MOTOR INTERVENTIONS FOR CHILDREN AND ADOLESCENTS WITH DEVELOPMENTAL DISABILITIES
A NARRATIVE REVIEW

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OBJECTIVE

To conduct a literature review investigating methods and outcome measures for motor skill programs in children and adolescents living with developmental disabilities. A focus on gymnastics-based programs, particularly the “Empowering Steps Movement Therapy” is used.

INTRODUCTION

Developmental disabilities with associated motor skill impairment are prevalent and increasing in childhood and adolescence. Improvements in motor skills have broad implications for health related quality of life for individuals and for their families.

Often, motor skill difficulties occur with multiple other problems, both health-related and also associated with the environmental context in which they occur. Behavioral issues, including low self-esteem are common. Environmental factors like family illness, financial pressures, inadequate school supports and inability to engage in community based recreation and sporting activities may be present. These barriers are interwoven with physical impairments to produce the picture of a complex developmental disability.

The identification of efficient, effective motor skills programs and assessment tools with evidence-based research has broad implications for health and wellness policies and for health care costs.
A gymnastics–based motor skills program which is part of a community based rehabilitation model is described and compared with other motor therapies. Preliminary evidence for positive outcomes and recommendations for future research are discussed.

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BACKGROUND

The definition of a developmental disability has been controversial and much debated. Currently, the concept has evolved and is now understood as an umbrella term for restrictions in activity and participation associated with a chronic health condition beginning during the developmental years up to age 18 (or 22 in some countries)(1).

The health condition may begin before birth with a congenital malformation of the brain or a genetic disorder like Down syndrome. It may be manifested or acquired after birth as with autism spectrum disorders or following a traumatic brain injury.

Restrictions in activity and participation often continue throughout life, reducing health related quality of life.

The degree of restriction is dynamically affected by an intimate interaction between manifestations of the health problem such as motor skill impairment and many aspects of the child’s or adolescent’s environment. Optimal environmental factors like the provision of a coordinated health and wellness care plan, strong family and community advocacy for inclusion, all reduce disability. Adverse environmental factors like poverty, parental illness, prejudice and gaps in needed treatments or social supports increase the burden of disability and the treatment cost of secondary complications.

A developmental disability with gross motor impairment implies a degree of functional limitation due to impairment involving the large muscles controlling the trunk, neck or limbs. This may be mild to severe but, by definition, causes restrictions in action, activity and/or mobility. Other motor impairments impacting hand manipulation, communication, eating and eye movements may coexist.
Motor impairment contributes to inactivity. Youth with autism spectrum disorders are significantly less active than peers. Early life physical activity may be the foundation for an active lifestyle, and physical activity level correlates with better health. Obesity is more common in children and adolescents with disabilities. Secondary problems may predispose individuals to increased long-term risk of diabetes, mental health disorders, cardiovascular disease, osteoporosis, joint problems and premature death. Individuals with developmental disabilities collectively show lower educational and vocational attainment and a higher prevalence of poverty than those without disabilities.

Developmental disabilities are common. Estimates of prevalence have been complicated by differences in definition and survey methods but recent estimates by the World Health Organization suggest that 106 million children under 14 years, worldwide, live with a disability. In the United States between 2006 and 2008, an estimated 15% of children between ages 3 and 17 years lived with a developmental disability. This represents 10 million children and adolescents.

The prevalence of disability is increasing both during developmental years and in adults. The largest cause of the latter is an aging population in all societies. Increasing prevalence in childhood and adolescence is due largely to a dramatic increase in the diagnosis of autism spectrum disorders and attention deficit hyperactivity disorder in developed countries. Both these health problems frequently have associated motor skill impairment. Improvements in survival of extremely premature infants, in medical and surgical care of previously fatal childhood diseases and birth defects also contribute. Between 2006 and 2008, the increase in prevalence for developmental disability in the United States amounted to 1.8 million young people.

Optimal management of health problems and equal opportunity for education, recreation and sport is a human rights issue defined by two United Nations international conventions on the rights of disabled persons and on the rights of the child. Other international agreements have defined applicable benchmarks and goals for the identification, prevention, management and destigmatization of disabled persons.

Large challenges face those with developmental disabilities, those who seek to provide efficient and effective management strategies and those who bear responsibility for the economic implications of lifelong interventions.

Motor disorders are associated with many congenital and acquired chronic disorders of childhood. In developed societies, autism spectrum disorders, cerebral palsy, intellectual disability, attention deficit hyperactivity disorder, developmental coordination disorder, spina bifida and genetic abnormalities are most common.

