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Effects of treadmill training with and without weighted ankle cuffs on gait parameters in children with down's syndrome

Asma Iqbal[1] , Bushra Ejaz[2]

1. Physiotherapist, Riphah International University
2. Physiotherapist, Hussain Memorial Hospital

Abstract

Background: The disorder known as Down syndrome is characterized by the presence of an additional chromosome in certain individuals. Within the human body, chromosomes are like little "packages" of genes. It is possible to have Down syndrome (DS), which is often referred to as trisomy 21, if a third copy of chromosome 21 is present, either in its whole or in part.

Objective: To compare the effects of treadmill training with and without weighted ankle cuffs on gait parameters in children with Down's syndrome.

Material & Method: Recent clinical trial was randomized. Ethical committee authorized research. After informed permission, patients were enrolled in the research based on inclusion criteria. Simple random sampling yielded 25 samples each category. Everyone was split into two groups. A group underwent treadmill training with weighted ankle cuffs, whereas the other received merely treadmill training. Both groups received conventional therapy—strengthening, and trunk training. The workout had 10 reps/session. Treadmill training for infants (with the help of attendant) lasted for 6 minutes, 4 days a week at 0.18m/sec. After informed consent, gait assessment rating scale and Berg balance scale were used to determine balance and gait characteristics. We gathered data before and after 6 weeks of therapy. Treatment lasted 6 weeks, 1 hour every day, 4 days a week. Comparing improvement before and after 4 weeks was done in SPSS 26.0.

Result: The findings indicated no significant difference between groups ($p > 0.05$). Rejecting the null hypothesis. Treadmill training with ankle cuff improved gait parameters in children with Down's syndrome more than treadmill training alone (Group B).

Conclusion: The study found that treadmill training with weighted ankle cuffs offers more clinical benefits than treadmill training without cuffs in improving gait parameters like cadence, cycle duration, and swing time. Additionally, treadmill inclination positively affects hip, knee, and ankle angles, suggesting potential advantages for gait rehabilitation in this group using treadmills.

Key words: Berg Balance scale, Down Syndrome, Gait Parameter, Posture

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Introduction

An individual with Down syndrome will have one additional chromosome, which is one of their symptoms. Metabolic "packages" of genes are what chromosomes are in a human organism. Their job is to shape and regulate a baby's anatomy and physiology throughout pregnancy and the first few weeks of life. At birth, a human being has 46 chromosomes. (1). Down syndrome is also known as multiple chromosome syndrome. John Langdon Down, a British physician who originally reported the illness in 1866 (2). One of the most common oncogenes linked to mental impairment is the Down syndrome (DS) genetic abnormality. Patients who have Down syndrome have triple-paired 21 markers rather than two markers in most cells (3). They have distinct metabolic, cerebral, biomechanical, perceptive, intellectual, and communication characteristics that can influence each other, as well as the ability of individuals to develop talents throughout their lifetimes (4). When it comes to chromosomal conditions, Down syndrome continues to be the most prevalent disorder identified in the United States. Within the United States, around 6,000 infants are born with Down syndrome every single year. To put this into perspective, about one baby out of every 700 is born with Down syndrome(2). Down syndrome (DS), which is a genetic defect, is one of the most prevalent oncogenes of mental retardation. Patients who have Down syndrome have triple-paired 21 markers rather than two markers in most cells (3).

They have distinct metabolic, cerebral, biomechanical, perceptive, intellectual, and communication characteristics that can influence each other, as well as the ability of individuals to develop talents throughout their lifetimes (4). Learning impairments in children are caused by this hereditary chromosomal abnormality, which is the most frequent of all genetic disorders. In addition, it often results in various medical problems, such as cardiac and gastrointestinal diseases (5). The contour of the face is flattened, the head is small, the neck is short, the tongue sticks out, the eyelids are slanted upward (palpebral fissures), the ears are small or unusually shaped, the muscle tone is low, and the hands are short and wide with one crease in the palm (6). In addition to having tiny hands and feet, they also have relatively short fingers. While it is possible for newborns with Down syndrome to be of average size, the majority will have delayed development and remain shorter than their peers of the same age (7). The majority of children who have Down syndrome have cognitive impairments that range from mild to significant. A delay in language development is seen, and both short-term and long-term memory are impacted (8).There is a high probability that individuals who have Down syndrome (DS) will lead a life of inactivity, which may lead to a wide range of medical complications, including heart and vascular disorders. For instance, infants with Down syndrome typically begin walking independently approximately one year later than their peers who are developing normally (9).

