EFFECTIVE

DO IT **S+**

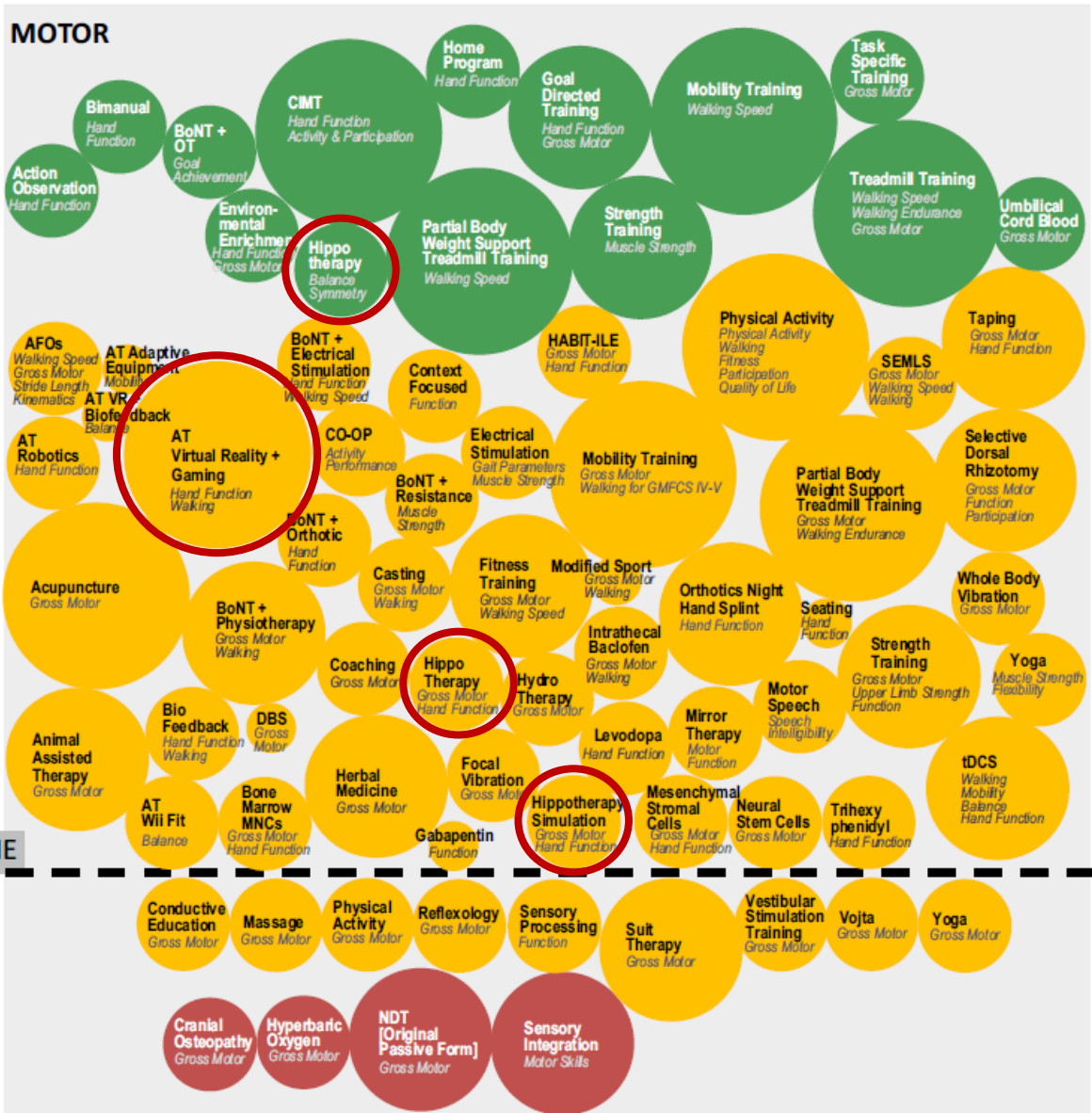
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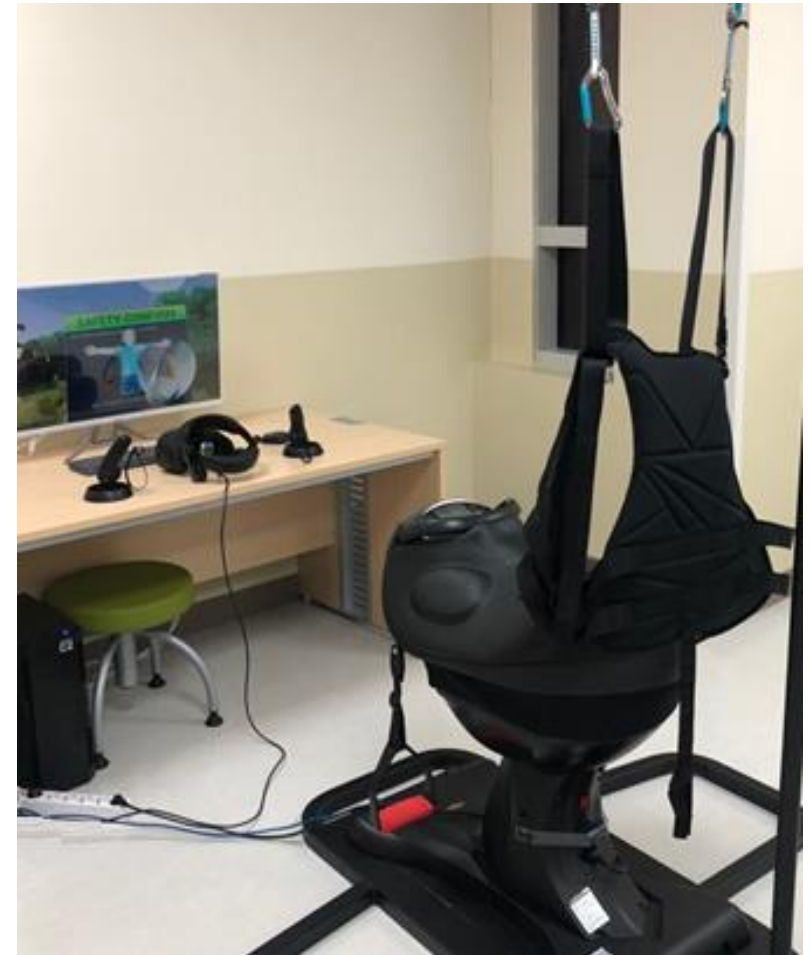
Virtual reality (VR)

