CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter begins by describing two types of Olympic-style weightlifting: the snatch and the clean and jerk. Then factors affecting low back pain in weightlifters are discussed. Three main outcome measures investigated in current study including pain, lumbopelvic stability and quality of life are reviewed. Finally, the back school concept applied as an intervention for this study and research related to back school program are summarized.

2.2 Olympic- style weightlifting

Olympic-style weightlifting is a sport in which competitors lift heavy weights in two events: the snatch and the clean and jerk. In the snatch lift, weightlifters lift a barbell from the platform and pull it toward the chest level and then flip the barbell overhead. As weight is always heavy, weightlifters usually receive the bar in a squatting position. When the position is secured, weightlifters rise and complete the lift (Figure 2.1). Core stability, strength and flexibility of the shoulders, coordination and explosive power of the legs are required to generate the upward momentum to snatch heavy load overhead.

Figure 2-1 Snatch lifting (15)

For the clean lifting, weightlifters squat down to grasp the bar with a hook grip. The arms are relaxed and positioned just outside the legs with the bar up against the shins. The bar is then pulled up as high as possible through extension movement of the hips, knees and ankles. Next, weightlifters pull under the bar by contracting the upper trapezius muscles. This mechanism pulls weightlifters into deep squat position under the bar. Weightlifters then stand up and prepare for the jerk phase (Figure 2.2).

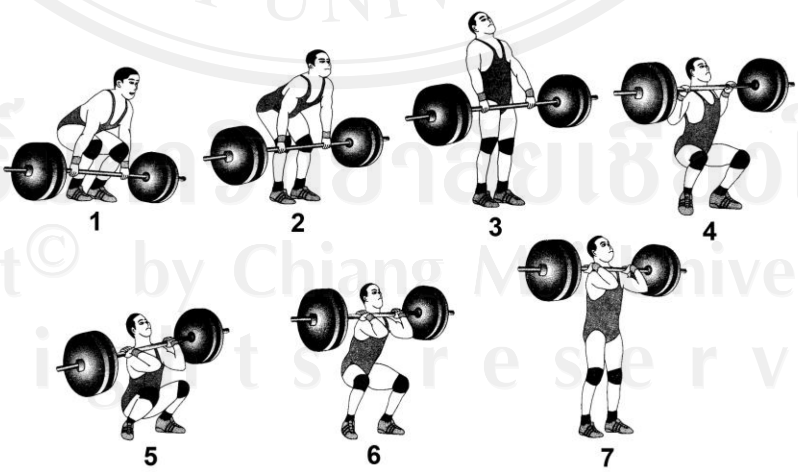

Figure 2-2 Clean lift (15)

From the standing position, both knees are bended and then straightened to push the barbell upwards. A split jerk is performed, in which one leg lunges forward while the other moves backward. The lifters hold the barbell overhead, keep the arms locked, and move the legs directly underneath the torso so that the entire body lines up in a single plane (Figure 2.3).

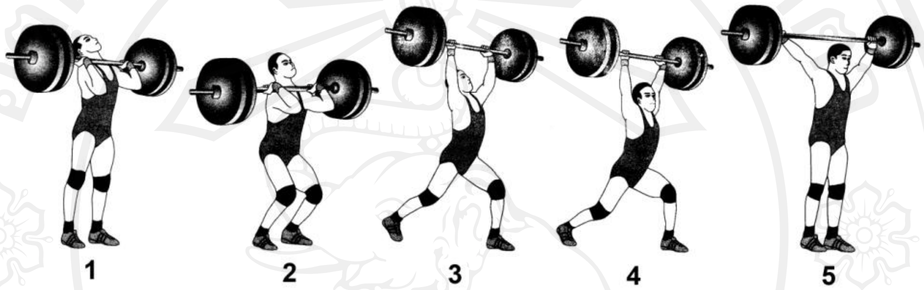

Figure 2-3 Jerk lift (15)

Specific and overload programs are used to improve performance of weightlifters. The process of overload training may lead to acute fatigues thus decrease performance. However, appropriate recovery could induce positive adaptation and improve performance (16).

