﴿ قالوا سبحانك لا علم لنا الا ما علمتنا

إنك انت العليم الحكيم ﴾

صدق الله العظيم

الآيه(32) سوره البقره

SYSTEMATIC REVIEW: EFFECT OF VIRTUAL REALITY ON BALANCE IN CHILDREN WITH CEREBRAL PALSY

Amal Youssef El-Saeed Wahba

فحص منهجي: تأثير استخدام الواقع الافتراضي على الاتزان لدى الأطفال المصابين بالشلل الدماغي

Acknowledgement

First and above all, I pray thanking ALLAH for giving me the ability to complete and accomplish this work

This is to Acknowledge the effort and express my sincere gratitude and deep appreciation to *Prof. Dr. Faten Hassan Abd El-Azim,* Chairperson of the Department of Physical Therapy for Growth and Development in Children and its Surgery, Faculty of Physical Therapy, Cairo University**,**

for her valuable supervision and continuous support throughout all the stages of this thesis. She gave me a great deal of her valuable time and effort to accomplish this work.

No words could ever express my deepest and special thanks to my *parents, family and colleagues* for their support and continuous encouragement during the whole work.

INTRODUCTION

A systematic review is the application of scientific strategies that limit bias by the systematic assembly, critical appraisal and synthesis of all relevant studies on a specific topic. *(Manchikanti, 2008).*

Systematic Review (synonym : systematic overview) is a review of a clearly formulated question that uses systematic and explicit methods to identify , select and critically appraise relevant research and to collect and analyze data from the studies that are included in the review .

Statistical methods (meta-analysis) may or may not be used to analyze and summarize the results of the included studies *(Pearson et al., 2005).*

A Systematic review is a "study of studies". All relevant research is analyzed in an effort to determine the overall evidence for an intervention.

A systematic review is a literature review focused on a single clear question which tries to identify, select and appraise all high quality research evidence relevant to that question then makes assessment of the included studies and synthesis of findings and interpretation. Systematic reviews are generated to answer specific, often narrow, clinical questions in depth **(Garg, 2008).**

Purpose of the study

To obtain evidence that virtual reality has an effect on balance on children with cerebral palsy and to provide physical therapists with guidelines to improve balance in children with cerebral palsy using virtual reality.

Significance of the study

The use of evidence in clinical decision making is promoted among many health professions in response to documented practice variation and decreasing health care costs, as well as in response to a desire for improved quality of care.

Using VR as an educational and therapeutic tool allows instructors and therapists to offer both flexibility and control when administering treatments, increasing the probability of skill transfer and ensuring safety during learning (Jones et al., 2007).

To gain evidence if there is an effect of VR on balance in children with cerebral palsy; Authors will add it in the physical therapy program, as it will assist in giving detailed instructions to the child and in time saving during treatment session.

Exclusion criteria of participants:

- Children who under the age of 7.
- Children who haven't cerebral palsy in the form of hemiplegia or diplegia eg.quadriplegia.
- Children who had according to GMFCS more than grade 2.
- Children who had previously used virtual reality.

Outcome Measures:

Primary outcomes:

- Balance.
- Standing balance
- Reactive balance
- Balance abilities.

Secondary outcomes:

- Gross motor functions.
- Upper limb function.
- Functional mobility.
- Control and synchronization of movement.

Methodology

Methodology was done according to criteria included in Cochrane Handbook for Systematic Reviews of Interventions by Higgins and Green (2011).

Criteria for considering studies for this review:

Type of studies

All full-length published articles related to the study concept were eligible for inclusion.

Type of participants

This systematic review concerned children with cerebral palsy (hemiplegia or diplegia), aged between 7 and 18 years, had according to Gross Motor Functional Classification System (GMFCS score) of I or II, could walk unaided for a period of ten minutes and had not previously used virtual reality.

Type of interventions

Virtual reality world in the form of: Wii balance games ((Nintendo Wii gaming console, Wii balance board and Wii Fit software (Soccer Heading, Ski Salom, Ski Jump, Table Tilt, Tightrope Walk, Balance Bubble, boxing, tennis, bowling, and golf)).

