Review Article

Flexibar and Non-Flexibar Exercises and its Effects on Trunk Activation: A Review of Literature

Nagaveni Hegde[1], Anitha M[2]

[1]1Musculoskeletal and Sports Physiotherapy, Assistant Professor at the School of Sports Education and Research, Jain (Deemed-to-be University), Bangalore, India.
[2]Neuroscience, Assistant Professor at Srinivas Institute of Physiotherapy, Pandeshwar.

How to cite this article: Nagaveni Hegde, Anitha M. Flexibar and Non-Flexibar Exercises and its Effects on Trunk Activation: A Review of Literature. Indian Journal of Physiotherapy and Occupational Therapy / Vol. 18 No. 4, October-December 2024.

Abstract

Objective: To systematically review the randomised controlled trials to evaluate the effects of flexi-bar and non-flexi-bar exercises, specifically stabilization training, on trunk muscle activity in various postures.

Methodology: The study included randomized control trials and clinical trials published between 2007-2018, focusing on patients with upper trunk muscle weakness aged above 18. Exclusion criteria included a study with overlapping data, a study with associated disorders, or abstract-only papers. The search strategy involved a search of existing literature from databases like PubMed, Google Scholar, Cochrane Library, PEDro, and Research Gate, removing duplicates and identifying relevant articles. The full-text screening was performed, and the remaining relevant articles underwent data extraction. Surface electromyography (EMG) was used to measure the activity of selected trunk muscles, which was then normalized to maximum voluntary isometric contraction.

Result: The findings of this study indicate that flexi-bar exercises resulted in higher activation of trunk muscles compared to non-flexi-bar exercises (stabilization training). The unique physical response induced by the vibration created through the swinging motion of the flexi bar triggered reflexive contractions of core muscles, leading to increased muscle activity. This suggests that flexi bar exercises may be beneficial in promoting muscular activation and potentially alleviating low back pain by evening out muscular imbalances.

Conclusion: The results of this study support the use of flexi-bar exercises for activating trunk muscles, particularly when compared to non-flexi-bar exercises (stabilization training).

Keywords: Flexibar, trunk muscles, non- flexibar, therapeutic exercises.

Introduction

Trunk muscle activity plays a crucial role in providing active stability to the spine and precedes the movement of the human body's upper and lower extremities.[1,2] Impaired and delayed trunk muscle activity leads to unstable upper and lower extremity

Corresponding Author: Nagaveni Hegde Musculoskeletal and Sports Physiotherapy, Assistant Professor at the School of Sports Education and Research, Jain (Deemed-to-be University), Bangalore, India.

E-mail: nagaveniheggade656@gmail.com

Submission date: June 4, 2024 **Revision date:** July 23, 2024 **Published date: Oct 10 2024**

movement.[3] Instability of the lumbar vertebrae is one of the primary causes of low back pain.[4] The global muscles, including the rectus abdominis, external oblique, and internal oblique, play a role in controlling overall trunk stability by generating torque. On the other hand, the local muscles, such as the transverse abdominis (TrA), multifidus (MF), and interspinalis, are deep trunk muscles responsible for fine spinal adjustments and stability between spinal segments. These smaller muscles are particularly effective in controlling the stiffness of individual spinal segments and maintaining proper spinal posture.[5,6]

The application of vibration stimulation, such as whole-body vibration exercise, can provide strong sensory stimulation that activates muscle spindles and enhances proprioceptive senses, ultimately leading to the strengthening of muscles crucial for postural stability. This effect is observed not only in healthy individuals but also in patients with various neurological disorders. By improving proprioception and motion perception during muscle contraction, vibration can contribute to enhancing muscle strength and promoting lumbar stabilization, involving both deep trunk and limb muscles.[7, 8, 9,10,11,12.]

This research seeks to explore how effective bar and non-flexi bar exercises, which involve levels of vibration, on the shoulder joints are in engaging core muscles in different body positions. Prior studies have indicated that vibration can notably boost muscle engagement yet there is a lack of research on vibration exercises targeting body areas. The study acknowledges the significance of both global muscles in ensuring stability in the core and the interaction between these muscle groups for stability. Although the distinction between global muscle systems is not always straightforward their coordinated functioning is vital for maintaining a framework. Hence understanding the balance between local and global muscle activation levels is crucial. Electromyography (EMG) ratios serve as indicators of recruitment patterns and muscle issues guiding this study to examine differences in how local and global muscles work together such as comparing the internal oblique, with rectus abdominis or lumbar with thoracic erector spinae muscles. This investigation includes both individuals and those experiencing back pain (LBP) to assess muscle engagement during various stabilization exercises.