Autism spectrum disorders (ASD) are a group of brain disorders of unknown cause with onset in early childhood. Affected children share problems with social interaction and communication skills. Intellectual disability is often present. The understanding and expression of emotions is disordered. Repetitive, stereotyped behaviours, interests and
activities occur. Abnormal perceptions of sensations associated with vision, hearing and touch may also be present. Joint position sense (proprioception) and vestibular senses may be abnormal. Recent studies describe a variety of motor abnormalities which show correlation with brain function and structure with new imaging technologies. Poor upper limb coordination during visuomotor and manual dexterity tasks and poor lower-limb coordination during tasks requiring balance, agility, and speed have been demonstrated. Appropriate motor skills are important components of communication and socialization. The prevalence of autism spectrum disorders has increased dramatically in the last 10 years to 1 per 110 children in North America (9).

Cerebral palsy is defined as a non-progressive abnormality of brain function with onset before or during birth. It results in a broad spectrum of developmental abnormalities most commonly characterized by various types of motor impairment. Spasticity or increased muscle tone is often but not always present. Many other developmental abnormalities may exist concurrently such as problems with feeding, self-care, growth, communication and chronic pain. Affected children and adolescents often require coordinated home and community-based care encompassing multiple interventions. Motor therapy is crucial. The prevalence of cerebral palsy has doubled in the last 40 years to around 2 per 1000 live births. This is largely due to the survival of low birth weight premature infants who have a significantly higher incidence of cerebral palsy (10).

Attention deficit hyperactivity disorder (ADHD) is a neurobehavioural abnormality characterized by a combination of inattention, distractibility, impulsivity and hyperactivity with onset before seven years of age. The cause is unknown but is thought to be an interaction between genes and unknown environmental factors. The prevalence in childhood and adolescence is approximately 6% and increasing. Motor impairments are frequently identified using standardized tests. These impairments cause problems with self-esteem, peer relationships and handwriting. They may disrupt involvement in recreational and sporting activities (11).

Developmental co-ordination disorder (DCD) is a motor skill disorder that is often first noticed in school-aged children. The cause is unknown. Affected children are unable to perform age-appropriate motor coordination tasks. This motor deficiency causes significant restriction in the ability to participate in sports and recreational activities. Difficulties in handwriting and other manipulative tasks affect the child’s ability to learn. This disorder frequently, but not invariably occurs with attention deficit hyperactivity disorder. Speech and language impairments are more often present than in children without DCD. Normal intellectual ability is usually present, or if intellectual disability exists, motor functions are lower than predicted by the degree of intellectual impairment. DCD is a common childhood disorder. The prevalence is between 3% and 6%. About half the children have impairment in one skill area while the rest have generalized difficulty (12).

Spina bifida refers to a range of abnormalities occurring with development of the spinal cord during fetal life. The majority of these children have a form of spina bifida (myelomeningocele) which results in degrees of paralysis in the lower limbs. These impairments may include muscle weakness, paralysis, loss of lower limb sensation,
abnormal bladder or bowel function and learning disabilities. It occurs in approximately 0.5 to 1.0 per 1000 pregnancies. Children require coordinated, multi-professional care, much of it in the home and community. Motor therapy is required\textsuperscript{(13)}.

Traumatic brain injury is the most frequent cause of acquired disability in childhood and adolescence, especially from ages 0 to 4 years and 15 to 19 years. Approximately 50,000 children and youth are hospitalized annually with traumatic brain injury in the United States. The severity of motor impairments relate to the duration of unconsciousness. Multiple functional deficits may result requiring individualized long-term care plans involving community-based services and professionals. Motor problems frequently are associated\textsuperscript{(14-15)}.

Intellectual disability affects 1 to 3\% of the world’s population. Institutionalized care has largely been replaced by community based care in developed countries. Research regarding effective community interventions for the physical challenges associated with intellectual disability rehabilitation is poorly addressed by scientific research. Motor delays and motor impairment are often present\textsuperscript{(16)}.

All these chronic health disorders have motor skill impairment as a contributor to developmental disability. All require evidence based, motor skill intervention.

**The Empowering Steps Movement Therapy Program (ESMT)**

The ESMT program is a community-based, family centred, motor skills program envisioned as one component of a comprehensive, community-based rehabilitation plan. It provides individualized therapy for children and adolescents with developmental disabilities and motor impairment. ESMT has been assessed and recognized by the federal government of Canada as eligible for benefits associated with the Scientific Research and Educational Development (SR&ED) program since 2007.

The program has evolved over nine years. Formal outcome assessments have been developed in the last year. Children and adolescents involved in the program have a broad spectrum of medical diagnoses with mild to severe motor impairments. Autism spectrum disorder is the most prevalent diagnosis.