During lifting, spinal column has a role in absorbing and transmitting force between the upper and lower limbs (17). Stability of the spinal column is the result of synchronization between spinal column (disk, ligaments and facets), core muscles (transversus abdominis (TrA), internal abdominal obligues (IAO) and multifidus) and neural control (16, 17). Dysfunction of one or more than one component may lead to compensation of other components to stabilize the spine (16).

2.3 Factors affecting low back pain in weightlifter

Low back pain is one of the most common problems found in weightlifters. Epidemiology study of back injury in USA found that incidence of this injury in weightlifters was 30-50% (9, 18). In Thailand, the prevalence of low back pain in weightlifters was 39% (10). Kulund et al suggested that most injuries occurred in the clean and jerk lift (19) while Thai national weightlifters reported low back pain during phase 1 of snatch and phase 1 and 5 of clean lift (10).

Lifting pattern including ballistic, repetitive, excessive load can lead to fatigue injuries (17). In weightlifters, ballistic and repetitive movement may induce more excitation of phasic fiber type than tonic fiber type. The effect of these mechanisms can decrease muscle endurance. Additionally, half-squat exercise with weight approximately 1.6 times body weight resulted in 10 times body weight of compressive loads across the L3-L4 (12). High intradiscal pressure and muscle and/or ligament injuries may occur from these excessive loads.

Several factors such as a recent change in the athlete's training , inflexibility of hamstring and hip extensor, muscle imbalance from deconditioning, improper technique and equipment, inappropriate load and recovery of training can contribute to back problems in weightlifters (17).

The most common factor reported was a recent change in the athlete's training procedure such as immediate increase in the intensity or frequency of training program (17). Both conditions were encountered at the start of a new season or before the main tournament and frequently initiated a painful back problem. Back components including muscle, tendon, and ligament may be injured from these activities (17).

Flexibility of hamstring and hip extensor can influence back problem in athletes (17). Hamstring tightness increases lumbar lordosis, while hip extensor tightness limits lumbar lordotic curve. Imbalance between hamstring and hip extensor makes the spine fail to resist the stresses of axial loading and transfers loading from spine and pelvis. Thus, it will increase stress to the spine and affects low back strain (17).

Muscle imbalance from deconditioning can predispose the weightlifters to back pain (17). During sport activity, abdominal and back muscles work together to stabilize spine. The ratio of trunk flexor strength to trunk extensor strength is 1:1.3. However, off season without maintaining a proper conditioning program may cause muscle imbalance (17).

Improper technique and poor equipment may also contribute to low back injured in weightlifting. A military press with excessive lordotic will place extreme strain on low back (17) and inappropriate belt may cause insufficient support at low back.

Finally, inappropriate load and recovery of training regimen can cause injuries in weightlifters (20). Inadequate recovery and excessive load of training with accumulation of stress result in decreasing short term performance capacity with or without physiological and psychological signs and symptoms of maladaptation. The restoration from this condition may take several days to several weeks. Consequently, continuum training procedure may induce long term decrement in performance capacity and long duration of restoration.

2.4 Measurement of pain

Pain has been defined as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" (21). In 1990s, the American Pain Society declared pain to be the fifth vital sign of medical examination (22). As pain is a highly personal experience therefore the patient is the best informance. Pain is a multidimensional phenomenon that includes physiologic, sensory, affective, cognitive, behavioral, and sociocultural aspects (23).

In low back pain, pain has been described as one of the important domains to be assessed along with back specific function, health status, work disability, and patient satisfaction (23). Pain is one of the best determinants of disability due to low back pain and is a predictive of return to work within the year following related short term absence (24).

The goals of pain assessment are to capture the individual's pain experience in a standardized way, to help determine type of pain and possible etiology, to determine the effect and impact the pain experience on individual and their ability to function, to develop treatment plan to management and finally to aid communication between interdisciplinary team members. Various pain measurement instruments have been developed to achieve the above goals.