- VR → provides an opportunity for active learning
 - intrigues and encourages the participant
 - ensures motivation
 - enables performing difficult movements in a secure environment

Cerebral Palsy-Challenges for the Future. InTechOpen. 2014

VR could be used in combination with **HRS** to make children feel like they were riding on horses and to enhance the therapeutic effect of HRS by providing multiple directional challenges for them.

HRS with VR



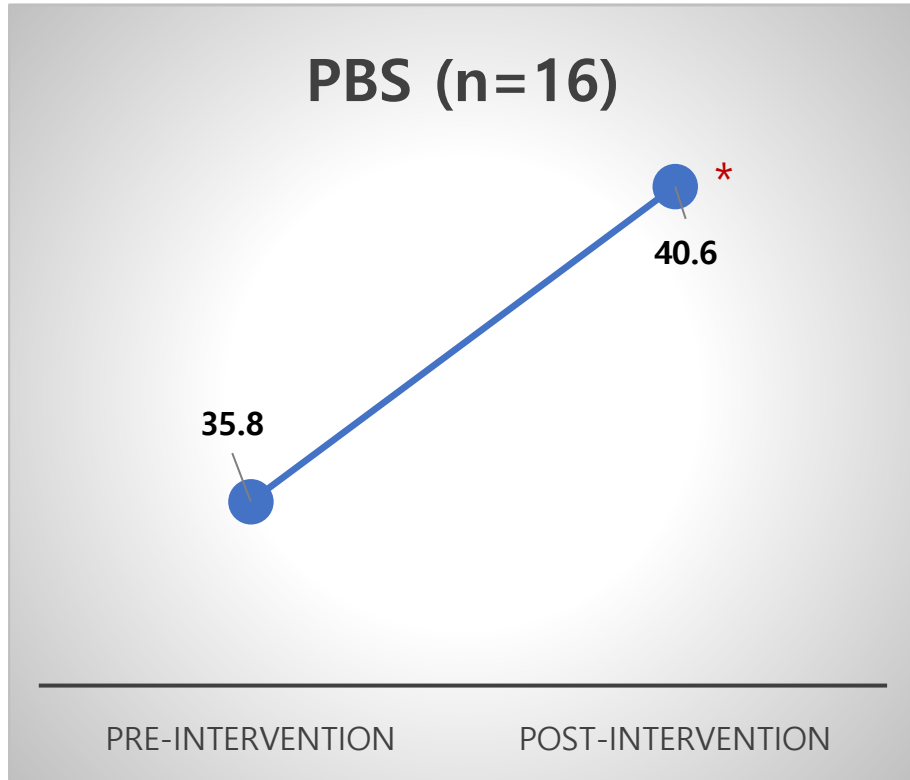
HRS with VR



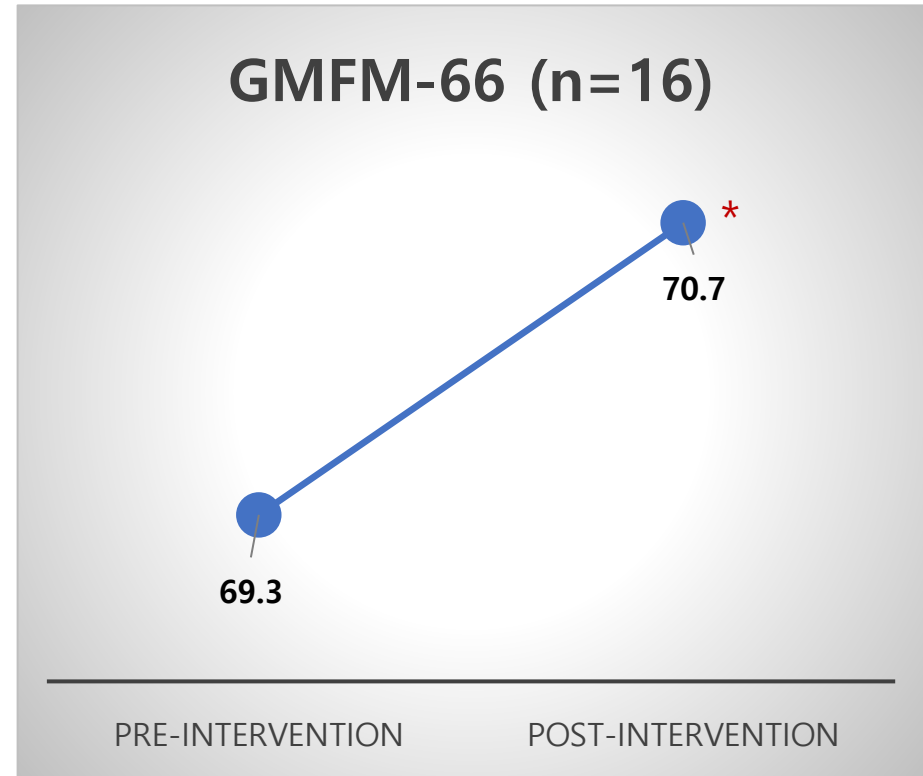
HRS with VR – 1st trial

- 16 Children with CP preschool- and school-aged children
GMFCS level I-IV
- 30 minutes session, 2 sessions/week, total 16 sessions
Vital sign such as blood pressure, pulse rate and body temperature was checked
before and after each riding, every session
- Pediatric Balance Scale (PBS) and Gross motor Function Measure (GMFM) evaluation
before and after two-month intervention

HRS with VR - Results



Changes in Pediatric Balance Scale (PBS)
* p<0.05



Changes in Gross Motor Function Measure (GMFM)-66
* p<0.05

HRS with VR - Results

< Changes in Gross Motor Function Measures - 88 >

(n=16)	Pre-intervention	Post-intervention	P-value
GMFM-88 total	81.2 ± 21.5	82.3 ± 20.3	0.021 *
A lying and rolling	94.9 ± 8.3	96.2 ± 5.4	0.285
B sitting	93.2 ± 16.1	93.9 ± 14.2	0.251
C crawling and kneeling	85.6 ± 24.4	86.8 ± 22.3	0.178
D standing	71.6 ± 30.8	73.6 ± 30.6	0.001 *
E walking, running and jumping	60.6 ± 34.8	61.3 ± 34.8	0.037 *

mean percentage ± standard deviation

COVID-19

- Children with CP - impairments in respiratory function
 - Higher risk for respiratory complications from COVID-19
 - Physical distancing, good hand hygiene, and minimizing trip to public place
- During the pandemic, not attending their routine control check-up 67.1%
discontinuing their physical therapy sessions 12.8%
decreased caregivers physical & mental quality of life