Materials and Methodology

Inclusion criteria consisted of the following: Randomized control trials and randomized clinical trials (RCT), the Publication year 2007- 2018, Patients with weakness of upper trunk muscles participants aged above 18 years, No restriction regarding country, race, or gender.

Exclusion criteria consisted of the following: Associated cardiovascular, neurological, and orthopedic disorders, study with data not reliably extracted, duplicate, or overlapping data, abstract-only papers as preceding papers, conference, editorial, and author response theses and books case reports, case series, and systematic review studies, articles without available full text.

Search strategy: A search of existing literature from the years 2007-2018 was completed from the following databases: PubMed, Google Scholar, Cochrane Library, PEDro (physiotherapy evidence database), and Research gate using keywords such as Flexibar, trunk muscles, non- flexibar, therapeutic exercises. After removing duplicates, relevant articles were identified by titles and abstracts. and underwent full-text screening and were ranked as relevant or irrelevant according to the inclusion criteria. Finally, the remaining relevant articles underwent data extraction.

Review of Literature

Sl. No	Title/ Author/Year	Methodology	Conclusion
	Chung S and Park S. conducted a study on the effects of flexibar and non-flexibar exercises on trunk muscles in different postures in healthy adults in 2015	The purpose of this study was to assess the effects of flex bar and nonflexi bar exercises on trunk muscle activity in different postures in healthy adults. Twenty healthy right-hand dominant adults (10 males and 10 females) were selected for this study. None of the participants had experienced any orthopedic problems in the spine or the upper and lower extremities in the previous six months. The subjects were instructed to adopt three exercise postures: posture 1, quadruped; posture 2, side-bridge; and posture 3, standing. Surface electromyography of selected trunk muscles was normalized to maximum voluntary isometric contraction. The external oblique, internal oblique, and erector spinae muscle activity showed significant differences between flexibar and nonflexibar exercises.	The results of this study suggest that flexibar exercises are useful in the activation of the trunk.
	Seong–Jin Lee, Yong–Nam Kim, Dong –Kyu Lee conducted a study on the effect of flexibar exercise with vibration on trunk muscle thickness and balance in university students in their twenties in 2016	The research evaluated 26 university students in their twenties, equally and randomly divided into two groups. Both the experimental and control groups used an ordinary pole for exercise. In addition, the experimental group exercised by using a flexibar. Ultrasonic imaging was used to measure the changes in trunk muscle thickness. A balance measuring equipment was used to measure balance ability. The thickness of the transversus abdominis and the multifidus muscles in the experimental group increased, and the experimental group showed increased thickness in the transversus abdominis muscle compared to the control group. After 6 months of exercise, there was an improvement in the blind Romberg test and center of pressure moving distance with one leg standing.	These results indicate that the flexibar exercise effectively increases trunk muscle thickness and improves balance.

	Louise Hurley conducted a study on strengthening transversus abdominis in subjects with a history of lower back pain and asymptomatic individuals: The flexibar vs stabilization training in 2007.	A convenience sample of seventeen subjects was classified into two groups; those with a history of LBP, and those without a history of LBP. Nine subjects formed the FLEXIBAR training group and eight the stabilization training group, both performed an exercise program for a training period of four weeks. A pressure biofeedback unit (PBU) was used to assess the performance of the TrA muscle by adopting a test-retest (pre-test and post-test) design. The statistical significance of the changes between TrA function before and after the program was analyzed before and after the program was analyzed by performing a mixed within-subject analysis of variance (ANOVA).Furthermore, another ANOVA was produced to investigate whether the impact is different for HLBP and NLBP subjects. Although not statistically significant, increases in strength were observed in subjects involved with the FLEXIBAR program. In particular greater strengthening of the TrA muscle was seen in the history of the LBP group. This study provides one step forward in the knowledge concerning the efficacy of exercise programs to strengthen the core stability system.	The results seem to indicate that the FLEXIBAR can strengthen the TrA, and could provide an application to aid the rehabilitation of LBP individuals.
	Sin Ho Chung, Young Youl You, Hyung Jin Lee, and Sang Hyo Sim conducted a study on the effects of stabilization exercise using flexibar on functional disability and transverse abdominis thickness in patients with chronic low back pain in 2018.	Twenty-seven patients were randomly assigned to an experimental (14 patients performing stabilization exercises)group. The patients in both groups then underwent stabilization exercises with or without FB 30 min/day, 3 times a week, for 6 weeks. The main outcome measures were perceived disability based on pain, Oswestry disability index (ODI), TrA activation capacity, and thickness. Both groups showed improved ODI, VAS, and TrA activation capacity performed for 6 weeks in patients with CLBP, but all outcomes, except for TrA thickness, showed greater improvements in patients following stabilization exercises with FB than following stabilization exercises.	lumbar stabilization exercises with FB could restore pain, and functional disability and improve TrA activation capacity in CLBP patients.