Babies' ability to walk is a cornerstone motor skill that helps them engage with their environment and build their social, cognitive, and motor abilities. Therefore, it is highly desirable to promote walking onset in infants with Down syndrome in order to facilitate their development and to alleviate the stress that parents experience when this delay continues (10). Children who are born with Down syndrome (DS) often learn to walk around one year later than children who are born without a disability (ND). Those infants who participate in high-intensity treadmill training may be able to walk even earlier (11). The increased risk of Down syndrome in females born beyond the age of 35 is well-known among medical professionals (12). Despite the fact that they do not completely comprehend this phenomenon. Condition may be passed on to children, despite the fact that it is very uncommon. The characteristics of a partner are often "translocated," as the specialists refer to them. You have a greater chance of having another kid with Down syndrome if you have already had one child with the condition in the past(13). This indicates that some of their chromosomes are not located in the normal location, and it is possible that they are located on a different chromosome from the normal one(14).While the parents does not have Down syndrome even if they have the right amount of genes, their kid may have "homologous recombination Down syndrome." Homologous recombination Down syndrome is not always passed from one's parents; it may arise by accident as well (15).

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People who have Down syndrome have three total count 21 chromosomes in some or all of their cells, but they only have two chromosomes in their cells. In terms of equilibrium and speed tasks, as well as racing speed, endurance, and data and recognition, individuals who have Down syndrome perform better than children who have other psychological illnesses(16)Down syndrome (DS), which is a cytogenetic abnormality, is one of the most common genetic causes of psychological disabilities(17). They have a variety of anatomical characteristics that can influence one another as well as the ability of individuals to acquire maturity level competencies(18)Orthopedic instability, exaggerated hip abduction and external rotation, shoulder girdle rigidity, unequal or abnormal muscle strength, and difficulty initiating action are all indications of developmental delay(19).This may be verified by the use of a cytogenetic test, which involves the coordination of the chromosomes and examines whether or not there is a trisomy 21. Despite the fact that there is no particular therapy for Down syndrome (20). There are nevertheless varieties of physiological and psychological treatments that are available to assist individuals with Down syndrome in achieving success. The sooner you get started, the better it was (21).Every youngster will have a unique set of requirements. Practice that is direct, biomechanical, and neurological in nature. In addition, you will collaborate with your child's physician to treat and assess any potential health problems that may occur because of the condition (22). Coordination, steadiness, reactionary reaction, and modulated muscle activity are all difficult for them, and they eschew axial loading, force shifts, and spinal lineup (23). These activities include social and leisure activities as well as programmes for job learning (24). All of these variables correlate to the requirement for a broad base of support while sitting and standing, and even the latency in mobility. The majority of children with Down syndrome are able to walk without assistance between the ages of two and three years old. Because of a number of significant medical problems, their embryonic development unfolds in an unpredictable manner (25).

One of the most important factors that determines the severity of hypertrophic cardiomyopathy and hypertonicity in children is the relative pace of improvement that they experience. Slow positional reactions to dizziness cause inadequacies in guaranteeing consistency(26). Some fundamental flexibility and reverse strolling activities that may cause issues with proprioception are snake curls, shoestring walker, suspension bridges, hermit stroll leg lift, abdomen punching trick marine line, judgmental sea line, seal grip, superhuman and football roll (27). Treatment for children with Down syndrome generally includes the use of an orthotic implants at the ankle and foot. But orthotics isn’t only for making walking easier by adjusting the ankle's kinematics and alignment. When kids who have disabilities stand still while wearing custom foot orthoses, their ankles do not turn out as far. An improvement in walking speed, a change in the initial landing position from a flatfoot to heel strike, a reduction in the range of the ankle progression angle, and a decrease in overall walking performance were all associated with the use of tailored foot orthoses. It was at the same time when all of these things changed. Using foot orthoses improved gross motor skills (28). This study is being conducted with the intention of providing doctors with new treatment strategies that will progress the prognosis of pace in children who have Down syndrome. The use of treadmill training routines was the means by which this was done. As a result, it makes a contribution to the enhancement of the therapeutic practice for children who have Down syndrome. This would be of immense service to the community of persons who have Down syndrome, as well as to their friends and family members who provide care for them. In addition to this, it has the ability to alleviate the burden that is imposed on hospitals by forcing condition management procedures to be less engaging.

Objective

Finding out how treadmill training affects gait metrics in Down syndrome children with and without weighted ankle bracelets is the main goal of this research.