The functional health status of children with cerebral palsy during the COVID-19 pandemic stay-at-home period: a parental perspective

Kübra Seyhan Bıyık[®], Cemil Özal[®], Merve Tunçdemir[®], Sefa Üneş[®],
Kıvanç Delioğlu[®], Mintaze Kerem Günel[®]

Results. One hundred and three parents of children with CP participated. At least one of four children with CP had increased levels of anxiety (41.8%), and increased level of a sensation of pain (34%) and sleep problems (25.2%). More than half of the children had increased tonus (67%), decreased range of motion (60.2%), decreased physical activity level (55.3%), and decreased support level of rehabilitation services (82.6%). During the stay-at-home period activity and participation levels and environmental factors of children explained the changes of body functions as 70% and 33% (RMSEA=0.077, $p<0.05$).

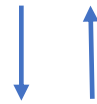
Conclusions. This study is the first study to examine the functional health of children with CP biopsychosocially during the COVID-19 stay-at-home period. According to the parents, the functional health of children with CP was affected at different levels during the COVID-19 pandemic. Body functions may also be affected positively if physical activity level, home program and environmental supports increase.

COVID-19

확진자 (Hwag-jin-ja)

확진자 (Hwag-jjin-ja)

Decreased physical activity level



Decreased motor function & increased weight

- Ambulatory children with mild spastic CP vs typically developing children
→ Lower height percentile, total physical activity count, markedly underdeveloped bone architecture, adipose tissue infiltration of skeletal muscle.

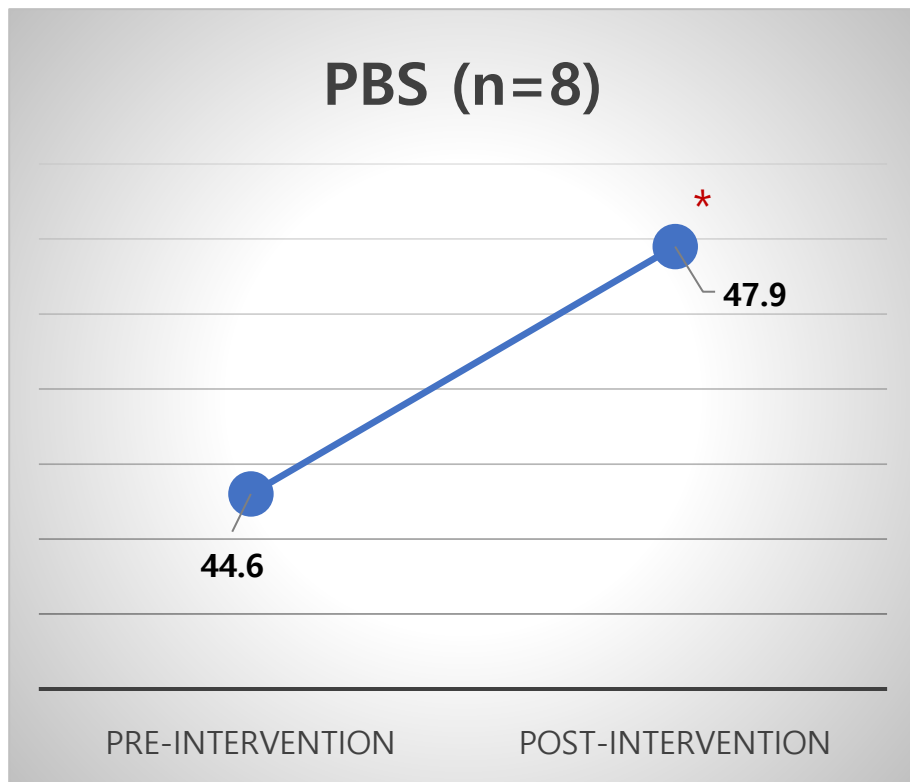
HRS with VR – 2nd trial

- 10 Children with CP preschool- and school-aged children
GMFCS level I-IV
- 30 minutes session, 2/week total 16 sessions
- Pediatric Balance Scale (PBS) and Timed Up and Go (TUG) test
Body Mass Index (BMI) and body composition (using Inbody)
before and after two-month intervention