The program is situated in a large gymnastics facility where participants share an inclusive environment with recreational and competitive gymnasts. Participants are formally assessed upon entry to allow for a baseline skill measurement and an individualized curriculum is then designed incorporating safety considerations. Assessments are repeated every 5 months using the ESMT scale and recently the ESMT parent perception questionnaire. Sessions are 30-60 minutes with a frequency of once or twice per week. More intensive therapy is encouraged during on site summer camps (20 hours per week over 5 days). The program's goals are to improve fundamental and complex motor skills, physical fitness, endurance and self-concept through procedures
reflecting the best available scientific evidence. Ongoing research is an integral part of both
the program and coach/therapist training.

Motor competency requires the integration of multiple neurological processes. Children
and youth with motor problems frequently show deficits or problems with integration of
these processes.
In association with motor skill training, ESMT incorporates techniques to address
abnormalities in age appropriate motivation, attention control, mood, behavior,
communication, memory, social skills and sensory modalities (hearing, touch sensation,
pain sensitivity, joint position sense and vestibular function). Improvements in motor skills
are also related to improvement in environmental factors like parental anxiety about injury
or financial costs and to the generalization of improved skills to functional activities at
home, at school and during community recreational and sporting activities. Liaison with
community members forms part of the environmental component of therapy.

The program encourages information exchange between ESMT coach/therapists, family
members, community-based healthcare professionals, teachers and coaches. Site based
networking of all care team members with families is encouraged.

Equipment used during the ESMT program is predominantly standard gymnastics
equipment with additions such as balls and racquets to allow complete fundamental motor
skill training. Adapted bicycles, aquatic equipment and alternative communication systems
are used. (See appendix 1)

Coach/therapist training

ESMT is a unique program adapted from the techniques of systematic learning of complex
movement skills used by developing gymnasts. The program is primarily gymnasium-based
but can be adapted to aquatics in special situations. It employs certified coach/ therapists
from a variety of relevant backgrounds such as occupational therapy, physiotherapy,
kinesiology and recreational therapy. Therapists are encouraged to complete national
gymnastics coaching certification programs in addition to undergraduate or master's
degrees in their foundation disciplines. ESMT apprentice certification involves completion
of a structured training curriculum encompassing 35 hours of volunteer preceptorship and
an 80 hour, minimum 6 month apprenticeship period under the supervision of a certified
coach/therapist. Completion of theoretical and practical examinations is required. Two
advanced levels of certification may be achieved. Volunteer preceptorship hours are
eligible for academic credits at faculties of two local universities.

Outcome Measures

1. The Empowering Steps Movement Therapy Scale

The ESMT scale measures the results of neuromuscular facilitation with progression from
basic movement patterns like crawling or walking through fundamental movement skills to
more complex motor patterns including motor sequences and locomotor activities like
skipping, galloping, hopping on one foot and combining serial tasks into a complex task. Bicycle riding skills are included. Implements such as racquets, balls and other hand held objects are used to practice striking and to develop visuomotor skills associated with eye-hand and eye-foot coordination.

Motor abilities of increasing complexity are measured in seven progressive stages. Skills can be mapped to the Developmental Code Sets of the International Classification of Disability, Functioning and Health-Child and Youth Version (ICF-CY). Stage 0 pertains to children who are unable to walk due to severe motor impairment. Stage 6 is the most advanced level beyond which older children are able to integrate into recreational gymnastics programs, eventually without special supervision. Children younger than 6 years may successfully integrate after level 4 or 5 when skill level matches the developmental expectations for this age. Children progress through stages by achieving increasingly complex goals.

2. The Empowering Steps Movement Therapy Parent Perception Questionnaire

The ESMT parent perception questionnaire has been recently developed to assess the transfer of measured motor skill changes to functional abilities in daily life. It also assesses non-motor changes in the child and family. Questions identify changes in ability to manage activities of daily living, activity level, recreational inclusiveness, sleep pattern, behaviour, mood, self-esteem and quality of life. Parental stress, anxiety, fears about child injury, financial or travel constraints to therapy and sibling well being are assessed. A school teacher perception questionnaire is currently under development.

The ESMT program shares a pervasive culture of enthusiasm, positivity and encouragement. This is seen as an integral component of therapy and is included in therapist selection and training. Skill progression at all levels is celebrated. Children are rewarded for goal attainment by participating in periodic group skill demonstrations attended by parents, friends and staff. An award ceremony, modeled on typical competition structure occurs where every child is a winner. Achievements are publicly celebrated and described by their coach/therapist. Certificates of achievement and trophies are awarded. These demonstrations are an integral part of the program designed to build self-esteem, confidence and resiliency in children and parents.