Search methods for identification of studies

Electronic searches

- PubMed (up to March 2015).
- Cochrane Central Register of Controlled Trials The Cochrane Library (up to March 2015).
- Pedro (up to March 2015).
- Google Scholar (up to March 2015).

Search strategy:

Search key words used as combination as following:

{Cerebral palsy OR Hemiplegia OR Diplegia} AND {virtual reality} AND {Nintendo Wii Fit OR wii fit games OR activity promoting computer games} AND {Balance OR Postural reactions}

Data collection and analysis:

Selection of studies

A comprehensive systematic literature search conducted to identify all relevant articles. The titles and abstracts were initially screened against the inclusion and exclusion criteria for identification of the relevant trials. When the title and abstract weren’t clear, the complete article would be read to determine its suitability.

- Inclusion criteria :

- Study type

Published, full text articles.

- Population :

Participants had to be children with Cerebral palsy aged from 7 to18 years.

- Intervention :

This review included studies which demonstrate the effects of virtual reality with reported findings for analysis of its effectiveness on balance on children with cerebral palsy.

- Language :

All published studies with no Language restriction.

- **Exclusion criteria :**

  - Unpublished studies
  - Studies that measured outcomes not related to the scope of our study.

Data extraction and management

Two observers **(Prof Dr. Faten Hassan Abd El-Azim and Amal Youssef El-Saeed Wahba)** extracted data from the original papers that were included in this review using a standard extraction form; disagreements were discussed by the two review authors until a consensus was reached.

Data were extracted according to data extraction form developed by the **American Academy for cerebral palsy and Developmental Medicine's (AACPDM) Treatment Outcomes Committee (2008 version).**

Steps of the data extraction process are:

1. Read the identified articles.

2. Code the level of evidence based on the research design of the article according to the classification of levels of evidence for group studies(Sackett's Levels of Evidence, 2015) and the classification of levels of evidence for single subject design studies (Romeiser et al., 2009) that the AACPDM uses in its reviews.

3. Extract descriptive information related to the definition of the population, the specific nature of the intervention of interest.

4. Assess the quality of the study and assign a quality rating. Quality assessment is performed for each study.

5. Identify outcomes of interest and the measures used to assess them according to **International Classification of Functioning, Disability and Health (ICF)** ***(WHO September 2001).***

