



Different types of Corrective exercises on Correction of Hyper Lumbarlordosis in Females- A Narrative Review

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Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 09 Nov 2023	<p>Back ground: Lumbar curvature carries the upper body weight and transfers it directly to the pelvis, which is of great significance. The structures in the lumbar region are one of the factors that affect the lumbar-pelvic balance, as well as the performance of lumbar lordosis and pelvic tilt. Also, weakness of abdominal, dorsal, and lumbar muscles has been considered as the most common factors increasing the lumbar curvature. Excessive lordotic curvature is also called hyperlordosis, hollow back, saddle back and swayback. Common cause of excessive lordosis includes tight low back muscle, excessive visceral fat, and pregnancy. Objectives: This review aimed at finding and analysing different forms of corrective exercises to correct hyper lumbar lordosis in females. Methods: The search was performed through online for English language articles. The databases used were Google 'corrective exercises' and 'lumbar lordosis'. The scientific literature related to physiotherapy management for lumbar lordosis published from 1997 to 2021 was searched. Screening of the reference lists of all the retrieved articles was also done. Through online database search 100 articles were reviewed, 19 articles were included in this study based on predetermined inclusion criteria. Inclusion criteria: Based on gender (only female's participant's studies). Participants: Studies had included individuals with hyper lumbar lordosis with pain or without low back pain. Conclusion: 16 articles show Corrective exercises plays a main role in reduction of lumbar lordotic curve and functional disability. With the help of corrective exercises (abdominal muscle strengthening exercises, gluteal strengthening exercises hip flexor stretching exercises, back stretching exercises) can maintain the core stability of spinal extensors and flexors, due to this, spinal curvature can be corrected indirectly and the posture is corrected and the spasm get released, pain will be subsided, finally the quality of life will be improved.</p>
CC License CC-BY-NC-SA 4.0	Keywords: Corrective exercises; Lumbar lordosis; Correction

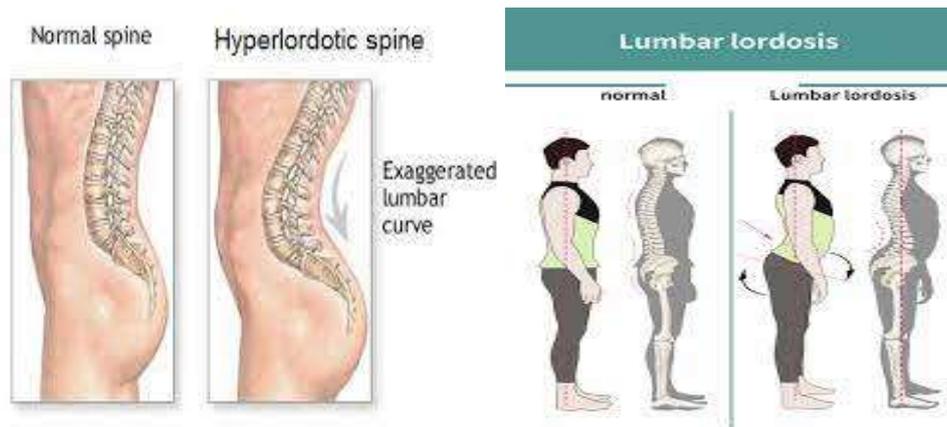
1. Introduction

In sagittal plane, lumbar lordosis is a key feature for maintaining balance. Spinal curvature in the sagittal plane, especially lumbar lordosis, is necessary for effective weight bearing, increasing efficiency of paraspinal muscles, and maintaining erect posture [2]. The balance of the muscles around the pelvis is an important factor in maintaining the lumbar lordosis. Lumbar lordosis is the ventral curvature of the spine formed by wedging of the lumbar vertebrae and intervertebral discs. [1] It is defined as the angle between L1-S1. [4] With normal lumbar lordosis, energy expenditure and stress on the supporting structures is minimised when balance is maintained between the lumbar spine and abdominal musculature [5]. Excessive lordotic curvature is also called hyper lordosis, hollow back, saddle back and swayback (31). Common cause of excessive lordosis includes tight low back muscle, excessive visceral fat, and pregnancy. Although lordosis gives an impression of a stronger back, incongruently can lead to disc degeneration, nerve root compression and wear and tear to all structures of lumbar spine and surrounding soft tissues cause moderate to severe low back pain (29). Abdominal muscles are being weak and the rectus femoris, quadriceps being tight are signs that improper muscles are being worked while pedestrian activities which leads to lumbar lordosis (30). The most obvious signs of lumbar lordosis lower back pain in pedestrian activities as well as having the appearance of a swayed back. All of these are signs that damage is being done, and preventive action needs to take place. Hence lumbar hyper lordosis is not a fixed condition like scoliosis and kyphosis, it can be reversed. This can be accomplished by stretching the lower back, hip flexors, and strengthening abdominal and hamstring muscles (27,33,26).

