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PICO question: For children with developmental disabilities, is adaptive seating more effective than standard seating in improving function?

Introduction:

Children with developmental disabilities often have muscle weakness and abnormal tone that can lead to decreased postural control and function.[1,2] Many times these children need support in the form of adaptive seating to maintain a functional posture.[2,3] Health care providers have prescribed adaptive seating for children with developmental disabilities to improve posture and function since the 1960s[3], but there is a limited evidence base to support these clinical decisions.[3,4] An adaptive seating device (ASD) is any seating device that is individualized to the child's unique body to promote improved posture and function in activities of daily living. Adaptive seating is a broad term that can include devices from wheelchairs and highchairs to toilet seats. Investigators have developed a theory that improved posture leads to improvements in function.[2,3,4,5,6] Many physical therapists prescribe adaptive seating devices based on this theory.[2,3] The therapists' goal is that the child would be stabilized in sitting so they can engage in functional activities.[2] Function is a broad term that refers to everyday activities, such as self-care, play, and social/recreational activities.[2] The effects of posture on function has been an under researched area in general.[6] This review of literature evaluates a wide range of adaptive seating devices, as compared with standard seating, in the attempts to answer the question:
For children with developmental disabilities, is adaptive seating more effective than standard seating in improving function?

Research on the effects of adaptive seating result in studies evaluating not only function, but also posture. The sections that follow will evaluate adaptive seating as compared to standard seating and its effects on function and posture in children with disabilities, as well as its effects on typically developling children. This research will be compared and evaluated for common themes, similarities and differences on research design, outcome measures, and results.

Adaptive seatings effects on function:

Three articles evaluate function exclusively as the outcome of interest from adaptive seating interventions. These studies have uniform research designs, prospective quasi-experimental A1-B-A2 designs.[2,4,5] The inclusion criteria are also similar, with all studies

evaluating non-ambulatory children with cerebral palsy. These articles also use the same outcome measure, the Canadian Occupational Performance Measure (COPM), to measure activity performance.[2,4,5] Rigby et al. uses a home activity log in addition to the COPM[2]. The other Rigby et al. study uses the Caregiver Assistance Scale (CGA) from the Pediatric Evaluation of Disability Inventory (PEDI) in addition to the COPM, as this study is evaluating function in terms of the amount of caregiver asssistance.[5] The COPM has the child and family identify three to five functional activities the child is having difficulty with at baseline in order to measure progress following the adaptive seating intervention.[2,4,5] The results show common themes in the activities identified on the COPM, with Rigby et al. and Reid et al. reporting self-care and play/productivity as being the most difficult functional activities.[2,4,5] Rigby et al. and Reid et al. both show improvements in COPM scores for activity performance and satisfaction following the five to six week intervention[2,4] and the other Rigby et al. study shows improvements in function by children requiring decreased caregiver assistance.[5]

The first study by Rigby et al. evalutes activity performance and satisfaction following a six-week intervention with one and/or two adaptive seating devices, the Flip2Sit activity seat and the Aquanut toileting seat, for 30 children with CP, GMFM levels III or IV.[2] The family was encouraged to engage their child in the COPM indentified activities while child was seated in the ASD.[2] COPM scores increased by four for activity performance and five for satisfaction after the six week intervention with the ASDs as compared to standard seating scores prior to the intervention.[2]

The second study by Reid et al. evaluates activity performance and satisfaction for six children with CP over a five-week intervention period.[4] The intervention includes a rigid pelvic stabilizer mounted to the child's wheelchair rather than using traditional lap belt for pelvic stabilization.[4] COPM scores for activity performance and satisfaction improved two to six points for all children following the intervention with the rigid pelvic stabilizer as compared to with their scores at baseline with the traditional lap belt.[4]

The third study by Rigby et al. used the same sample population and intervention as the second study, however investigators used the CGA from the PEDI to evaluate function in terms of the amount of caregiver assistance.[5] Following the intervention caregiver assistance was reduced in 57% of the tasks for all children using the rigid pelvic stabilizer as compared to their baseline scores with the traditional lap belt.[5]

These studies used different adaptive seating interventions.[2,4,5] Rigby et al. used an activity seat that can be used for play on the floor or in a chair, the Flip2Sit, and a seat to be used for toileting, the Aquanut.[2] Reid et al. and Rigby et al. used a rigid pelvic stabilizer that was mounted to all the children's wheelchairs.[4,5] All of these studies showed improvement in function with the use of an ASD as compared with their prior level of function which included using standard seating[2] or an ASD with a traditional lap belt.[4,5] Rigby et al. was the only sample size that was justified with a power of 80% (alpha =0.05).[2] Reid et al. and Rigby et al. had no power analysis performed to define alpha or effect size and both had small sample sizes (n=6).[4,5] The COPM and CGA outcome measures are valid and reliable measures that previous research has found to be successful for measuring ASDs effectiveness in children with CP.[2,4,5] Bias could be present as all the outcome measures used were subjective and the therapists administering them knew the goals of the study.[2,4,5] These three studies address the research question and suggest that adaptive seating is more beneficial than standard seating for improving function in children with cerebral palsy.[2,4,5] Future research is needed to determine if adaptive seating is effective in children with other developmental disabilities.