Pain intensity can be used to express how much a patient is hurt when experiencing low back pain. It is a quantitative estimate of the severity or magnitude of perceived pain. The two most commonly used methods to assess pain intensity are the visual analogue scale (VAS) and numerical rating scale (NRS) (25). Both scales are commonly used in clinical and research settings.

A VAS consists of a horizontal line with stops and anchors at each end. The endpoints define extreme limits such as “no pain at all” and “pain as bad as it could be”. The patients were asked to mark the line at a point corresponding to the severity of their pain. The distance between “no pain at all” and the mark then defines the subject’s pain. A line-length of 10 or 15 cm showed the smallest measurement error, compared to 5- and 20- cm versions and seem to be most convenient for correspondents (25, 26) .

VAS is quick and able to be repeated regularly and does not require complex language. It is also sensitive to pharmacological and non pharmacological procedures which alter the experience of pain. Numbers of response categories are high because it is considered as having 101 response levels. This makes the VAS potentially more sensitive to changes in pain intensity. Validity of VAS of pain intensity is supported by many studies. It was found that pain intensity scores as measured by the VAS correlated well with other self-reported measures of pain intensity (27).

When assessing the effectiveness of treatment in CLBP patients, therapists are facing the question of minimal clinically important difference (MCID) or the smallest change that is important to the patients. Beurskens et al (28) assessed the responsiveness of the VAS in patients suffering from non specific low back pain for at least 6 weeks. It was concluded that the smallest change in VAS that was possible to detect with 95% probability beyond the measurement error in subacute or CLBP patients was at least 20 mm. Sloan et al (29) provided provisional benchmarks for MCID in pain intensity of chronic pain. Reductions in chronic pain intensity at least 10% to 20% reflected minimally important changes, ≥ 30% reflected at least moderate clinically important differences and ≥ 50% reflected substantial improvement.

NRS is measured by asking patients to rate the pain from 0 to 10 with the understanding that "0" represents no pain and "10" represents the other extreme of pain intensity i.e. pain as bad as it could be. The patient is asked to tick a score that best represents the intensity of the pain. NRS is easy to administer and to score; it can also be administered over the phone. The smallest change possible to detect with 95% probability beyond the measurement error is 2.5 (25, 26) and the highest value of the MCIC is 4.5 points on NRS (25).

2.5 Lumbopelvic stability

Lumbopelvic stability refers to internal stabilization gained by the isometric contraction of abdominal and lumbar muscles to maintain stability. It has also been referred as core strengthening, motor control training, and dynamic stabilization (30). Panjabi theorized that spinal stability is the synchronization of 3 subsystems: passive (spinal column), active (spinal muscles), and control (neural control) subsystems (16). A neutral zone is defined as being a midrange position with minimal resistance to displacement owing to minimal tension in the passive subsystem (16). The passive subsystem can not control the spinal movement per se. The stabilization can be attained by the cocontraction of the active subsystem (transversus abdominis (TA) and lumbar multifidus). This action increases the intra-abdominal pressure (IAP) and the tension of the thoracolumbar fascia. Consequently, stabilization of the spine is maintained by the IAP in the abdominal cavity and the stiffness of the lumbar spine to control excessive motion and to compensate for instability (16).

Lumbopelvic stability test is originally developed by Wohfahrt et al, called an isometric stability test (IST) (31). The test is an objective method for assessing the ability of abdominal muscles to actively stabilize the lumbar spine (31). A pressure biofeedback unit (PBU, Chatanooga Australia Pty Ltd) has been used to detect motion of the lumbar spine during lower extremity movement under external loads by indicating changes in the pressure reading (31, 32). The subject is required to maintain the desired pressure and a constant lumbar position by the pressure biofeedback unit that placed under the low back and inflated. Changes in the pressure during hip movement reflect an inability to maintain isometric contraction of the abdominal muscles, resulting in uncontrolled movement and instability of the lumbar spine

The IST is allocated in 1-5 ordinal level (31). The test is based on "the ability of subjects to perform isometric contraction of the abdominal muscles in order to hold the pelvis and lower trunk stable, while load gradually added by movements of the lower limb". However, reliability of the IST was not reported and many subjects could not reach the lowest score of the IST (33).