Abnormal curvature of the spine can create increased stress on the body which can, overtime, lead to muscle imbalance. One of the most important postural deformities of the spinal column is lumbar hyper lordosis which means exaggerated curve of lumbar spine. According to previous studies, the normal lordosis angle is 30° and angles $>40^{\circ}$ are considered as hyper-lordosis [14]. Normally, the abdominal muscles rotate the pelvis posteriorly and, the erector spinae muscles tilt the pelvis anteriorly. Correct activation of muscle or groups of muscles results in normal compressive and tensile forces occurring at the lumbar spine. There are minimal stresses placed upon the intervertebral disc and the zygapophyseal joints with lumbar spine in neutral position [5].

Line of gravity lies slightly posterior which causes extension of lumbar spine. Anterior longitudinal ligament and iliolumbar ligaments as well as, the anterior fibres of the annulus fibrosus of the intervertebral disc and zygapophyseal joint capsules provide passive opposing forces which are necessary to counteract extension of lumbar spine. Active opposing forces are also provided by abdominal muscles which is necessary to counteract extension at the lumbar spine [6]. Because of relationship between the sacrum and the pelvis through the spine, any change in the biomechanics of sacro-pelvic region leads to changes in spinal curvatures, especially the lumbar lordosis [3]. Various anomalies are caused in the lumbar and pelvic regions when body balance is affected by any increase or decrease in lumbar curvature [10]. The lumbosacral region is the most important region in the vertebral column in terms of mobility and weight bearing. Mechanical disorders of this region cause LBP [12]. Various studies have examined the relationship between changes in the angle of the lumbar spine and back pain [13]. Among the causes of LBP, the alteration of lumbar curvature on sagittal plane mostly due to aberration of posture plays a great role on LBP. [14] The restoration of lumbar lordosis is important in the restoration of the balance in the sagittal plane of the spine [15]. Lumbar curvature carries the upper body weight and transfers it directly to the pelvis, which is of great significance. The structures in the lumbar region are one of the factors that affect the lumbar-pelvic balance, as well as the performance of lumbar lordosis and pelvic tilt [11]. Also, weakness of abdominal, dorsal, and lumbar muscles has been considered as the most common factors increasing the lumbar curvature [10].

Hyper lordosis causing changes in its surrounding structures



When the lordotic angle of lumbar spine is more than 45° it is termed as hyper-lordosis [9]. In hyper-lordosis there is compression of the posterior vertebral bodies and the posterior zygapophyseal joints since they are in a close-packed position, which increases intervertebral disc pressure and narrowing of intervertebral foramina. There is excessive stretching of the anterior longitudinal ligament and abdominal muscles while shortening of lumbar spine extensors, posterior longitudinal ligament, interspinous ligaments and ligamentum flavum [5].

Physiological changes after hyper lordosis

With a hyper-lordotic lumbar spine posture there is impaction of the zygapophyseal joints. The resultant alteration in the spinal biomechanics results in decreased range of motion of the lumbar spine. The inflammation from the dysfunction phase of the degenerated intervertebral disc along with the decreased range of motion results in the hypersensitivity of proprioceptors and nociceptors in the intervertebral disc, ligaments, joint capsules, zygapophyseal joints and nerves. This hypersensitivity initiates a reflexogenic response thereby inducing muscle spasm [7].