Time to take to rise from chair,
walk 3m, turn around 180°,
walk back to chair, and sit down

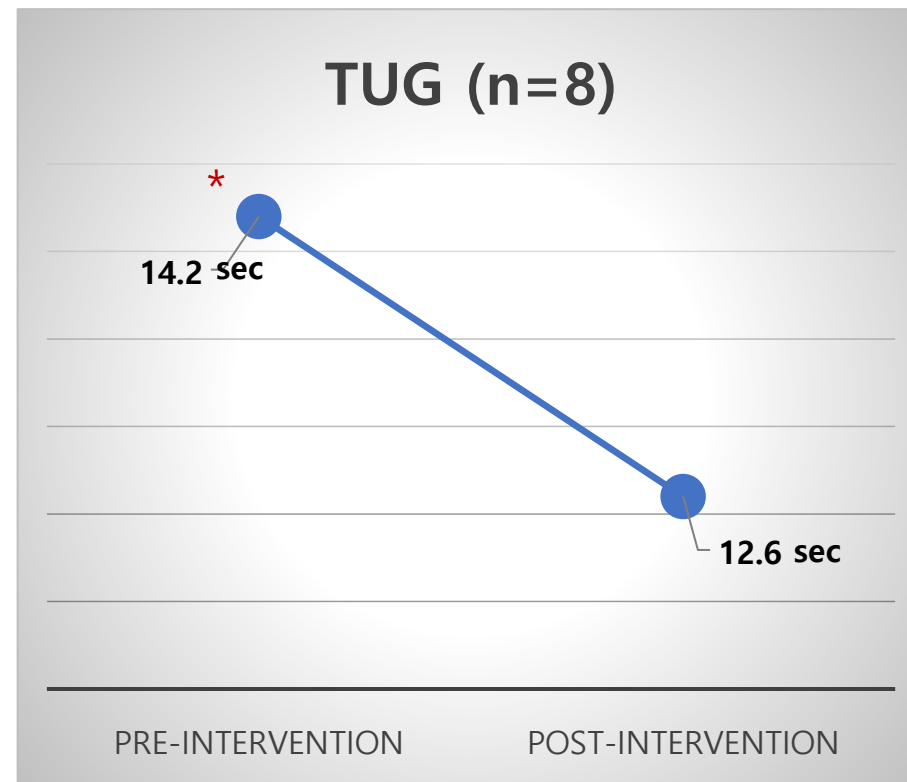
From Wikipedia

HRS with VR - Results



Changes in Pediatric Balance Scale (PBS)

* $p < 0.05$



Changes in Timed Up and Go (TUG)

* $p < 0.05$

HRS with VR - Results

< Changes in Body Composition >

(n=10)	Pre-intervention	Post-intervention	P-value
Body mass index	20.2 ± 4.8	20.0 ± 4.1	0.932
Height	130.8 ± 17.7	132.4 ± 19.1	0.018 *
Weight	36.7 ± 17.8	37.0 ± 17.1	0.573
Fat mass	9.9 ± 7.1	9.1 ± 6.2	0.263
Fat free mass	26.7 ± 11.5	28.0 ± 11.5	0.008 *
Skeletal muscle mass	13.4 ± 7.1	14.2 ± 7.2	0.012 *

mean ± standard deviation

Motivation

- Important factor in pediatric motor rehabilitation
- Vital modulator of neuroplasticity
Successful task-specific practice is rewarding and enjoyable to children
→ Spontaneously regular practice
- Motivated children have better rehabilitation outcomes.

How COVID-19 Will Accelerate A Digital Therapeutics Revolution

Digital Therapeutics

- Software-based therapies with proven clinical efficacy
- Replace or augment treatments that traditionally have been provided through medication or **in-person care**, with **software**
- The potential to be convenient and cost-effective treatments for conditions that affect billions of people

HRS with VR?

To be...

- Randomized controlled trial with large sample size
- Comparison of the effects according to GMFCS level
- Next version

Conclusion

- **HRS with VR** – effective therapeutic approach for rehabilitation of children with CP
 - Improve motor function, mobility and balance control
 - Improve body composition (increase lean body mass, especially muscle mass)
- The EAAT is the excellent intervention for promoting balance and gross motor function of children with CP. And **HRS with VR** can be a good surrogate for EAAT when EAAT is not available.



Thank you for attention

reh.chang@gmail.com



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