Material and Methods

Study Design:

This study was a Randomized ControlledTrial (Trial Registry Number:NCT06176755).

Study Setting:

Department of Physical Therapy, Khawaja Arshad Hospital Sargodha.

Study Duration:

Six months (after the approval of synopsis)

Sample Size:

The calculated sample size is 46after adding 10% Attrition Rate the sample size is46+4=50 (9).

Sample Size For Comparing Two Means

Input Data

Confidence Interval (2-sided)	95%
Power	80%
Ratio of sample size (Group 2/Group 1)	1

	Group 1	Group 2	Difference*
Mean	0.28	0.36	-0.08
Standard deviation	0.1	0.09	
Variance	0.01	0.0081	

Sample size of Group 1	23
Sample size of Group 2	23
Total sample size	46

*Difference between the means

Results from OpenEpi, Version 3, open source calculator--SSMean
Print from the browser with ctrl-P
or select text to copy and paste to other programs.

Figure 1: Sample Size

$Z_{1-\alpha/2}$ Level of significance=95%

μ_1 Expected mean change in Control Group= 0.28

μ_2 Expected mean change in Experimental Group=0.36

δ_1 Expected standard deviation in Control group=0.1

δ_2 Expected standard deviation in Experimental group=0.09

$Z_{1-\beta}$ power of the study= 80%

n Expected sample size in a group= 23

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After adding 20% drop out 23±2=25 in each group.

Sample size in group A =25

Sample size in group B =25

Study Groups:

All participants weredivided in two groups
Group A: wore weighted ankle cuffs and participated in treadmill exercise.
Group B: only trained on treadmills.
Traditional treatment methods include exercises that build strength, such as isometric and trunk exercises. Each group did the activity 10 times throughout each session.

Sampling Technique:

From among the fifty individuals chosen, a simple random sampling technique was used.

Sample Selection:

Inclusion Criteria

- Age from five to ten years old(31)
- having no signs of visual or intellectual disabilities,
- gross motor function level of 1, 2, or 3(11)
- Participation in the training program is contingent upon the trainees' ability to walk for at least 12 months(29).

Exclusion Criteria

- Not accept children who have had neuromuscular blocks or orthopedic surgeries within the last year (30).

Data Collection Tools

Berg Balance Scale for functional balance

When it comes to evaluating balance, the Berg Balance Scale (BBS) is an excellent and trustworthy tool. The whole thing takes around twenty minutes and is composed of fourteen easy steps. The BBS's absolute dependability varies across the board, falling anywhere between 2.8/56 and 6.6/56 at the 95% confidence level. Near the middle of the spectrum, absolute dependability is low, while at the other end, it's high. When it comes to testing how well someone keeps their balance, many people turn to the BBS.(32, 33).

Interpretation:

- A score on the Berg balance scale may vary anywhere from 0 to 56. This means that the lower your score is, the greater the likelihood that you may lose your equilibrium. In general, the following is how the scores on the Berg balance scale are interpreted:
- When a person's score falls within this range, it is quite probable that they will need the help of a wheelchair in order to move about in a secure manner.
- A person with a score in this range will need some kind of walking help, such as a cane or a walker, in order to proceed with their daily activities.
- When a person's score falls within the range of 41 to 56, they are deemed independent and should be able to move about without the need for help.

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- Gait Abnormality Rating Scale (GARS)
- It is an evaluation of 16 aspects of human gait that is based on videotapes. As a screening tool, it has been studied for identifying patients who are at risk for harm as a result of falls. as well as being used in the examination of gait remotely. The year 1996 saw the publication of a revised edition.
- Each item may have a score between 0 (great function) and 3 (poor function), as stated in the interpretation. When added together, the 16 components make up the GARS score, which is a ranking of fall risk. Both the total number of gait abnormalities detected and the severity of each anomaly are used to determine this ranking(34)

Data Collection Procedure:

Participants will finish a Performa that has been thoroughly tested. For gathering gait parameters, following questions were used. Comparative analysis was performed on the difference in improvement that occurred before and after the sixth week. The therapy is administered to the children for a total of six weeks, four days per week, for one hour each day.

Group A: Treadmill training and Ankle cuff.