In 1999, the modification IST was developed by Hargin et al (33) from the basic guidelines suggested by Wohlfahrt et al (31) and Sahmann (34). A signal of movement compensations that failed to achieve the appropriate muscular control and quantity of verbal and instrumented feedback were defined. The progression of the test is based on the magnitude of torque that is defined by the mass of the legs and the moment arm from the center of mass of the legs to the axis of rotation.

To examine the level of lumbopelvic stability. Hargin et al have modified the original method of assessing of lumbopelvic stability into seven levels. Details are presented below (33).

Level l-Abdominal Hollowing

In the beginning, the subjects lie in crook position, place both hands on lower abdomen below the navel and feel the muscles tightening. Exhale and bring the belly button to the spine (Figure 2-4). This position is a starting position for the next level.

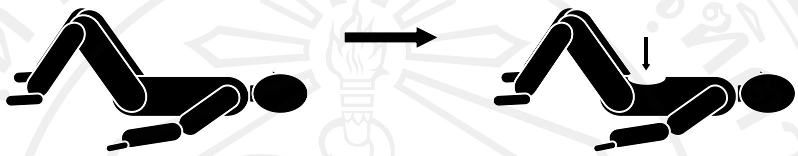

Figure 2-4 Abdominal hollowing

Level 2-Unilateral Abduction

From starting position, subjects maintain contraction of the belly and abduct the right leg approximately 45º to the floor while keeping the contralateral knee motionless. Return to the starting position (Figure 2-5). Subjects continue a normal breathing pattern throughout the exercise.

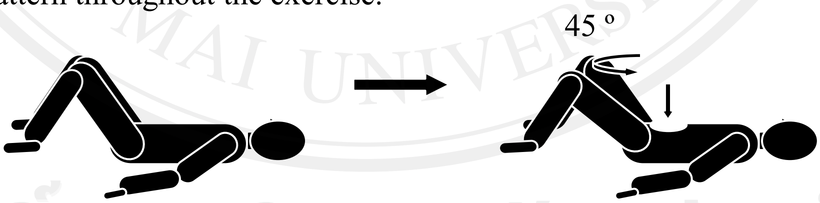

Figure 2-5 Unilateral abduction

Level 3-Unilateral Knee Raise

From starting position, subjects maintain contraction of the belly and slowly raise the right leg toward the chest until approximately 90 º of hip flexion with the knee naturally flex. Subjects are not allowed to press down the left foot while performing the lift or moved the head, neck, or shoulders. Then, return to the start position (Figure 2-6).

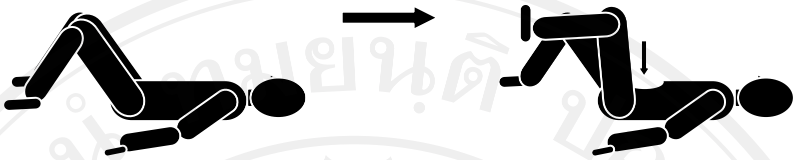

Figure 2-6 Unilateral knee raise

Level 4-A Bilateral Knee Raise

From starting position, subjects maintain contraction of the belly and raise right leg to hip flexion 90 degrees with knee flexion and slowly raise left leg to the same position. Return right leg to the start position and then left (Figure 2-7). Subjects continue to breathe normally throughout the exercise.

Figure 2-7 A bilateral knee raise

Level 5-Unilateral Heel Slide

From starting position, subjects maintain contraction of the belly and slowly raise one leg to hip flexion 90 degrees with knee flexion and slowly raise another leg to the same position. Slowly lower one leg to the floor, glide it out to the straight position and move it back to the starting position (Figure 2-8).