Statistical analysis

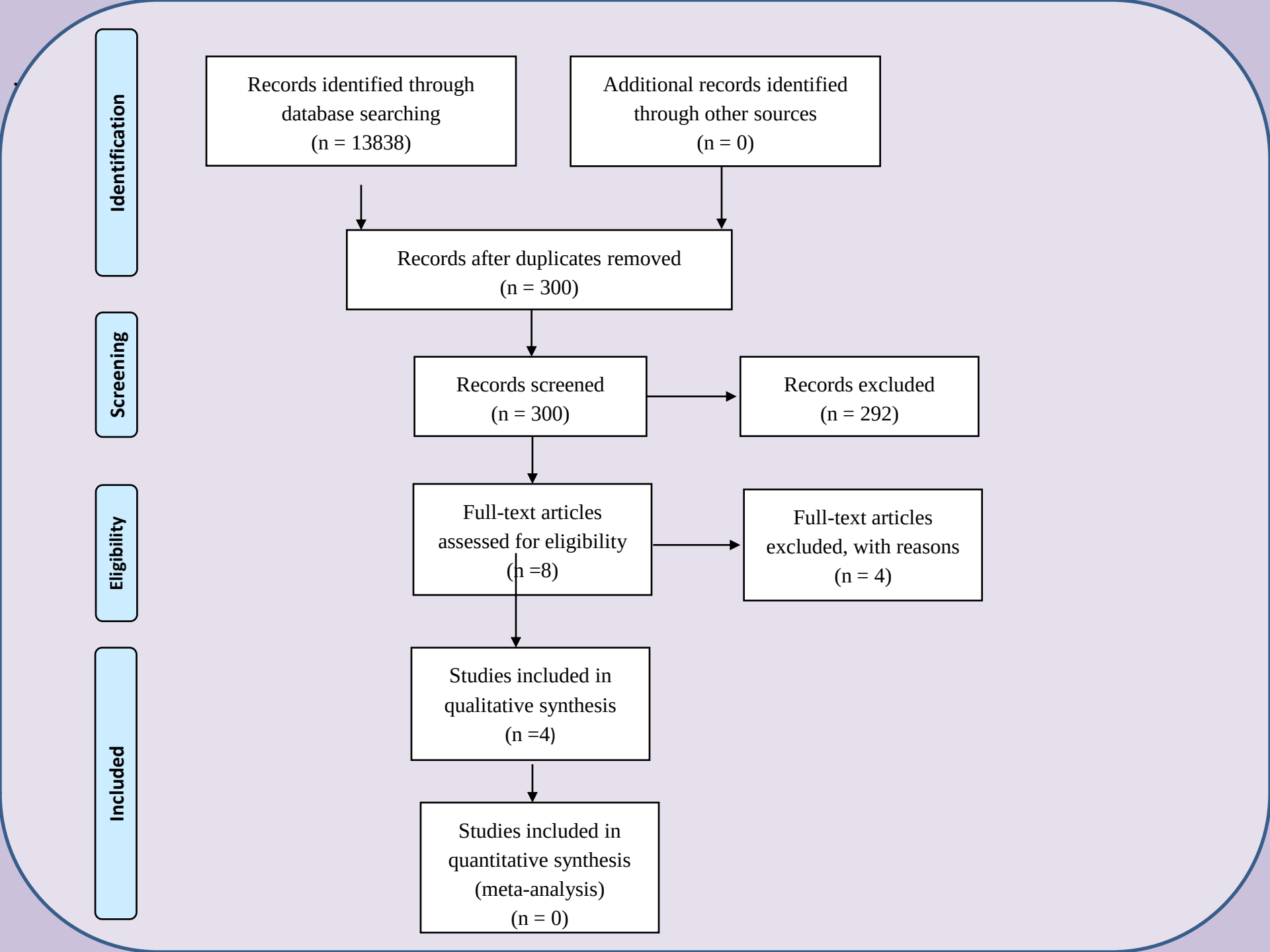
The current studies were analyzed by using **Descriptive analysis** due to the heterogeneity among studies


RESULTS

Results

The results represented according to criteria included in Cochrane Handbook for Systematic Reviews of Interventions by ***Higgins and Green (2011).***

Search results: will be represented through the following Prisma flowchart.


Identification
Screening
Eligibility
Included
Records identified through database searching (n = 13838)
Additional records identified through other sources (n = 0)
Records after duplicates removed (n = 300)
Records screened (n = 300)
Records excluded (n = 292)
Full-text articles assessed for eligibility (n =8)
Full-text articles excluded, with reasons (n = 4)
Studies included in qualitative synthesis (n =4)
Studies included in quantitative synthesis (meta-analysis) (n = 0)

This systematic review includes four studies that fulfill inclusive criteria, studying the effect of virtual reality on balance (as primary outcome) in cerebral palsied children and studying its effect on secondary outcomes ; Gross motor functions, functional mobility, upper limb function and control and synchronization of movement. The whole participant’s number included in this review was 52participants, the range of age from 8 to 17years.

All four studies included in the descriptive analysis due to heterogeneity of the primary and secondary outcomes. The included studies published from 2011 to 2012.

Causes for excluding studies in this review are numerous causes either due to study nature (as case study) or different outcomes measured not covered in the scope of this study

DISCUSSION

This systematic review analyzed 4 articles, by applying strict selection criteria for inclusion; only full text articles were included and participants had to be children with Cerebral palsy aged from 7 to18 years. After collecting data according to items of AACPDM sheet it was found that:

From all 4 studies included, one study fulfill the criteria of high methodological quality which judged as strong ("yes" on 12-14 questions), two studies fulfill the criteria of moderate methodological quality ("yes" on 10-14 and 5-7 questions) and one study fulfill the criteria of weak methodological quality ("yes" on 1-7 questions) according to AACPDM method of quality assessment of the studies reflecting the quality of included studies.