Treadmill training:

Group A was given motorized, tiny treadmills that have been specifically created for them, as well as instruction for their parents so that they may suitably conduct exercise in their homes. On the treadmill, the parents kept their children in an upright position at the front of the belt at all times. When the belt of the treadmill was activated, it caused the children ' legs to travel backward, which in turn prompted them to stride forward. Parents would move their children to the front of the seat belt if they saw that their children were not making any steps. Babies were subjected to the regimen for six weeks at a speed of 0.18 m/s, with administration occurring around four times weekly for an hour each day. A small amount of weight proportional to the children's anticipated calf mass was also applied to their ankles, and this weight was progressively increased as the training progressed. Not only that, but the duration of the training sessions and the pace of the belt were also increased over time. As soon as the subjects could walk three steps alone, the treadmill sessions ceased(35).

Weighted Ankle Cuffs: The adjustable ankle cuffs with weights are up to you. To prevent the weight cuff (0.5 kg) from sliding down your leg as you exercise, wrap it around your ankle and make sure it's tight enough. For a snug fit, use a hook and loop fastener. Listen to your specialist's recommendations and make the required weight modifications (28).

Group B: Treadmill training only.

Babies were subjected to the regimen for six weeks at a speed of 0.18 m/s, with administration occurring around four times weekly for an hour each day. We also started the newborns out with a little amount of weight on their ankles, which we increased as their expected calf mass grew during training. Not only that, but the duration of the training sessions and the pace of the belt were also increased over time. Treadmill training came to a close when participants could walk alone for three steps. For a total of six weeks, kids will get therapy four times a week for an hour each day(46).

Data Analysis:

The data was examined using SPSS 25, which displays demographic and category information using techniques such as percentage terms, mean, and standard deviation. At $p \leq 0.05$, the threshold of significance was established. Numerical values were determined using the standard deviation and mean. If the result was more than 0.05, parametric tests were used; otherwise, the Shapiro-Wilk test was utilized to test for normality. Within each group, we used pair t tests, and when we wanted to compare two groups, we used independent t tests. We resorted to non-parametric testing if the p-value was 0.05 or below. Every group was subjected to the Mann Whitney test, and when comparing groups, the Wilcoxon test was used.

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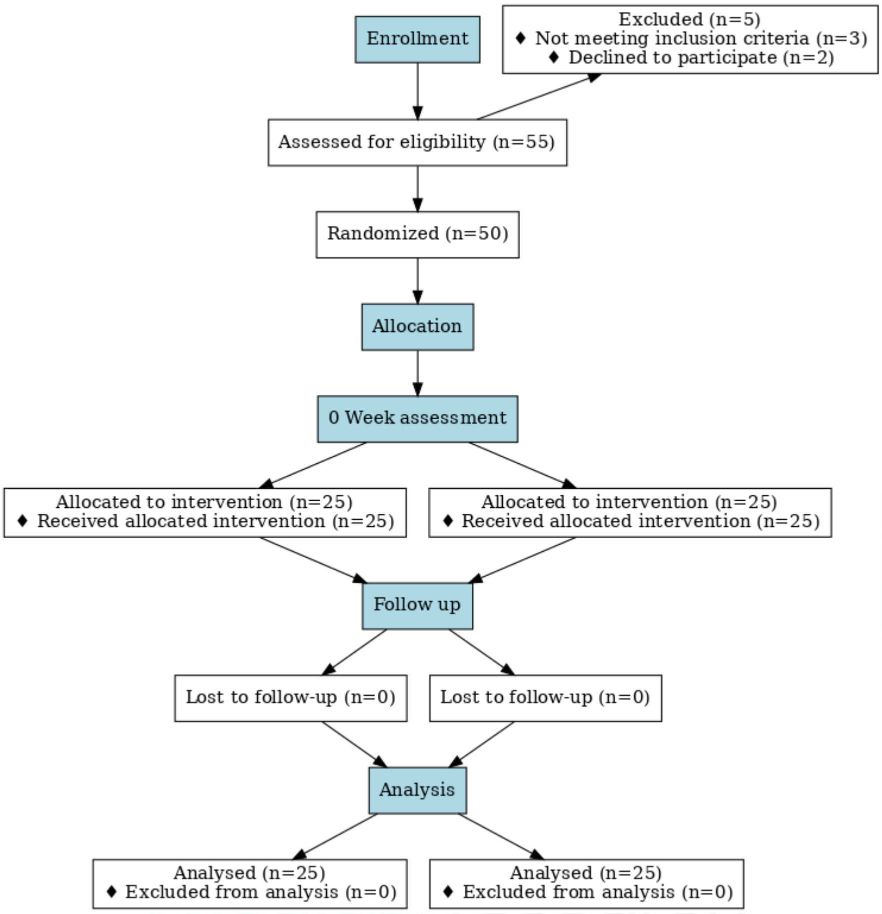