METHOD

1. Literature review

A literature review was conducted to investigate gross motor skill programs and therapies intended to improve motor function or to promote activity and physical fitness in children and adolescents with developmental disabilities and motor impairment. The programs and therapies available were explored and found to range from general application to those used for specific disorders. Evidence for valid and reliable evaluation measures of motor function and health related quality of life, particularly outcome measures following
intervention, were explored. A search for articles describing evaluation of comprehensive
disability management including Community-Based Rehabilitation (CBR) was included.

Two researchers completed independent electronic literature searches of multiple
databases related to subject areas in medicine, allied healthcare, sport, education and the
social sciences (Pubmed, CINAHL, Embase, Cochrane Database of Systematic Reviews,
SPORTdiscus, ERIC, PsycInfo and Google Scholar). Relevant abstracts were identified by
discussion and full text articles obtained and reviewed where possible. Internet search
engines were used to identify motor programs and outcome measures that were not found
in research literature. Further relevant information was obtained through personal
communication with international experts in gymnastics, adapted gymnastics, sports
medicine and Special Olympics preparation and participation.

2. Empowering Steps Movement Therapy Program Evaluation

A cohort of 31 children and adolescents aged 2-17 years with a variety of developmental
disabilities, and a minimum of six months participation in the (ESMT) program were
assessed with the ESMT scale on two occasions, six months apart to assess change in gross
motor skills. The ESMT parent perception questionnaire was completed at six months to
assess parent perceptions about their children’s changes in motor skills and other domains
of functioning at home, school and during community based activities.

The cohort included the following primary medical diagnoses:
autism spectrum disorder, cerebral palsy, attention deficit hyperactivity disorder,
developmental delay (cause unknown), developmental coordination disorder, bipolar
disorder, seizure disorder, Sotos syndrome. Down syndrome.

RESULTS

1. Literature review

Motor skill interventions for children with developmental disabilities and gross motor
impairments are numerous, encompass a variety of techniques and are provided by many
different professionals in settings like healthcare, sport and education.

Therapy may be conducted individually or in groups. Frequency and duration of therapy
varies widely. The intended outcomes of motor programs or motor therapy are the
improvement of skill deficits or the maintenance and improvement of physical fitness or
both. Motor therapy has traditionally been conducted in clinical settings such as hospitals,
clinics or private offices with a schedule of short visits over blocks of time. Some studies
report a proportional relationship between the intensity of intervention and the degree of
improvement in specific situations. Others report benefits with the development of motor
skill programs that are incorporated into daily life in the home, at school or as part of
community activities. The transfer of coordinated management plans implemented in
hospitals to home communities is frequently described as challenging due to fragmentation of community services and poor collaboration between members of a community management team. Community Based Rehabilitation (CBR) is often cited as a potential solution but requires more research \(^{(17,18)}\).

The improved diagnosis of disorders like developmental coordination disorder and the recognition of significant motor impairment in highly prevalent conditions like autism spectrum disorders and attention deficit hyperactivity disorder are the subject of a body of current research \(^{(19)}\).

Recent conceptualization of disability as a dynamic interaction between a health condition and an individual’s environment has resulted in an increased focus on modifying environmental factors as an important additional strategy for improving function.

Different and sometimes incompatible theories of motor function have formed the basis for intervention strategies for different professions such as occupational therapy, physiotherapy and medical rehabilitation \(^{(20)}\). Sport derived interventions are usually adapted techniques to facilitate participation and improve physical conditioning. Education derived studies include adaptive activity designed to facilitate participation in physical education programs and school based play.

Research studies were often focused on a group of children with a specific medical diagnosis and motor impairment. Many children have multiple, co-existing impairments due to medical, social, emotional and other environmental factors. These interact to influence motor and other functional outcomes. Deficits in motor function also produce secondary health problems. All these factors contribute to disability and complicate research study design.

Systematic reviews of studies evaluating the effectiveness of motor skill programs for children and adolescents describe difficulties in comparison due to inconsistencies in the classification of motor impairment, problems with methodology, a paucity of valid assessment tools for measuring “real life” outcomes and low quality of evidence for therapy effectiveness. Treatment is not easily measured. Individualized therapy programs vary in many parameters and incorporate subjective as well as objective elements. Clear documentation of efficacy related to all variable parameters of therapy and other individual and environmental factors, continues to be elusive. This problem may in part reflect difficult methodological issues including the measurement of treatment-related change on a background of developmental maturation, the establishment of appropriate outcome criteria, heterogeneity of the populations involved, and the complex nature of the interventions.\(^{(18-19)}\)

Recommendations advise the adoption of currently accepted guidelines for research design, however others feel that current best methodology recommendations may not be suitable for the complexity of developmental rehabilitation research and that new research design may be needed \(^{(20)}\). A lower level of evidence quality based on international
standards may be more applicable when current methodology is used. Multiple outcome measures may be required to adequately validate functional outcomes of interventions.\textsuperscript{[21]}

Classification consistency for motor and other impairment may be improved by using the World Health Organization’s International Classification of Functioning, Disability and Health - Child and Youth Version (ICF-CY). This system has been accepted by 143 countries. Uniformity in classification has valuable implications for management, research and policy development \textsuperscript{[22,23]}.