Adaptive seatings effects on posture and function

Much of the research on the effects of adaptive seating focuses on posture and function together as outcomes of interest.[1,3,7,8,9,10] Many investigators believe that function is related to posture, therefore improvements in posture are necessary for there to be advances in function.[2,3,4,5,6,10] For example, if a child with CP cannot maintain an upright posture, they may assume a spastic posture that would limit their ability to use their upper extremities, therefore limiting functional activities that require use of their upper extremities.[5] A wide range of functional activities are evaluated in this review, including: respiratory funciton, upper limb function, activities of daily living, feeding, reach, grasp, and hand function. [1,3,7,8,9,10] The inclusion criteria for most studies were non-ambulatory children with CP,[3,7,8,9,10] however one study's inclusion criteria was non-ambulatory children with a progressive neuromuscular disorder (PND).[1] Five of these studies had prospective quasi-experimental research designs[1,3,7,8,9], and one study was a systematic review.[10] All of these studies had different adaptive seating interventions and diverse outcomes measures. [1,3,7,8,9,10]

A study by Clark et al. evaluated the effects of postural support within a wheelchair on posture, respiratory function, and upper limb function for 19 children with PNDs, including Duchenne's muscular dystrophy (DMD) and Friedreich's ataxia (FA).[1] This is the only study that evaluated children with disabilities other than CP with adaptive seating interventions.[1] Outcome measures were implemented at one time period in a standard wheelchair and an individualized wheelchair.[1] Posture was measured with a CODA motion analysis system, upper limb function was measured with the Jebsen test, and respiratory function was measured with a compact spirometer.[1] There were immediate improvements in posture with use of an individualized wheelchair, but not in respiratory or upper limb function.[1] The Jebsen test is an inappropriate outcome measure for measuring upper limb function in this population, as it only measures speed of the task.[1] A more appropriate measure of upper limb function for this population may be one that measures task completion and quality. Also, the results could have been contaminated by fatigue from taking measurements twice in one day or from drastically changing the child's position from one they were accustomed to being functional in.[1]

A study by Vekerdy et al. examined the effects of the thoracic-lumbar sarcal orthosis with non-rigid SIDO frame (TLSO-SIDO) for 47 children with CP on spine curvature, functional activities, posture, parental satisfaction, and feeding.[7] The only measurement that was taken at baseline and follow-up appointments were x-rays to evaluate spinal curvature. The baseline x-ray was taken in standard seating and at follow-up x-ray was taken in an ASD.[7] Questionnaires were mailed at various points in time (4 to 18 months) to measure function, posture, satisfaction, and feeding.[7] Following the TLSO-SIDO intervention 89% of children had a significant change in their spine's position in the TLSO-SIDO seat.[7] Parental reports on the questionnaires showed improvements with function, posture, satisfaction, and feeding.[7] A limitation of this study was use of mail questionnaires as the primary measurents for posture, function, satisfaction, and feeding.[7] There was only a 88% return rate of questionniares.[7] The results could be contaminated as most of the data collected was subjective and it was received over a wide time period (4 to 18 months) rather than at one point in time.[7]

A study by Hulme et al. evaluated the effectivenss of ASDs on 19 children with CP on sitting posture, head control, visual tracking, reach, and grasp.[3] The intervention consisted of an individualized seating system for wheelchairs to be used for nine months.[3] Half of the group was given the option to participate in additional exercise interventions.[3] An assessment instrument

was created by researchers that included seven observational items in order to evaluate the outcomes of interest.[3] There were significant improvements with sitting posture and head control, but no significant improvements with reach and visual tracking with use of an ASD.[3] A limitation of this study was that only half of the group was given the option to participate in exercise programs which could lead to contamination in the results.[3]