How lumbar hyper lordosis causing low back pain

An increase in lordotic angle proportionally increases the shearing strain or stress in the anterior direction and shifts the centre of gravity anteriorly. This increased angle and stress are thought by some to be associated with poor posture and back pain. From a biomechanical point of view, the accentuated lumbar lordosis is associated with an increased prevalence of low back pain [9]. However, several studies have concluded that low back pain is not directly related to lumbar hyperlordosis. There are factors that contribute to a higher amount of lumbar lordosis. These etiological factors, like the weakness of the trunk, short back muscles, weak thigh, and hamstrings, etc. in turn can cause low back pain. It is important to mention that not solely the lumbar hyperlordosis is the causing factor for low back pain. It is thus not reasonable to conclude that there is a relationship between LBP and the size of the lumbar lordosis [10]. On the other hand, it is likely that trunk muscle weakness can influence the shape of the lumbar lordosis and might be a cause of LBP. The multifidus, transversus abdominis and internal muscles in the trunk act late in patients with hyperlordosis. [9] There is a correlation between the weakness of the trunk muscles and an increased lordotic angle, which can be a cause of low back pain [11]. Weakness in any of the muscles of the lumbar-pelvic belt can follow pelvic rotations and diversions of back-arc by impairing muscular balance in this area and thus a person can be prone to musculoskeletal disorders. [9] There are various factors affecting lumbar lordosis. Some studies show that the range of lumbar lordosis is affected by age, sex, movement in the center of mass such as pregnancy and obesity [9]. People with low back pain have reduced lumbar ROM and proprioception. Their stabilizing muscles act more slowly compared to people without LBP. Normally the stabilizing muscles are activated before the movement is initiated, but in people with low back pain, this contraction is delayed [12]. Changes in postural patterns have been indicated as a risk factor for developing pain in the lumbar region, since abnormal posture causes tension in the ligaments and muscles, which indirectly affects the lumbar curvature, thus triggering pain.

How the exercises reduce lordosis

Hyper-lordosis can be corrected with exercises. Exercises should be such that hip flexors and back extensors will be lengthened and abdominal muscles and hip extensors will be strengthened. Strengthening exercises send normal signals to the neuromuscular control unit, which generates muscle response patterns to activate and coordinate spinal muscles to provide muscle mechanical

stability. Repetition of strengthening exercise has a role in the reduction of pain by increased plasma concentration level of beta endorphins and activation of ergoreceptors (the ending of delta fibers) which stimulate enkephalinergic nerve cells in the thalamus which decrease the pain and improve functional activities [20]. Stretching exercise reduced muscle tension and relieved the compression on muscles nociceptors and on the nerve root and broke the vicious circle. also, it decreased cellular connective tissues in paravertebral muscles and decreased muscle stiffness which leads to a reduction of pain [21]. William's flexion exercises which are designed to alter spinal curvature due muscular imbalance. Asper the study in hyper lordosis the back flexor and hip extensor goes for weakness and back extensor and hip flexor goes for tightness. William flexion exercise include active stretching and strengthening of this muscle group. In a study by Stan E Blackburn has shown that electromyography activity during William's exercise with posterior tilt is minimised in lumbar and sacral regions are occurs in conjunction with lengthen of the tight muscle during posterior tilt. Thus, it proves the postural changes during William's exercise [2,28]. These exercises accomplished a proper balance between the flexors and the extensors group of postural muscles. William's flexion exercises stretch the ligamentous structure of the back, open the vertebral canal thus it helps to reduce the pain and the exaggerated lumbar lordotic curvature. The result is best obtained by maintaining a posterior pelvic tilt during the exercise [2,28,29]. McKenzie manual correction exercises work on spinal movement and curvature. In this study all the manual correction exercises are derived from McKenzie flexion-based exercise which is effective to correct the hyperextension of lumbar vertebra otherwise known as hyper lordosis of back. The exercises centralize the pain and effective in acute stage [20]. Lumbar hyper lordosis could have been reduced with Pilate's intervention due to the following reasons. Hyper lordosis is characterized by tightness of the lumbar multifidus, thoracolumbar fascia, erector spinae, rectus femoris and iliopsoas along with weakness of abdominal muscles, pelvic floor muscles and asymmetrical tension in lumbo pelvic region. Pilates exercises focus on core and breath control that activates local muscles especially the diaphragm, lumbar multifidus, pelvic floor muscle, transverse abdominal muscle, and the obliques [6]. Another possible reason for the change in lumbar lordosis angle and the anterior pelvic tilt could be that Pilates exercises involve muscle conditioning that focuses on recruiting most abundantly used motor units. Type I fibers are recruited the most in day-to-day activities which are abundant in mitochondria, oxidative enzymes, and capillaries. Pilates exercise mainly focuses on Type I fibers, thereby improving the strength and endurance of these fibers at the lumbar spine. This improvement will enhance synchronous stimulation of these motor units conditioning the muscles that are responsible for maintaining lumbar lordosis [9].