Brain research incorporating major technological advances in imaging technology have allowed a rapid accumulation of new knowledge about the flexibility of the healthy and injured brain to structurally change in response to normal developmental experiences, therapeutic interventions and manipulation of the environment in a range of functional domains. These changes are often referred to as neuroplasticity. Evidence of nerve cell growth and formation of new nerve cell connections occur. This may be influenced by motor experience including motor therapies. Damaged brain and spinal cord regions may show evidence of repair. Brain areas thought previously to be confined to specific functions may adapt to compensate for injured adjacent regions with different functions. Underused areas of the brain may show reductions in nerve connections while activities to promote the use of particular brain regions show evidence of nerve cell growth increased connectivity and measurable increases in anatomical size \textsuperscript{[24,25,26]}.

Early childhood is shown to be a time of extensive remodeling of the brain. The fact that this occurs in both children and adults is now commonly accepted. Evidence suggests that automatic remodeling of brain architecture occurs throughout life in response to a variety of influences not just as in response to neurological injury. The evolving knowledgebase surrounding neuroplasticity has significant implications for the type, timing, frequency, intensity and evaluation of motor deficit interventions \textsuperscript{[24,25,26]}.

Some areas of research show results which meet standards for quality, evidence-based recommendations. Early age intervention for developmental delays in children born with extreme prematurity improves cognitive outcomes at school entry. Benefits for motor delays still await more research evidence. Physical exercise programs in young children may reduce complications related to bone weakness (osteopenia) of prematurity \textsuperscript{[27]}. The use of constraint-induced movement therapy in children with asymmetrical upper limb paralysis and cerebral palsy or brain injury shows significant benefit in recent studies \textsuperscript{[28]}. An outcome measure for assessing motor therapies in children with cerebral palsy and Down syndrome, the Gross Motor Function Measure (GMFM) is a valid measure of improvements in gross motor skills due to therapy or development and is used to predict future functional ability using repeated assessments over time when used with the Gross Motor Function Classification Scale (GMFCS) \textsuperscript{[29,30]}.

Early diagnosis and intensive behavioural intervention is strongly endorsed by many professionals and parents of children with autism spectrum disorders, however many questions remain unanswered by research including optimal therapies for motor impairments in these children \textsuperscript{[31]}. 
Research revealed a number of validated measures for evaluation of motor function for different age groups. The most widely used validated tools are: the Bruininks Oseretsky Test of Motor Proficiency - Second Edition (BOT2-2005), a measure of fine and gross motor skills of children and youth, 4 to 21 years of age, the Movement Assessment Battery for Children (MABC-II), an individually administered test that takes between 20 and 40 minutes to complete and can be used within the age range of 3 years through 16 years and the Peabody Developmental Motor Scales, Second Edition (PDMS-2), designed to evaluate gross and fine motor skills in young children from birth through age 5.

A paucity of reliable validated outcome measures for this population is evident, particularly tools that measure all variables that contribute to motor disability, especially environmental variables.

2. Results of evaluation of the ESMT program students.

ESMT Scale results

Scores on the ESMT scale show that 100% of participants assessed showed improvement on raw scores reflecting improvements in complex motor skills over the 6 month period of study. An average increase of 16.25 points occurred (The Scale is scored from 0-120 across 6 stages). 7 children were excluded due to incomplete assessments. Children with autism spectrum disorders showed the largest improvement in ESMT scale scores (See figure 1)

![figure 1](image1.png)

*figure 1. ESMT Scale raw score improvement for (i) all students (ii) students with autism spectrum disorders*
ESMT Parent Perception Questionnaire results

24 of a possible 31 ESMT parent perception questionnaires were completed. Results show that:

100% of parents believe their child’s overall progress in the program demonstrated some or marked improvement.

100% of parents reported some or marked improvement in non-motor domains such as child anxiety or self-esteem,

100% of parents reported some or marked improvement in the child’s functioning at home, at school and in the community.

80% of parents reported some or marked improvement in questions relating to parent and family functioning.