	EunKyung Kim, and Seong –Gil Kim conducted a study on the effect of an active vibration stimulus according to different shoulder joint angles on functional reach and stability of shoulder joint in 2016.	Thirty healthy male students participated in this study. The upper limb length of each subject was measured to obtain normalized measurement values. The exercise groups were as follows: group 1(n=10, shoulder joint angle of 90), group 2(n=10, shoulder joint of angle 130), and group 3(n=10, shoulder joint of angle of 180). After warm-up, an active vibration stimulus was applied to the subjects with a Flexi Bar. The functional Reach Test and Y-balance test were conducted for the measurement of shoulder stability. Analysis of covariance was conducted with values before the intervention as covariates to analyze the differences among the groups in the two tests. There were significant differences among the groups. According to Bonferroni's post hoc comparison, group 1 showed greater improvement than Group 3 in the Functional Reach Test, and Group 2 showed greater improvement than Group 1 and Group 3 in the Y-balance test.	The effect of the exercises with different shoulder joint angles revealed that the shoulder joint has a certain effective joint angle for its function and stability. In addition, the application of an active vibration stimulus with a flexi bar can be a very effective tool for the improvement of functionality and stability of the shoulder joint.
	Jae-Heon Lim conducted a study on the effects of flexible pole training combined with lumbar stabilization on trunk muscle activation in healthy adults in 2018.	twenty-five participants were enrolled in this study. The subjects were randomly allocated into either the flexible or rigid pole groups. Participants performed lumbar stabilization exercises on quadruped and curled up, with the flexible pole or rigid pole. Electromyography was used to assess the percent maximal voluntary isometric contraction (%MVIC) of the rectus abdominis (RA), external oblique (EO), internal oblique (IO), and erector spinae (ES) muscles. All participants completed one 3-minute session per day, 3 days per week, for 6 weeks. The evaluation was performed before and 6 weeks after the training, and follow-up. The data were analyzed using an independent t-test and two-way repeated measure analysis of variance to determine the statistical significance.	The flexible pole curl-up and quadruped showed an improvement in trunk muscle activation. The flexible pole combined with lumbar stabilization will be useful as an exercise tool to improve the activity of trunk muscles.

	Carolyn Richardson, Rowena Toppenberg, and Gwendolen Jull conducted an initial evaluation of eight abdominal exercises for their ability to provide stabilization for the lumbar spine in 1990.	Eight abdominal strengthening exercises were investigated to evaluate their ability to promote stabilization of the lumbar spine. Twenty-three healthy volunteers aged between 18 and 32 participated in the study. During each of the selected exercises, surface electromyography was used to measure the level of motor unit activity in the right upper rectus abdominis, the right lower rectus abdominis, the right oblique abdominis, and the right lumbar para-vertebral muscles. A formula, based on the relative importance of each muscle in the proposed stability pattern was devised and used to give a single 'stability' score to compare each of the eight exercises tested.	Results indicated that the exercises that involved applied rotatory resistance to the trunk appeared to activate a more appropriate stability pattern for the lumbar spine.