In the present study Pilates exercises also showed improvement in an anterior pelvic tilt. This could be due to the fact that Pilates exercises focus on posterior pelvic tilt. Posterior pelvic tilt has been promoted to cause co-contraction of the local stabilization musculature. This will recruit abdominal muscles thereby preventing excessive anterior pelvic tilt which will reduce the lumbar hyper lordosis [34]. Habibi *et al.* stated that the weakness of anterior pelvic muscle causes an increase in lumbar lordosis. Secondly, hamstring muscle is connected to the pelvic bone. Changing the length of hamstring can change the position of pelvis thereby correcting and changing the spinal curvatures [35]. The main motive of the Egoscue Method is to apply corrective exercises to get the whole body or the spine closer to "ideal" posture which will help in reducing the pain. Exercises selected were mainly focused on the lumbar and pelvic region. This might have corrected the posture at the lumbar spine and the pelvis in turn reducing the curvature of the lumbar spine and pelvic tilt. The exercises included have caused more of the posterior tilting at the pelvis than the anterior tilting. Egoscue exercises have stretched and strengthened the muscles effectively in order to correct the spine and the pelvis posture. They are majorly corrective exercises and the main focus of these exercises is that it corrects the whole-body posture [32]. Lumbar stabilization exercises are said to reduce the load on the spine and reduce the stress on the spinal structures [36]. Stabilization exercises have been planned to improve the neuromuscular control system and perfect the dysfunction. Lumbar stabilization exercises help in enhancing motor units which are regulated by a large unit muscle system as well as the local muscular system. This helps in building up the postural control of the muscles of the trunk and abdominal [37].

2. Materials And Methods

The search was performed online for English language articles. The databases used were Google 'corrective exercises' and 'lumbar lordosis'. The scientific literature related to physiotherapy management for lumbar lordosis published from **1997 to 2021** was searched. Screening of the reference lists of all the retrieved articles was also done. Through online database search 100 articles were reviewed, 16 articles were included in this study based on predetermined inclusion criteria.

Inclusion criteria: Based on gender (only females participants studies).

Participants: Studies had included individuals with hyper lumbar lordosis with pain or without low back pain

Intervention: studies with the experimental intervention had to give physiotherapy treatment in form of strengthening program Treatment includes are, Pilates, egosue exercises, lumbar stabilization exercises, traditional exercises, corrective exercises, NASM corrective exercises ,hydrotherapy exercises, dry land exercises, Swimming Technique Backstroke, abdominal strengthening exercises, Stretching Exercises, Williams exercises, McKenzie session duration, frequency and division of group for comparison of treatment were recorded to assess the similarity of the interventions among the studies.

Outcome measures outcome measure is: lumbar lordosis angle. The articles were excluded in the study for review, if they were not relevant to lumbar lordosis, were not given physiotherapy treatment or given post-operative physiotherapy treatment, were published in other languages, were systemic reviews/meta-analysis and their full texts were not available. Details of the 16 articles included for final analysis, is shown in Table-1. To make recommendations based on a high level of evidence (1a), this review included only hyper lumbar lordosis correction studies.

causes is postural adaptation [2,18]. These mechanical changes are well described in a study titled relation between mechanical factors and incidence of low back pain by Mohammad Reza Nourbakhsh and Amir Massoud Arab in 2002. Both these exercise protocols are designed to alter the postural adaptation by strengthening the muscles group [28].

Habibi *et al.* stated that the weakness of anterior pelvic muscle causes an increase in lumbar lordosis. Secondly, hamstring muscle is connected to the pelvic bone. Changing the length of hamstring can change the position of pelvis thereby correcting and changing the spinal curvatures [44]. Nourbakhsh, *et al.* found no significant relationship between LBP occurrence and the degree of lumbar lordosis and concluded that the degree of lumbar lordosis did not differ between normal subjects and those with low back pain. This can be explained by the wide variation of the degree of lumbar lordosis among normal subjects (39,41) and any changes that might occur sooner or later may still within this normal range and that large variation of pelvic morphology masks any difference in pelvic tilt between normal subject and a group of LBP [42]. In contrast to the study done by Davis, *et al.* where the pain was reduced without change in lumbar curve. Literature shows that hyperlordosis of the back is not a fixed condition like scoliosis or kyphosis, it is mostly acquired and can be reversible [32].