DISCUSSION

Motor skill programs or therapies are widely used by a variety of professionals to manage children and youth with developmental disabilities. Motor therapies usually aim to improve functional impairments caused by abnormal posture or gait, spasticity, muscle weakness, problems with coordination, motor planning and sequencing, body position sense and other sensory abnormalities. Other motor programs are designed to improve activity and physical fitness and endurance. Community based fitness programs for children and youth with disabilities have been successfully implemented (32). Healthcare professionals including rehabilitation specialists, orthopedic surgeons, physiotherapists and occupational therapists have traditionally provided interventions. More recently, research by recreational therapists, physical education teachers and sport coaches have engaged these children in programs termed "adaptive physical activity" and "adaptive sports". The international Special Olympics movement organizes training and athletic competition in a variety of Olympic-type sports for children and adults with intellectual disabilities, many of whom have motor skill impairments.

The sport of gymnastics has contributed to the development of adaptive programs for individuals with developmental disabilities. Gymnastics is considered by many to be a foundational sport for human movement development. Gymnastics teaches Fundamental Movement Skills (FMS) and research evidence suggests that FMS competency is related to later healthy levels of activity. Early life physical activity may be the foundation for an active lifestyle.
Research evidence is strong for beneficial effects of physical activity on muscle and bone health, heart and blood vessel health, obesity in overweight youth, and blood pressure in adolescents and it is supportive for positive effects on self-esteem, anxiety, depression symptoms, and academic performance \(^{(34)}\).

Any therapy, rehabilitation, intervention or activity program that results in movements of limbs in meaningful, volitional ways to accomplish activity goals has traditionally focused on a medical model of disability with therapies that are specifically directed at improving the functions of muscles, associated skeletal structures and the motor and sensory nerves which innervate them. This model is changing and continues to evolve. A holistic understanding recognizes that the performance of any action not only involves muscles, bones, joints and local neural structures but the integration of a host of higher neurological functions including almost all sensory input, combined with the broad contextual environment in which this occurs. This describes the biopsychosocial model in the disability literature.

The biopsychosocial model applied to motor disability in a child or adolescent recognizes the contribution of many factors beyond "body states" due to a health condition, which may collectively inhibit developmentally appropriate motor skill acquisition. For example, a child living with spastic diplegia, a form of cerebral palsy, might have a combination of stiff, hypertonic lower limb muscles, a dislocated hip, weakened bone structure due to osteoporosis and spinal deformity, secondary to abnormal postural configuration associated with prolonged wheelchair use. The medical model of disability associated with this child would traditionally address these body state issues with a combination of perhaps bracing, casting, surgery and injections of a tone reducing agent [botulinum toxin]. Traditionally a medical specialist professional would prescribe these interventions.

Physical and occupational therapists would likely be involved in an attempt to maintain joint range of motion, improve or maintain weaker muscle groups, improve seating posture, and practice maintenance of ambulation if possible. Training in the use of assistive devices like wheelchairs and a walking frame might be required. The biopsychosocial model of disability associated with this child recognizes the need for the above interventions but also the limitations and inadequacies of regarding this child solely as a series of medical or surgical problems.

This broader model of disability and habilitation would require intervention planning in the context of all things affecting her life. Aspects of family functioning might provide opportunities for, or barriers to functional improvement. Poverty, parental physical or mental illness, a single parent’s challenges finding time to work, parent, attend medical appointments and purchase assistive aids would require assessment. Individual child resiliency issues would need identification and promotion. The quality of friendships and relationships with extended family would be regarded as important therapeutic issues. School and community-based educational, social, sporting
and recreational opportunities would be assessed and optimized through a philosophy of inclusion through education and adaptation.

The child and family’s personal preferences, goals and opinions about intervention options would be sought and considered crucial. The child’s health-related quality of life in the context of family, school and community would comprise an important outcome measure of any intervention plan. Realistic, individual goal attainment would be an ongoing priority rather than intervention outcomes measured against "normal" children.

Excellent communication and collaboration between child, parent/s, school teachers, special-education aides, care workers, health care professionals, recreation supervisors, sport coaches and social assistance agencies would require a predominantly community based rehabilitation setting with a central meeting place where networking of stakeholders could occur.

Successful and cost-effective intervention planning would require ongoing community based research to allow evidence-based strategies rather than populist or profit driven approaches. Lack of evidence-based research however, would not limit novel ideas and new approach options when strong anecdotal impressions of value were present in the opinion of the therapeutic team when potentially harmful practices are excluded.

The establishment and maintenance of a predominantly community-based, closely collaborating therapeutic team would be seen as central to the child’s habilitation strategy (35,36,37).