FLEXIBAR[11,12,13,14,15]

The use of flexible poles and flexibars in vibration exercises is effective in improving stability and muscle coordination. These exercises generate vibrations at specific frequencies, such as 5Hz and 4.6Hz, which are transmitted throughout the body. The active vibration exercise using a flexibar stimulates the proprioceptive senses of the joints and causes the tonic vibration reflex in the enthesis, leading to muscle contraction and adjustment of instability during exercise. This type of exercise has been reported to improve trunk muscle thickness, balance, and spinal stability. The vibration stimulation applied to muscles during these exercises also provides strong proprioceptive stimulation, which has a significant impact on movement perception in both healthy individuals and patients with neurological disorders. Furthermore, whole-body vibration exercise can activate muscle spindles and strengthen proprioceptive senses, thereby enhancing postural stability. Overall, these findings highlight the effectiveness of vibration exercises using flexible poles and flexibars in promoting physical stability, and muscle coordination, and improving various aspects of health and well-being.

Variations of the Bar and Oscillatory Force

Table 1: Visualising Bar and Oscillatory Force

STANDARD (RED)	INTENSIVE (BLUE)	ATHLETIC (BLACK)	KIDS (GREEN)
Standard version, ranges of use to cover all indications.	In contrast with the standard Flexi-Bar, the Intensive Flexi-Bar was specifically developed for the management of obesity and weight issues and requires a more forceful swing, which burns fat faster and more effectively.	This Flexi-Bar was specifically designed for advanced and experienced athletes who already have existing successful training routines with the bar and who desire a more demanding load	For children ages 7 - 14 years due to the frequent occurrence of postural disorders in children and young teens. Its measurements and weight have been customized to this model's design following the most current findings on the subject.

PRACTICAL USES AND TRAINING VARIABLES

The intensity of the training is determined by different variables and combinations thereof.

Table 2: Variables Influencing Training Intensity

1	Amplitude motion size Speed of movements
2	Regularity of rhythm (rhythmic or irregular) Frequency of movements
3	Direction of movements Length of training session
4	Number of participating joints Angles or planes of swing
5	Direction of swing Elbow position
6	variations of grips (supination, pronation, inward- or outward-rotation
7	Intmigration of rotation (i.e. in the glenohumeral articulations of extension, adduction, inward rotations after flexion abduction outward rotations)
8	distance of the bar from the body while swinging it, e.g. sagittal elbow extension flexion, upper body right-left rotation, shoulder adduction, and abductions)
9	Dual-task exercise (plus breathing, plus squat, plus crunch, plus leg lift, plus knee lift)
10	In combination with Pilates, Yoga, Thera-Band, Balance-Pad, gyroscopic exercise, trampoline, exercise ball, and Pezzi Ball.

BASIC AND STARTING POSITION WITH SIMPLE VARIATION

- Foot position: at hip width and parallel (heightened stability of pelvic area)
- Foot arch in 3-point position (even distribution of pressure on the heel bone, 1st and last toes)
- Knees: slightly outward
- Pelvis: pelvic neutral
- Buttocks: contracted
- Stomach: pulled in (indirect activation of transverse abdominals and pelvic floor)
- Chest: lifted up
- pull shoulder blades together during all exercises (shoulder adduction and scapular depression)
- Shoulders and pelvis should make as few compensatory movements as possible
- If the bar stops swinging, start over - wrists: neutral (0) position
- Thumbs: neutral (0) position (adduction)
- Thumbs: 90° position (abduction)
- Head in a neutral position (gently nod the chin towards the chest)
- Long, deep breaths to expand the rib cage to its fullest.

DETERMINING PROPER INTENSITY

The desired level of intensity is dependent on the respective exercise being done, the level or amplitude of one's arm, the intensity of the oscillations, and for how long the oscillations are maintained.

- **DEGREE OF SWING (BASED ON AN AXIS)**
  - ✓ Easy: Level 1 – 5 to 10 degrees
  - ✓ Intermediate: Level 2 – 10 to 20 degrees
  - ✓ Hard: Level 3 – 20 to 50 degrees max
- **DURATION**: The duration of the oscillations can be anywhere from a few seconds to over a minute per exercise.

These recommendations are approximations and should be based primarily on the subjective responses of the patients, as well as their medical profile, age, gender, constitution, and physical condition.