Myhr and von Wendt examined 23 children with CP to determine a functional sitting position (FSP) by evaluating six different positions.[8] Children would sit in each of the six positions for a total of five minutes in order to evaulate head control, trunk control, foot control, arm function, and hand function.[8] These outcomes were evaluated using the Sitting Assessment Scale (SAS) and using video/photography for observational purposes.[8] The position that showed improvements in all outcomes of interest was referred to as the FSP.[8] The FSP includes the seat tipped forward, a firm backrest supporting the pelvis, a table to support arms, and footrests that allow feet to move backwards.[8] Mhyr et al. used the FSP for 10 of the children from the Myhr and von Wendt study to evaluate posture and function after five years of using the FSP.[8,9] Myhr et al. used the same measurements as Myhr and von Wendt to measure head control, trunk control, foot control, arm function, and hand function.[8,9] After five years of using the FSP there were significant improvements in the head control, trunk control, foot control, arm function, hand functiong and the SAS score.[9] Limitations of both of these studies are the small sample sizes.[8,9] Myhr et al. results may be contaminated as over the five year period the chidlren could have participated in other interventions that could have contributed to the positive outcomes.[9]

Chung et al. performed a systematic review to evaulate the effects of an ASD on posture and if changes in posture lead to changes in function.[10] This review included 14 articles with the inclusion criteria of non-ambulatory children with CP, ages 0-20 years old.[10] Each of the 14 articles evaluated various forms of adaptive seating.[10] Chung et al. found that the majority of studies on ASD's effects on children with CP had weak to moderate methodological quality and a low level of evidence.[10] The authors concluded that no one adaptive seating intervention is better than another for improvement in posture/postural control.[10] They also found evidence to weakly support that improvements in posture lead to improvements in function.[10] This review was limited due to the lack of generalization across ASDs and outcome measures, and the reviewed articles low levels of evidence.[10]

In summary, Clark et al. and Hulme et al. showed improvements in posture alone,[1,3] whereas Vekerdy, Myhr and von Wendt, Myhr et al., and Chung et al. showed improvements in posture and function with the use of an ASD.[7,8,9,10] All of these studies have prospective quasi-experimental research designs, except Chung et al. being a systematic review. [1,3,7,8,9,10] Myhr et al. is a longitudinal study over the most extended period of time (five years).[9] Limitations of these studies are the small sample sizes, no power analysis' performed to determine effect size, no control groups, and potential bias from subjective outcome measures. [1,3,7,8,9] The data is difficult to compare as there were no consistent outcome measures or interventions used across studies. [1,3,7,8,9,10] Outcomes measures varied from use of x-ray[7], motion analysis system[1], Jebsen test[1], observational methods[3,8,9], and the SAS[8,9]. The only outcome measures that have research as being valid and reliable are the x-rays[7] and the Jebsen test[1], however the Jebsen test may not be an appropriate measure for the sample population.[1] Interventions included individualized ASDs[1,3], a TLSO-SIDO[7], and an ASD with a FSP[8,9]. The lack of generalizability of outcome measures and interventions make application to clinical practice more difficult.[10]

Adaptive seatings effects on typically developing children

There are two studies that evaluated that use of adaptive seating on function and posture in typically developing children.[6,11] Hopkins and Ronnqvist evaluated reaching and posture in ten six-month old infants with the use of a modified seat and standard seat.[6] A camera/video recording and reflective markers were used in order to create graphs, algorithms, and equations to determine the effects on posture and function with each seat at one visit.[6] Results showed improved head stability and reaching ability for a six-month old infant when using a modified chair as compared to a standard seat.[6] Smith-Zuzovsky and Exner compared object manipulation skills while children sat in an optimal position in individually fitted classroom furniture versus standard classroom furniture.[11] The optimal position includes the desk being positioned so the child can have their feet flat on the floor, knees at 90°, back on backrest, and desk height at approximately one inch above bent elbows.[11] Forty children ages six to seven were inlcuded, with one group (n=20) having their object manipulation skills tested in the individually fitted furniture and one group in the standard furniture (n=20).[11] This is the only study in this literature review that has a control group.[11] The Developmental Test of Visual Motor Integration (VMI) and the In-hand Manipulation Test (IMT) were used to measure object manipulation skills at one

time period.[11] The results were that children in the individually fitted furniture scored significantly higher on the object manipulation test (IMT) than children in the standard furniture, specifically on more difficult items.[11] Both of these studies have prospective quasi-experimental research designs. Limitations of these studies are that there were no long-term effects evaluated or power analysis' performed to determine effect sizes.[6,11] The study by Hopkins and Ronnqvist could have been strengthened with the use of standardized outcome measures for evaluating posture and function rather than using a video analysis system, however this system is valid as it has been commonly used in other reasearch to measure postural control.[6] There is potential for bias in the Smith-Zuzovsky and Exner study as examiners were not blinded.[11] Also, there is not sufficient validity for the outcome measures used in this study.[11] This research suggests that improvements in posture can contribute to advancements in function for typically developing children.[6,11] This research cannot be directly applied to children with disabilities, but it suggests that further research should be done on the relationship between posture and function in children with disabilities.