Figure 2: Consort Diagram

Results

The mean age of participants was 7.16±1. 845.minimum age was 5 years while maximum age of the participants was 10 years. The histogram shows that the total number of participants were 50 whereas the mean age of participants was 7.16 and the standard deviation was 1.845. in the following table and pie graph, distribution of gender is shown. Among patients, there were 31(62%) female and 19(38%) male participated in study. This bar chart shows 25 subjects were involved in each group for study, out of which 10 female and 15 male were allocated in group a (treadmill training weighted ankle cuffs) while 9 females and 16 male were placed in group b (treadmill training only). The shapiro_wilk statistic was used in order to confirm that the data were, in fact, normal. According to the findings, the p-value for variables such as BBS and gars was significant, with a value more than 0.05. This, in turn, shows that the data follows a normal distribution. In order to compare the groups both between and within themselves, we used parametric testing. A comparison of the pre-treatment means of groups a and b was carried out with the use of the independent t test. At baseline treatment values, both groups had comparable levels of BBS and gars, with a p-value greater than 0.05. ankle cuff training plus treadmill training (group a) have a mean and standard deviation of 11.50±2.065 for the BBS, while the mean and standard deviation for treadmill training alone (group b) is 11.93±1.730. ankle cuff training and treadmill training (group a) have a mean and standard deviation of 34.18±3.745 for gars, while the mean and standard deviation for treadmill training alone (group b) is 34.06±2.719. A comparison of the pre-treatment means of groups a and b was carried out with the use of the independent t test. At baseline treatment values, both groups had comparable levels of

BBS and gars, with a p-value greater than 0.05. The mean and standard deviation of the BBS after treatment in group a, which includes both treadmill training and ankle cuff, is 47.16±2.322, while in group b, which only includes treadmill training, the mean and standard deviation is 36.80±2.380. The mean and standard deviation of the gars after treatment in group a, which includes treadmill training and ankle cuff, is 3.84±1.106, while in group b, which just includes treadmill training, the mean and standard deviation is 7.24±.779.

With a p-value greater than 0.05, the findings indicated that there was no statistically significant difference between the two groups. Therefore, we are unable to accept the null hypothesis. result indicates that the mean difference in treadmill training and ankle cuff (group a) is more than mean difference in treadmill training only (group b) that showed that the treadmill training and ankle cuff was more effective than modified thera suits in improving gait constraints. The paired t-test is used to compare the mean values within each treatment group. The mean difference for BBS in treadmill training with an ankle cuff (group a) is 23.44±1.124, whereas the mean difference for treadmill training alone (group b) is 12.8±1.156. The average difference in gars between groups a, which includes treadmill training and ankle cuff, is 6.52±0.044, while group b, which only includes treadmill training, has a mean difference of 3.04±0.358. A statistically significant mean difference (p=<.001) was found between the pre-treatment and post-treatment means, according to the study's findings. Children with Down syndrome benefited more from the combination of treadmill exercise and ankle cuff than treadmill training alone, according to this difference.

Table 1: Demographic Characteristics of Participants (N = 50)

Variable	Category	Frequency (n)	Percentage (%)	Mean ± SD	Min–Max
Age	–	–	–	7.16 ± 1.845	5 – 10 years
Gender	Female	31	62%	–	–
	Male	19	38%	–	–

The study included 50 participants with a mean age of 7.16 ± 1.845 years, ranging from 5 to 10 years. Descriptive statistics revealed a higher proportion of females (62%) compared to males (38%). The gender distribution and age variability indicate a moderately young and predominantly female sample population.

Table 2: Between- and Within-Group Comparisons of BBS and GARS Scores (N = 50)

Outcome	Group	N	Pre-Treatment Mean ± SD	Post-Treatment Mean ± SD	Mean Difference ± SD	Between-Group p-value	Within-Group p-value
BBS	Group A (Treadmill + Ankle Cuff)	25	23.72 ± 3.446	47.16 ± 2.322	23.44 ± 1.124	.003	.002
	Group B (Treadmill Only)	25	24.00 ± 3.536	36.80 ± 2.380	12.80 ± 1.156		.002
GARS	Group A (Treadmill + Ankle Cuff)	25	10.36 ± 1.150	3.84 ± 1.106	6.52 ± 0.044	.002	.003
	Group B (Treadmill Only)	25	10.28 ± 1.137	7.24 ± 0.779	3.04 ± 0.358		.001