TRAINING FREQUENCY

When starting a training program with flexible poles or flexibars, it is important not to overdo it. It is advisable to incorporate short breaks into the routine and alternate with other exercises that do not involve oscillating the bar. The recommended frequency of training is ideally 2-3 times per week, with each session lasting at least 10-15 minutes. It is recommended to start with lower amplitudes and gradually increase intensity. The duration of oscillations should be based on the individual's strength, endurance, and coordination skills. Initial difficulties are normal and should not discourage one from continuing the training. It is beneficial to switch upper-body positions, such as flexion, lateral inclination, and rotation, while the bar is still swinging as this activates the muscles and provides protection to the back.

Table 3: Indications and Contraindications Overview

INDICATIONS	CONTRAINDICATIONS
1.Degenerative and chronic spinal disorders 2.protruded/prolapsed discs 3.Spinal canal stenosis 4.Spondylolisthesis (slipped disc) 5.Disorders of the cervical, thoracic, and lumbar vertebrae 6.Post-surgical ailments following spinal and vertebral disc operations 7.Intervertebral disc training 8.Scoliosis therapy 9.Rehabilitative care for spinal and pelvic fractures (bone fractures) 10.Muscular imbalances and damaged/weak posture 11.Back training, postural training 12.Joint flexibility and mobility training 13.Stretching/flexing exercises with vibrations transferred to the musculature 14.Back, shoulder or neck strain 15.Headaches, backaches 16.Improvement of sensorimotor skills 17.Prevention of falls in older adults 18.Coordination training 19.Obesity and weight management 20.Torso rotation training and training of rotation-stabilizing muscles (joint stabilization training of the muscle multifidi)	1.Extreme hypertension 2.Acute inflammations of any body parts to be involved in the exercise 3.1-2 weeks after intervertebral disc surgery 4.Advanced disorders of intervertebral discs, with neurological symptoms 5.Coronary heart disease in acute stages 6.The first few months following a heart attack - heart failure or inflammatory heart disease 7.Arteriosclerosis (peripheral arterial vascular disease stages III or IV) 8.Brain aneurysm 9.Abdominal aortic aneurysm 10.Third trimester of pregnancy 11.Malignant tumors and metastasis

EMG ELECTRODE PLACEMENT:

Surface electrodes were used to measure the electrical activity of specific muscles. The electrode placements for each muscle were as follows:

- ✓ Rectus abdominis: the electrode was attached to the midline of the muscle belly between the umbilicus and pubic bone.
- ✓ External Oblique: The electrode was placed 15cm lateral to the umbilicus.
- ✓ Internal Oblique: The electrode was attached at the midpoint between the anterior superior iliac spine (ASIS) and the symphysis pubis.
- ✓ Erector Spinae: The electrode was placed 2cm lateral to the belly at the height of the first lumbar vertebra.

A reference electrode was placed on the inner third of the clavicle shaft.

To standardize the muscle's action potential, the maximal voluntary isometric contraction (MVIC) was used. Each position was held for 7 seconds to reduce measurement variation at the start and end points of the exercise.

During analysis, the muscle activity was measured for 5 seconds, excluding the first and last second to focus on the consistent activity period.

The EMG values were measured in microvolts (uV).

Discussion

This study indicates that the impact of Flexibar exercises on trunk muscular strength can vary with nonflexibar exercises. A study has shown that the impacts of flexibar exercises on trunk muscular strength differ. While some have revealed severe increases in trunk muscular strength through Flexibar training, others have resulted in no differences from typical resistance training or control groups. As proven by studies, core stability, and typical resistance training significantly increased Trunk Muscular strength. Potential reasons might be differences in study designs, the type of exercises performed, exercise regimes, and other participant characteristics.

Trunk muscular stability is necessary to keep the spinal alignment and help manage external forces. Deep stabilizers of the trunk may be activated by oscillatory or vibratory exercises called Flexibar, resulting in more stamina and energy (additional information on Flexibar workouts was provided in the above text section). There was no discussion regarding the precise impact of Flexibar exercises on trunk muscular stability due to a lack of adequate information. However, the findings show the results of other non-flexibar activities. Additional research should be conducted to see how comparable these outcomes can be transferred to the Flexibar itself.