Limitations, Missing Knowledge, Future Research

A significant limitation to the reviewed studies on adaptive seating is the weakness in research design, as all studies reviewed had a quasi-experimental research design.[1-11] There are no randomized control trails (RCTs) published on adaptive seating for children with disabilities. This low level of evidence introduces an increased probability for biased results across studies, as samples are not randomized, examiners are not blinded, and many studies methodologies have the potential for contamination. Another limitation among the reviewed literature is that only one study had performed a power analysis to determine the effect size.[2] Across the studies reviewed on adaptive seating a limitation is the lack of standardation in terminology, types of adaptive seating, and outcome measures. Performing searches for research on adaptive seating is convoluted as different terms for adaptive seating include, but are not limited to, individualized seating[10], modfied seating[6], use of specific terms for the seating (TLSO-SIDO)[7], and optimal position[8,9]. Common terms seen for posture in the literature are postural control[6], head control[3,8,9], and trunk control[8,9]. Terms for function could be activity performance[2,4,5], activities of daily living, participation, or specifying functional activities (reaching, grasping, object manipulation, upper limb function, respiratory function).[1-11] This variety of terminology makes

research difficult to find and compare. It is also challenging to standardize studies on adaptive seating as there are so many types of ASDs and variables that can be considered, such as lateral pads, back inclination angle, foot rests, pelvic support, etc. Also, the variety of outcome measures used across studies makes results from studies on adaptive seating arduous to compare.

There are gaps in knowledge on the effects of ASDs in children with disabilities other than CP, the most optimal ASD, and how posture influences function. All the studies in this literature review, but one[1], were focused on Cerebral palsy.[2-10] Therefore, the results from these studies cannot be translated to children with other disabilities. There is also missing knowledge on what is the optimal ASD for improving posture and function, as this review evaluated a variety of ASDs versus standard seating rather than comparing the ASDs to each other. This would make it difficult for a clinician to synthesize the research to determine the most effective ASD for their patient. Finally, investigators have developed a theory that improved posture leads to improvements in function[2,3,4,5,6,10], but there is a lack of research in this area.[6,10] The systematic review by Chung et al. attempted to address posture's effects on function, however only had weak levels of evidence to support the theory.[10]

Further research is needed to address these limitations and gaps in knowledge. Further research should focus on higher levels of evidence, but I would be hesitant to recommend RCTs, as it may be unethical to have a control group that withholds the intervention, as research suggests that adaptive seating has benefits for posture, function, satisfaction, and preventing secondary deformity.[1-11] Studies with higher levels of evidence on ASDs should include larger sample sizes, power analyses' and implement controls for bias, such as applying randomization or blinding investigators. Terminology and outcome measures also need to be standardized for adaptive seating, posture, and function so research can be compared and synthesized more easily. Future research could study the effects of ASDs on children with disabilities other than CP, so research could be more widely applicable to other populations. Research could also be expanded to further study the effects of posture on function.

Clinical practice/capstone project

The reviewed literature suggests that adaptive seating is more beneficial than standard seating for improving function in children with disabilities.[1-5,7-10] The majority of the current literature has a low level of evidence making it difficult to generalize for populations other than

CP. The reviewed literature also uses a wide variety of ASD recommendations and outcome measures making it challenging to integrate research into clinical practice. However, prescriptions for adaptive seating for children with disabilities is common clinical practice for the improvement of posture and function.[3,4] The insufficient evidence calls to question what clinicians have been basing their adaptive seating decisions on. Further research needs to be completed with the suggestions previously mentioned on the question, "For children with developemental disabilities, is adaptive seating more effective than standard seating in improving function?" There is a great need for further research in this area so clinicians can shift their basis for adaptive seating recommendations from clinical opinion to evidence-based practice.

Though the current evidence on adaptive seating is weak, it creates a basis for a capstone project that will entail the development of an education curriculum for families of wheelchair users in developing countries. This curriculum will incorporate the basics of wheelchair maintenance and use, as well as the benefits of using adaptive seating in their child's wheelchair. This curriculum is being developed in the English language for a non-profit organization in Turkey called "Friends of Kardelen" with the intent of being able to be translated into different languages. Friends of Kardelen supports and cares for children with disabilities and their families. The hope of this project is that it will increase knowledge and decrease anxieties with wheelchair use for families with non-ambulatory children with disabilities.

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