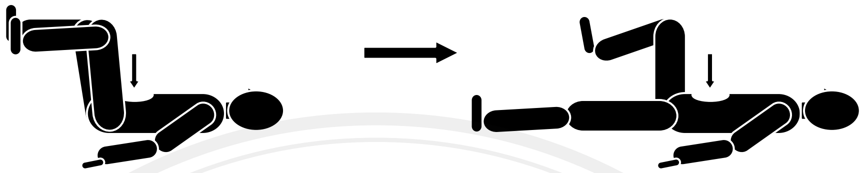

Figure 2-8 Unilateral heel slide

Level 6 Bilateral Heel Slide

From starting position, subjects maintain contraction of the belly and slowly raise one leg to hip flexion 90 degrees with knee flexion and slowly raise another leg to the same position. Slowly lower both legs together to the ground, glide both legs out to the straight position and moved them back to the starting position (Figure 2-9).

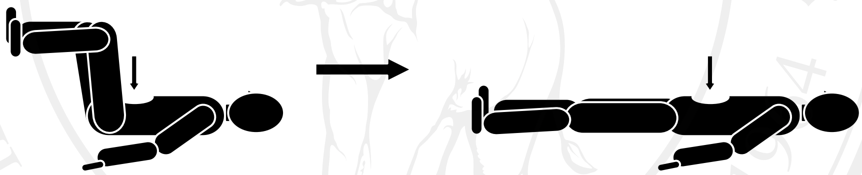

Figure 2-9 Bilateral heel slide

Level 7-Bilateral Heel Hover

From starting position, subjects maintain contraction the belly and slowly raise one leg to hip flexion 90 degrees with knee flexion and slowly raise another leg to the same position. Slowly lower both legs together to the ground and maintain heels approximately 12 cm. from the ground, glide the legs out to the straight position and moved them back to the starting position (Figure2-10).

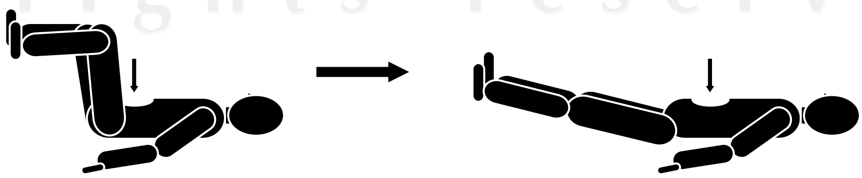

Figure 2-10 Bilateral heel hover

The transversus abdominis and lumbar multifidus are important deep muscles for this stabilization (16). It was also suggested that patients with low back pain demonstrate overactive of the rectus abdominis or external oblique muscles than cocontraction of these deep muscles (35). In addition, the patients with CLBP failed to contract the TA generally and cannot achieve a voluntary "hollowing" action of the abdomen attributed to the TA compared with patients without LBP(36).

Nowadays, physical therapists have focused on the muscular system as the most reachable and changeable contributors to lumbar stability (33). Neuromuscular dysfunction and fatigue of back and abdominal muscles in back pain can be improved both subjective and objective outcomes of treatment using lumbopelvic stability exercise.

Stabilization exercise programs were designed to train lumbar muscular control by specifically isometric contractions of the lumbar muscles while imposing progressively demanding loads through various extremity motions (37). The concept of exercise programs is to improve the ability of the muscular system to stabilize the spine in neutral position to avoid excessive lumbar segment motion (33). So, the higher lumbar segment motion can express the high levels of repetitive stress and tissue damage (33).

During muscle re-education, the protection of a neutral lumbar position allow healing of damaged tissue as being essential for the condition of a protective environment of the spine. Panjabi used the influence of lumbar muscle stability as method of restoring the neutral zone within normal physical limits (38). In addition the proprioceptive function of multifidus muscle may have an influence on the neuromotor element within the stabilizing system (39).

2.6 Quality of life

The World Health Organization (WHO) Constitution defined health as 'a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity'(40). The physical, mental, and social health statuses of an individual are interrelated at any point in time (40). Poor physical health can obstruct the emotional health, while mental illness and disorders such as depression or anxiety can stimulate poor physical condition (41). Both physical and mental disorders are strongly correlated with poor social and economic outcomes for individuals.