The ESMT program is one component of a Community Based Rehabilitation (CBR) strategy. It encourages a collaborative team management approach promoting inclusive, whole child development. Intervention considers the child in the context of family, peer group, school and community functioning. Improvements in health related quality of life for child and family are core determinants. The ESMT philosophy includes motor therapy, social skill and behavioural management, child and parent education, healthcare team networking, school and community outreach. Staff model this philosophy in each session making this a key training requirement for all therapists/coaches. The program actively promotes ongoing evaluation of interventions by developing outcome measures like the ESMT scale and the ESMT parent perception questionnaire.

Outcome measures in this project suggest significant global improvements among program participants and their families.

LIMITATIONS OF THIS STUDY

Potential bias exists in the weight given to chosen articles in a narrative review. A systematic review would reduce this potential but provide other disadvantages. The ESMT scale and ESMT parent perception questionnaire are not yet validated as research tools. Comparison of the results of the ESMT program with other motor skill therapies is
required. We were unable to control for normal developmental progress and other variables. A control group should be used in future studies.

CONCLUSION

Contemporary evidence from brain research considered in the context of internationally established rights for disabled children together define the management and moral responsibilities for health and wellness providers and for policy makers.

Children whose brain development reflects early, effective intervention in a supportive environment of family and community will mature to contribute their best thought and action to a generation. Fragmented services for disability in childhood breed greater disability burden and societal financial burden in adulthood.

Motor skill interventions appear effective for motor skills but evidence for efficacy in real world functioning requires more research evidence. Research methodology should follow current guidelines where possible and explore innovative approaches when necessary. Accurate classification of functional disability using international standards is important. Children grow and develop in communities where all necessary components of a comprehensive health and wellness plan are best coordinated and where outcomes research will be most fruitful.

We describe optimistic preliminary results in the evolution of a community-based intervention and rehabilitation research model with promising initial results, an obligation for further research and potential for adoption by other communities.

DIRECTIONS FOR FUTURE RESEARCH

The positive global improvements measured in this study require replication. Validation of the ESMT Scale and Parent perception questionnaire is required using currently accepted methods. The ESMT program requires further development and evaluation as part of a community based rehabilitation model for child and youth disability. Comprehensive outcome measures will be used to evaluate results of the parent perception questionnaire. Further analysis of subgroups based on diagnosis, age, degree of disability and other variables is required.
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Appendix 1.

ESMT Equipment List

ESMT gym therapy

The gym portion of the ESMT program requires access to a gymnastics facility with the following equipment. Please note that the equipment outlined is accessible for purchase through most gymnastics equipment or special education suppliers. The major suppliers of Gymnastics Equipment in North America are American Athletic Inc (AAI), Spieth Anderson, and Gymnova, all of which can supply the standardized equipment. Equipment with an * has been made specifically for this program.

Floor
- Sprung floor exercise area (40 ft. x 40 ft. / 12.19 m x 12.19m)

Bars:
- A Single bar(s) than can be adjusted to various heights. We use both the wooden rail (Women’s artistic gymnastic) and the metal rail (Men’s artistic gymnastic).
- Low parallel wooden bars (7 ft (2.1m) long, 17 inches (43.2cm) apart, 18 inches (45.7 cm) tall.

Beam
- 3 regulation beams (4 in / 10.16 cm wide) with height adjustment
- 1 low beam (8 inches / 20cm above the floor; 4 inches / 10.1 cm wide)
- Four 6 inch (15.2cm) beam expanders, 2 of which are reinforced for incline and 12 inch beam activities.
- Three 7 inch (17.8cm) wide foam beams

Airtrack:
- 30 foot airtrack
- 7.5 ft (2.29m) tall mountain attachment with dowel ladder* and knotted climbing rope apparatus

Tumbletrak:
- 30 ft (9.14m) long in-ground tumble trak
Appendix 1 (continued)

Pit:
- Large 5 ft. (1.52m) in-ground foam pit with 6 inch foam cubes

Small Apparatus:
- Multiple trapezoid boxes (4 sections): each 12 inches (30.5 cm) tall at varying widths - high density polyurethane foam covered in vinyl
  - Mushroom/Foam dome: 16 inches (40.6cm) tall, 54 inch (137.2cm) diameter – high density polyurethane foam covered in vinyl
- Pac Man/handspring trainer; available in 32 inch (975.4cm), 36 inch (1.1 m), 40 inch (1.22 m), 44 inch (1.34 m) diameter - high density polyurethane foam covered in vinyl
  - 10 inch Blocks (25 cm)
- Rollers of all sizes: 1 ft (30.5 cm), 1.5 ft (45.7 cm), 2 ft (61 cm) diameter round rollers; 20 inch (50.8 cm), 30 inch (76.2 cm), 40 inch (101.6 cm) diameter Octagon shaped rollers - high density polyurethane foam covered in vinyl.
  - 20 ft (6.1 m), 1.5 inch (3.81 cm) diameter climbing rope
  - 20 foot (96.1m) knotted climbing rope *
  - 8 ft tall Wall bar ladder, rungs 6 inches (15.2 cm) apart.
  - Beatboard
  - 4 ft x 4ft ( 1.22 m x 1.22m) Mini trampoline
  - 10 ft (3 m) Climbing ladder – rungs 1 ft (30.5 cm) apart.
  - Slide *