In a study on 2010 titled Comparison of three therapeutic exercises protocols to lumbar hyper lordosis improvement in asymptomatic youths has shown that hyperlordosis is a reversible condition by using different exercises protocol and in this study Williams flexion exercise is one of the criteria [19]. In another study on 1984 by David Joseph Ponte titled A Preliminary report on the use of the McKenzie Protocol Versus Williams Protocol in The Treatment of low back pain has shown that both these exercises are used in back pain has a significant improvement. Whereas in this study McKenzie group has shown better improvement than William exercise group [6]. In the above-mentioned study McKenzie extension and flexion exercise were used as an intervention to improve back pain, but in this present study only flexion exercise is used to correct the exaggerated lumbar lordosis which relieves back pain, in this study Williams group has shown better improvement than McKenzie group in relation to hyper lumbar lordosis, back pain and disability. Anand Kalaiselvan 2018 Williams flexion exercise is found to be effective than McKenzie manual correction technique. These exercises accomplished a proper balance between the flexors and the extensors group of postural muscles. William's flexion exercises stretch the ligamentous structure of the back, open the vertebral canal thus it helps to reduce the pain and the exaggerated lumbar lordotic curvature. The result is best obtained by maintaining a posterior pelvic tilt during the exercise [2,28,29]

Farzam, 1995; Greene & Roberts, 1999; Hamill *et al.*, 2006; Carter *et al.* 2002 evaluated the effect of stretch exercises and concluded that corrective exercises affect chest kyphosis and low back lordosis abnormalities and reduces spinal curvature (Carter *et al.*, 2002). Hindle *et al.* evaluated the mechanism and the effect of neuromuscular stretching exercises on motor range and performance and muscles' function. They concluded that neuromuscular stretching improves muscular power and increases motor range (Hindle *et al.*, 2012). Myer observed in his study the significant decrease of low back lordosis angle. Strength trainings affect the tendon length of muscles and displace different skeletal sections and stabilize ligaments. On the other hand, stretch exercises serve as the coordinator of agonist and antagonist muscles. Therefore, such exercises increase the length of muscles in concave side, increase power of convex side and in turn decrease abnormalities. Behnaz KARIMI (2018) revealed that combined exercises can decrease low back lordosis abnormalities, mitigate pains induced by sciatic abnormalities and promote the quality of life of the studied cases. Combined hydro and dry land-specific exercises are used as supplementary exercises in order to mitigate the tiredness and monotony of exercises and promote the effectiveness of exercises with respect to pain level. Significant increase of the quality of life of the studied cases after exercises. This agrees with the results of Rozenzwick *et al.* (2010), Carlson *et al.* (2012), Cool *et al.* (2010) and Moron *et al.* (2008). Participating in physical activities provide a proper structure for socialization. The patients who participate in exercising programs show better mental and intellectual performance. Sport plays a vital role in mitigating mental stresses. In addition, people who regularly exercise have higher percentage of body net mass compared to inactive people (Rosenzweig *et al.*, 2010; Carlson, Linda, 2012; Colle *et al.*, 2010; Morone *et al.*, 2008). Magora [45] reports that changes in the spinal curvature of patients with low back pain are a reliable indicator of severe low back pain. In contrast, Day *et al.* [46] and during *et al.* [47]. Report that spinal curvature is unassociated with low back pain. Jackson and McManus (48) report that the mean LL Asin healthy adults and low back pain patients were 60.9° and 56.3°, respectively. Furthermore, Kim [49] applied trunk stabilization exercises and found that lumbar lordosis was significantly lower after treatment. That in the control group Hwang (50) studied the effects of a gymnastics program aiming to relieve low back pain and reports the LLA increased significantly in the gymnasts after exercise. Choi [51] reports the LLA increased significantly after an

8-week core program for middle-aged women. Yoo [52] reports that low back pain decreased, limited lumbar range of motion was relieved, and pelvic tilt angle recovered after individual strengthening exercises were implemented in patients with excessive lordosis.

Clinical evidence indicates that lumbar lordosis is associated with such factors as reduced strength of abdominal musculature; lack of flexibility in the trunk and hamstring muscles; weak posture during sleeping, sitting, standing, or walking positions; bad habits of lifting objects; and poor capability of facing anxiety [53]. Mahnaz Manshouril, Nader Rahnama (2014) The iliopsoas is the most important postural muscle and is gradually shortened due to normal daily life activities. Muscle becomes flexible by the kicks during backstroke swimming. The extensors and spine musculature also contribute to increased lordosis as a result of weakening. Again, backstroke swimming can strengthen these muscles to improve and reduce lumbar lordosis.