Chronic musculoskeletal pain (CMP) is a primary cause of the prevalence of chronic disease morbidity (41). Musculoskeletal disorders produce severe long-term pain (41). Consequently, prolonged untreated or under-treated chronic pain can have significant negative physical, psychological, and social effects, and disrupt an individual's daily life (41). The impacts of CMP especially low back pain on patients' health-related quality of life (HRQoL) can be divided into three dimensions: physical health, mental health and social health (41).

Low back pain impacts negatively on physical health in several ways (41). Firstly, individual with low back pain is more likely to have long-term activity limitation. Pain is strongly associated with physical inactivity. A critical role in individual's physical functioning may be reflected by pain severity, duration or localization (41). Physical inactivity due to pain may lead to progressive muscle weakness, inflexibility and obese. All consequences may exacerbate the chronic pain associated with musculoskeletal disorders. The epidemiologic studies showed that pain is the most important determinants of physical disability among patients with low back pain (42).

While adequate sleep is crucial for everyone, it is particularly vital for those living with a chronic disease. Sleep disturbance is an important clinical complaint for some CMP sufferers. Half of CLBP participants reported sleep difficulties (43). Pain, sleep disturbance, and depression are the strongest independent predictors of fatigue. Physical fatigue is a common complaint in low back pain patients. There may be an aetiological relationship between pain and fatigue. The consequences of fatigue are decreased ability to manage everyday tasks, disruption of work capacity, and difficulty maintaining personal and social relationships (44).

Overtime, living with a chronic disease creates a psychological burden (41). A high degree of chronic pain and impairment may progress into pain-related fear and anxiety, activity avoidance, and depression that further reduce daily function and quality of life. Depressive symptoms are quite common among patients with low back pain. Prevalence of major depression in patients with chronic low back pain is 3–4 times greater than in the general population (41). Meanwhile, anxiety is another comorbid condition reported frequently among patients with chronic pain. Prevalence of anxiety disorders was 17% in patients with low back pain (45).

Further, chronic pain can also be harmful to the social functioning of sufferers. Apart from the pain itself, fatigue, sleep disturbance, impaired physical functioning, anxiety, and depression may product a lessening in leisure-time activities and social contacts. In addition, side-effects of drugs used for pain relief as well as medical procedures and frequent visits to the clinics may contribute to limited time with family and friends (41).

After an injury in athlete, the psychological characteristics and different reactions may exhibit the reactions according to variable time line. An injured athlete typically undergoes a sequence of predicable psychological reactions similar to those of person facing death (46). Initially, they respond to disbelief: saying “there is no damage”, “the injury is less severe than originally thought” or “it will be probably be better tomorrow”. If the injury remains, they feel denial, isolated and lonely. The athlete commonly becomes irritate with himself and others formerly with injury. Anger is followed by a true sense of loss. With his arm in a fixator such as sling or a cast, the athlete lacks of the ordinary comfort and freedom. They are well aware that the injury makes the difference between actually competing and merely watching from the sideline. Ideally, this depression stage should be followed by that of acceptance and hope, but various factors may intervene to delay or prevent this from happening.

Assessment of HRQoL provides a way for clinician to better understanding the effect of this chronic condition on overall well-being (41). In addition, the assessment of physical, mental, and social health are necessary to determine other modalities of treatment that may be needed in combination with medication. HRQoL is a holistic concept that views human health and well-being within the context of the WHO's definition of health (47). HRQoL measures are often used to evaluate individual patients or groups of patients with chronic musculoskeletal disorders in many health-care settings (41).

In the last second decade, the recognition of the patient's point of view are increasing as an important component of the assessment of health care outcome. This results in the development of several instruments to measure HRQoL. One of the most widely used and psychometrically sound instruments is the Medical Outcomes Study 36-item Short Form (SF-36) (47).