Mats
- Smartie mats 2 ft x 8 ft (6m x 2.4m)
- Multiple incline mats: 36 inches x 72 inches x 16 inches (91.4cm x 182.9cm x 40.6cm) – high density polyurethane foam covered in vinyl
- Soft Spot mats: 4 ft x 6 ft x 2" thick (1.22m x 1.83m x 5.1cm) soft rebound foam covered in vinyl and mesh.
- Throw mats for trampoline: 4.5 ft x 8 ft x 4 inches (1.37m x 2.44m x 10.2cm)- lighter density foam covered in vinyl or fabric.
- 20 cm landing/training mats: 5 ft x 10 ft x 8” (1.52m x 3.05m x 20.3 cm) polyurethane foam covered in vinyl.
- Crash mats
- Resi/pit module mat: 5 ft x 10 ft x 32 inches (1.53m x 3.05m x 81.3 cm)
- Musical mats

Trampoline:
- In-ground Eurotramp trampoline: jumping bed size 168 inches x 84 inches (426cm x 213cm)
- Three above ground trampolines with end decks and padded walls *
  
  End decks are padded platforms surrounding 2 sides of the trampoline for individuals to land on if they lose control while jumping.
Appendix 1 (continued)

Swinging apparatus:
- Hammock
- Baby sized plastic swing
- Youth sized plastic swing
- Trapeze: 24 inches (61cm) wide x 80 inches (203 cm) long ropes
- Gymnastics Rings: 72 inch (183cm) straps, 9 inch (22.8cm) diameter rings, 1.25 inch (3.17cm) thick rings
- 2 different sets of pulleys with chain link adjustment points for raising and lowering the heights of the swings and trapeze *.

Hand apparatus:
- Racquets of various sizes and weights: badminton, tennis, mesh.
- Assorted colored latex balloons
- Bean bags *: hand held size
- Variety of squeaky, soft, and sensory toys
- Pool noodles
- Sidewalk chalk
- Bubbles
- Skipping ropes
- Hula Hoops: various sizes
- Variety of balls of different sizes, weight and density
- Shopping bags
- Felt shapes *:
  - squares, triangles, hearts, circles, rectangles,
  - Footprints, Handprints
  - Theme shapes: for example under the sea shapes,
- Drumsticks

Other:
- Staircase
- Plastic Buckets
- Overhead spotting belt for the trampoline
- Traffic cones
- Exercise balls: 18 inch (42 cm) diameter, 22 inches (53 cm) diameter.
- Padded wall*
- Measuring tape
- Stop watch or timer
- Velcro straps and specially cut foam cubes for leg alignment while jumping*
Appendix 1 (continued)

ESMT Bike Riding Therapy:

Equipment requirements:
- Tricycle
- Children’s sized bicycle with training wheels
- Children’s size bicycle without training wheels
- Fat wheels training wheels: a set of wheels for each bicycle
  - A set for 16-20 inch (40.6cm – 50.8cm) diameter wheels.
  - A set 24 or 26 inch (61cm or 66 cm) diameter wheels.
- Two sets of adult women’s bicycles (Trek 820) sized at 13 inches, 16 inches, 19.5 inches (33cm, 40.6cm, 49.5cm).
- We have matching sets of bicycles: one with Fat Wheels attached and one without.
- Helmets: varying size range to fit from young children to adolescents and adults
- Traffic cones

Aqua Therapy:

The pool we use has two pools within the same facility.
- Pool 1:
  - It is a warm shallow water pool with a stream, showers, bubbles, hot tub, ramps for wheelchair accessibility, and is 5 feet deep at one end only.
- Pool 2:
  - It is a deep-water pool with both a 1 meter and a 3 meter diving board.

Equipment requirements:
- Toy flutes and horns
- Plastic floating Buckets
- Watering cans
- Flutterboards
- Sinking toys for teaching diving
- Goggles
- Personal flotation devices (PFDs)
  - Jacket and belt form
- Balls
- Pool Noodles
- Foam flotation dumb bells
Appendix 1 (continued)

ESMT Communication System:

Equipment requirements:
- Pic symbol book
- Pic symbol board for ESMT curriculum
- Pic symbol board for trampoline based sequencing activities
- Pic symbol board for Aqua therapy
- Individual client workbooks

http://bmo.sagepub.com/content/25/5/725.abstract