Trunk muscle function refers to an individual's ability to perform daily activities and sports-specific movements efficiently. The vibration characteristic of the flexi-bar creates a strong proprioceptive stimulation, which has a significant effect on movement perceptions not only in healthy individuals but also in patients with a variety of neurological disorders. In summary, the vibration resulted in the creation of strong external loads by intense stimulation of the muscle proprioceptors, thereby increasing the trunk activities during the exercise. Flexibar exercises have been found to enhance trunk muscle function, but further research is needed to understand their impact on functional performance. Stabilizing the spine during daily activities can increase the risk of future spinal pathology, even in those without low back pain. The flexi-bar has been demonstrated to strengthen the TrA muscle, however, further research is required to evaluate pain, function, and disability in LBP patients. As stabilizing regimens and training become more prevalent, there is a rising demand for a reliable, inexpensive, and quantitative measurement and monitoring system to assess the efficacy of exercise programs.

Conclusion

The study reveals that strength training increases trunk muscle strength, with flexi-bar exercise and non-flexibar exercise strengthening core stability. Vibration training using Flexibar has a more beneficial effect than stabilization training, as it produces 270 vibrations per minute and immediately activates trunk muscles, potentially aiding the rehabilitation of low back pain patients.

Acknowledgement: Not applicable

Conflict of Interest: There is no conflict of interest.

Funding: Self-funded study.

Ethical Clearance: Not applicable

References

1. Kim JH, So KH, Bae YR, Lee BH. A comparison of flexi-bar and general lumbar stabilizing exercise effects on muscle activity and fatigue. J Phys Ther Sci. 2014;26(2):229-33.
2. Chung JS, Park S, Kim J, Park JW. Effects of flexi-bar and non-flexi-bar exercises on trunk muscle activity in different postures in healthy adults. J Phys Ther Sci. 2015;27(7):2275-8.
3. Lee SJ, Kim YN, Lee DK. The effect of flexi-bar exercise with vibration on trunk muscle thickness and balance in university students in their twenties. J Phys Ther Sci. 2016;28(4):1298-302.
4. Hurley L. Strengthening transversus abdominis in subjects with a history of lower back pain and asymptomatic individuals: The Flexi-Bar vs stabilization training [master's thesis]. Birmingham: School of Health Sciences at the University of Birmingham; 2007 Oct.
5. Morris JM, Lucas DB, Bresler B. Role of the trunk instability of the spine. JBJS. 1961 Apr 1;43(3):327-51.
6. Richardson C, Toppenberg R, Jull G. An initial evaluation of eight abdominal exercises for their ability to provide stabilization for the lumbar spine. Aust J Physiother. 1990 Jan 1;36(1):6-11.
7. Norkin CC, Levangie PK. Joint structure & function: a comprehensive analysis. (No Title). 1992 Jan.
8. Chaurasia BD. BD Chaurasia's Human Anatomy Regional and Applied, Dissection and Clinical Volume 3: Head, Neck and Brain. CBS publishers; 2004.
9. Buchbauer J. Gerategestutze Krankengymnastik und medizinische Fitness. KRANKENGYMNASTIK. 2004;56(4):628-39.
10. Wang JS, Park SE, Shin HJ, Choi WS, Kim HR, Kim BK, Park JH, Lee JH, Min KO. The correlation between flexi-bar exercise and trunk muscles strength and body composition in juvenile soccer players. Journal of international academy of physical therapy research. 2015;6(1):781-7.
11. Gunsch MD. Die Behandlung des patellofemoralen Schmerzsyndroms mit Kompression und deren Wirkungsweise ("Treatment of patellofemoral pain syndrome with compression and its effectiveness"). Z.f. Physiotherapists. 2006;58(1):21-3.
12. Colby LA. Therapeutic exercise: Foundations and techniques. FA Davis Company; 2007.
13. Kling M. Markenbildung für die Physiotherapie-Praxis. Physiopraxis. 2003;7:44.
14. Müller-Wohlfahrt HW, Schmidtlein O. Besser trainieren!: den ganzen Körper und nicht nur Muskeln stärken;[so lernen Sie von den neuen Erfolgsstrategien der Profis; was der Arzt und der Fitness-Coach der Fussball-Nationalmannschaft empfehlen]. Zabert Sandmann; 2007.
15. Frisch H. Programmierte Therapie is Bewegungsapparat ("Programmed musculoskeletal therapy"). Berlin: Springer; 2003.