Virtual reality is an attractive, enjoyable and non-invasive method in dealing with cerebral palsied children as it didn’t cause adverse effect, so there was no report about any adverse effects of virtual reality in the included studies.

The study by ***Brien and Sveistrup (2011)*** which included in descriptive analysis, the study evaluated Balance abilities, coordination, accuracy, and speed component which assessed using Community Balance and Mobility Scale (CB&M) after application of virtual reality training, and found that participants who received virtual reality had refinement of coordination, timing, and speed of high level balance skills.

another study included in descriptive analysis by ***Jelsma et al., (2012)*** who conducted a study exploring effect of using the Nintendo Wii Fit Console and games on balance in children with cerebral palsy. The study evaluated balance which assessed by Subtests 5 (balance) of the Bruininks-Oseretsky test of Motor Proficiency 2nd Edition (BOT-2). They concluded that Nintendo Wii Fit training was found to be enjoyable and effective in balance education.

Also ***Sharan et al., (2012)*** who have had the same result as they used the Pediatric Balance Scale (PBS) to assess balance. They explained that improvement in balance of postoperative cerebral palsy children was possible through the use of VR-based therapy in the form of Wii-Fit.

This previous results supported by ***Deutsch et al., (2008)*** who conducted a study exploring the effect of using a Low-Cost, Commercially Available Gaming Console (Wii) for Rehabilitation of an adolescent with Cerebral Palsy. There was an improvement in postural control.

These previous results by ***Pavao et al., (2014)*** which studied the Impact of a virtual reality-based intervention on motor performance and balance of a child with cerebral palsy concluded that the use of the VR-based therapy with a body scanning device resulted in positive effects on motor performance and functional balance of the analyzed child, who has CP with mild functional impairment.

Ramstrand and Lygnegard (2012) showed disagreement with the previous studies as they evaluated standing balance by modified sensory organization test (mSOT) and reactive balance was measured by investigating the latency of response in the lower musculature following an external perturbation. Authors concluded that use of a Nintendo Wii balance board and Wii Fit software for a minimum of thirty minutes per day in the patient's own home was not effective as a balance training tool in children with cerebral palsy.

CONCLUSION

Implication for practice

The current level of evidence to support the effectiveness of virtual reality on promoting balance in children with cerebral palsy remains weak. The main limitations are the heterogeneity between included studies in the review and the small number of the studies involved.

Implication for research

High quality RCTs study the effect of virtual reality on balance on children with cerebral palsy. Future researches needed to ensure blinding as far as possible, in addition researches on virtual reality effectiveness on postural control and upper limb function

would be strengthen by the use of long term follow up and periodical evaluation to determine the long term effects of virtual reality and also to describe the existing evidence for linkages of effects within and between different outcomes.

Recommendations

Based on the concluded results of this study, the following items are recommended:

1. Virtual reality recommended to be implemented in balance training of children with cerebral palsy in order to improve their balance abilities and postural control.

2. Suggestions for future research conducting appropriately high quality RCTs studying the effect of virtual reality training on postural reactions, balance abilities and upper limb functions e.g. blinding of training applicator and results assessor in addition to application of allocation concealment as far as possible.

3. Suggestions for future research studying the effect of combination of different techniques of physical therapy like using balance board in conjunction with Wii fit games.

4. It is recommended to consider outcomes representing the ICF component of environmental factors of the effect of virtual reality on children with cerebral palsy in future researches.

5. Suggestions for future research conducting appropriately systematic review to study effect of virtual reality on secondary outcomes that have impact on fine motor functions e.g. hand and upper limb functions.

6. Use evidence based practice as a method to perform a decision making process in practice in pediatric physical therapy area.


Thank You!