An independent t-test revealed no statistically significant difference at baseline between Group A (Treadmill + Ankle Cuff) and Group B (Treadmill Only) for both BBS (p = .778) and GARS (p = .806), indicating homogeneity between groups. However, post-intervention analysis showed a significant improvement in BBS scores for Group A (47.16 ± 2.322) compared to Group B (36.80 ± 2.380), with a p-value of .003. Similarly, GARS scores were significantly lower in Group A (3.84 ± 1.106) than in Group B (7.24 ± 0.779), with a p-value of .002, indicating better gait improvement. Paired t-test results within groups confirmed statistically significant pre-post improvements in both outcomes. Group A demonstrated a greater mean difference in BBS (23.44 ± 1.124) and

GARS (6.52 ± 0.044) compared to Group B (BBS: 12.80 ± 1.156; GARS: 3.04 ± 0.358). All within-group p-values were <.005, indicating strong treatment effects. These findings suggest that the combined intervention of treadmill training with ankle cuff was significantly more effective in enhancing balance and reducing gait abnormalities in children with Down syndrome.

Discussion

The researchers Garcia-Del et al. set out to compare the impact of two different treadmill treatments on the maturation of joint kinematic patterns in infants with Down syndrome. The patient had a very high degree of progress in joint kinematics development at the gait follow-up. A longer forward thigh swing followed toe-off and maximum ankle plantar flexion occurred at or before toe-off in the high-intensity group(29).Current study supported the evidence by concluding that treadmill training improve gait parameter. An investigation on the effects of physical exercise on babies with Down syndrome who were given a treadmill intervention was carried out by Johnson et al.throughout the course of their research. Taking into account the activity that was caused by the intervention itself, the findings indicate that babies who were given the HI TMT had greater levels of High act than children who were given the LG version of the intervention. Children in the LG group spent a greater amount of time in the Low act than those in the HI group. In addition, these findings seemed to be maintained during the post-intervention follow-up (6).Current study supported the evidence by concluding that treadmill training improve gait parameter.

An investigation was carried out by Maïano et al., to examine the impact of individualized treadmill training that gradually increased in intensity on the developmental outcomes of babies who were diagnosed with Down syndrome. The findings indicate that the infants who participated in the individualized training programme with a higher intensity level saw a more significant rise in their stepping during the duration of the training. The majority of the motor milestones were accomplished by the infants in the group that received instruction of a greater intensity at an earlier mean age (30). Current study supported the evidence by concluding that treadmill training improve gait parameter.

Martínez-Espinosa et al.'s study provides important information on the effects on babies with Down syndrome's development of using an orthosis with treadmill training, as compared to jogging on a treadmill alone. In order to assess the progress of motor skill development, all the babies increased noticeably with time. After a month of walking, the control group's GMFM ratings were higher than the experimental group's. Standing, walking, running, and jumping subscale scores were all higher in the control group, which explained the result. A potential downside of orthoses is their potential to hinder the overall development of gross motor abilities. (7). Current study supported the evidence by concluding that treadmill training improve gait parameter. Adding an ankle load to treadmill walking helps youngsters with Down syndrome (DS) improve their gait kinematics significantly. Ankle plantar flexors may have a greater role in this enhancement. Ankle weights improve walking in Down syndrome youngsters, according to 2014 study by Larry Hand. It was determined that "inclusion of external ankle load may be a promising approach to strengthening leg muscles and eliciting a more powerful push off in individuals with DS." In support of the research, Current concluded that individuals with Down syndrome had an increased gait parameter while using weighted ankle cuffs.

Conclusion

The study concluded that both techniques are effective in improving the condition however Treadmill training with weighted ankle cuffs provide more clinical benefit than Treadmill training without weighted ankle cuffs on gait parameters such as cadence, cycle duration, swing time. Additionally, there was an increase in the hip, knee, and ankle angles. These gait parameters tended to be favorably affected by treadmill inclination, which suggests that there may be potential advantages for gait rehabilitation in this group using treadmills.

Limitations

1. Because this was a time-bound study project, it is not possible to make conclusions on the intervention's follow-up
2. Single-Centered Clinical Settings
3. Lack of blindness is the major limitation of this study at the end of assessor

Recommendations

1. The intervention in this study was restricted to two groups and lasted for a period of four weeks; hence, this study suggests that future studies extend the length of treatment periods in order to get more favorable and prolonged outcomes.
2. The current study recommends the use of treadmill training and weighted ankle cuff in Down syndrome.
3. In the future, there is the possibility of making efforts to reduce any form of bias that may be created by the lack of blindness in order to conduct more standardized and advanced investigations.

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