Out of 16 articles, one article discussed Neda Rezvankhah Golsefidi (2013) about detraining effect of exercises for lordosis Shavandi et al. indicated that 7 weeks of corrective exercises led to reduce the abnormalities, but the abnormalities increased again after 4 months of detraining [38]. The results of Sinaki *et al.* (2002) indicated that strength training led to reduce the abnormalities in women, but a follow-up of 8 years revealed that the strength of muscles reduced again and the angle of abnormalities increased [17]. Detraining decreases the muscular power and strength of teenagers to the level of the control group [13]. Faigenbaum *et al.* (1996) reported that a rapid and meaningful reduction occurs in the strength of teenagers after 8 weeks of detraining [8]. Fatma A. El-Hamalawy (2011). The current study introduced newly developed exercise program succeed to decrease pelvic tilt and consequently accentuated lumbar lordosis and support the relation between low back pain and accentuated lumbar lordosis. Gayatri S. Kudchadkar (2020) pilates, Egoscue exercises, and Lumbar stabilization exercises for 4 weeks were all effective in reducing the lumbar hyperlordosis angle and anterior pelvic tilt. Pilates exercises, Egoscue exercises, and Lumbar stabilization exercises for 4 weeks were all effective in reducing the lumbar hyperlordosis angle and anterior pelvic tilt. However, Pilates group and Egoscue group were found to be equally effective and superior to lumbar stabilization group. Further, ease of performance of exercise was rated highest for Pilates followed by lumbar stabilization which was followed by the Egoscue exercise. Roghayeh A froundeh, Rana Saidzanoi2(2016) Based on the findings, it is suggested that to treat lumbar lordosis both Pilates and traditional corrective exercises can be used. Both training methods may treat hyperlordosis with increase in the flexibility of back muscles and quadriceps muscles and with increase in the power of hamstring and of abdominal muscles. Abbaszadeh (2012) Upon 8 weeks corrective exercise, the amount of the back curved decreased significantly. There was a significant increase in abdominal muscle strength and endurance, and hamstring muscle flexibility. Varadharajulu1, Manpreet Bajaj (2021) it is concluded that this exercise protocol with posterior pelvic tilt is effective in reducing hyperlordosis of lumbar spine as well as improving abdominal muscle strength in asymptomatic individuals. Igsoo Cho (2015) Lumbar stabilization exercise is more effective than conservative treatment for improving functional disability and lumbar lordosis angles. Hadiseh Okhli (2019) the lumbar lordosis angle decreased in both NASM and Pilates exercises groups following the intervention, with NASM exercises resulting in more reduction in the lumbar curvature compared with Pilates exercises. Therefore, therapists and experts of corrective movements can make use of these exercises as novel approaches to correcting lordosis. Zeynab Javadipour et al combining core stability with stretching exercises can, in addition to improving chronic low back pain, reduce the severity of lumbar lordosis and the trunk muscle endurance and its balance. The study Majidi Siahtan Samira et al yielded the result that 8-week Pilates exercise has a significant result on the degree of lumbar lordosis and BMI in female students aged 15-18. With the help of corrective exercises (abdominal muscle strengthening exercises, gluteal strengthening exercises hip flexor stretching exercises, back stretching exercises) can maintain the core stability of spinal extensors and flexors, due to this, spinal curvature can be corrected indirectly and the posture is corrected and the spasm get released, pain will be subsided, finally the quality of life will be improved.

4. Conclusion

In this narrate review, 16 studies have been reviewed and from that we analysed corrective exercises were effective in reduction of lumbar lordosis and low back pain and disability, and improvement in core muscle strength in the lumbar region. we find relation between the lordosis and low back pain, and disability. Discussed about the detraining program after the treatment lead to change in reduction of lordotic curve. So, we feel there is a gap in the maintenance of lordotic curve after the treatment, from this review we want to create awareness regarding maintenance of the lumbar lordotic curve after the treatment, feel to do the research with combination of manipulatory techniques with corrective exercises program. Combination of techniques can reduce the lordosis and maintain the

lordosis reduction for long time, so the low back pain can be postponed, quality of life can be improved, hence the future studies should concentrate on this. 16 articles show Corrective exercise plays a main role in reduction of lumbar lordotic curve and functional disability.

Conflict of Interest: Nil.

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