SF-36 is a widely used, generic, patient-report, health status measurement (47-50). It is recommended for use in health policy evaluations, general population surveys, clinical research, and clinical practice. SF-36 reflects the ability of the patients to function and the impact of emotions on daily functioning (6). It is easy to administer and can be assessed across age, disease, and treatment groups (48). This instrument has been proven to be valid and reliable (48, 51, 52). SF-36 is a questionnaire consisting of 36 items that cover 8 aspects of quality of life. The questionnaire is composed of two main components: physical component summary (PCS) and mental component summary (MCS). SF-36 reflects patients' perception of quality of life by means of scores ranging from 0 to 100, with 100 being the ideal score.

The SF-36 contains 36 items that, when scored, yield eight domains. Physical functioning (10 items) evaluates limitations of physical activities such as walking and climbing stairs. The role physical (4 items) and role emotional (3 items) domains compute problems related to work or other daily activities, which are the results of physical health and emotional problems, respectively. Bodily pain (2 items) assesses limitations due to pain, and vitality (4 items) measures energy and tiredness. The social functioning domain (2 items) examines the effect of physical and emotional health on normal social activities. Mental health (5 items) assesses happiness, nervousness and depression. The general health perceptions domain (5 items) evaluates personal health and the expectation of changes in health (52).

In 1996, the international version 2.0 of the SF-36 was introduced to improve the two role functioning scales (53). Version 2.0 included simpler instructions and questionnaire items, an improved layout for questions and answers in the self-administered version, greater comparability with widely used translations and cultural adaptations, and five level response choices in place of dichotomous response choices for items in the two role functioning scales.

A generic quality of life instrument, designed for a variety of populations and measuring a comprehensive set of health concepts, is likely to face problems with the ceiling and floor effect (49). It is widely accepted that the more homogeneous the distribution of scores, the lower the floor and ceiling effects, the better the measuring instruments. The SF-36 has been shown to be susceptible to ceiling and floor effects, and it has been suggested that ceiling and floor effects are over-expected in generic HRQL instruments, simply because they aim to be applicable to a wide range of populations (48).

The Thai version of the Medical Outcomes Study Short-Form Survey version 2.0 (SF-36v2) has been translated by Jirarattanaphochai et al in 2005 (53). SF-36v2 has been successfully constructed with apparent equivalence to the original SF-36 and with an acceptable level of reliability (52). Establishing norms is an important step in the translation and cultural adaptation of a scale. Because the absolute number of a scale score has little meaning by itself, norms provide anchors to interpret an individual's or a group's score in relation to those of others (52). The Chronbach's alpha coefficient of the physical health and mental health summary scales of 0.93 and 0.92 respectively was demonstrated (53).

2.7 Back school

2.7.1 The Swedish back school

Back school was originated in Sweden by Zachrisson-Forssell in 1969. The aim of back school was to increase patients' ability to take care of their back by teaching what was already known about low back pain and what could be useful for the patients. The program was intended to reduce the mechanical stress and prevent the recurrence of episodes of CLBP (54). Contents of the program consist of the knowledge on anatomy of back, biomechanics, optimal posture, ergonomics, and back exercises (54, 55). The contents were based on modern knowledge of the etiology of low back pain, intradiscal pressure measurement, the result of electromyographic studies, and epidemiological studies (54, 55). This program was constructed as a group education by physical therapist with four 45-minute lessons during a 2-week period.

In the first lesson, different aspects of back disorders are discussed, including timing and individual location of back pain. After that, the basic knowledge of anatomy and back function is thoroughly explained and results of back pain studies are briefly presented. Various treatment methods and healing process are discussed. The facts that increase strains on the back aggravate the symptoms are emphasized and consequently, the strain-relieving position (semi-Fowler or psoas position) for the back during rest is demonstrated to the patients. The patients lie down during teaching session, to reduce load on the spine as much as possible. The rest position is advised at home.

During the second lesson, the mechanical strain on the back in different positions and during movement is discussed. Influence of the center of gravity on back strain is explained. The lower back muscle function is demonstrated and their influence on the back is emphasized. Relaxation training of shoulder and neck muscles and isometric abdominal muscle training are included in this lesson. After that, the "low pressure theory" (how to work dynamically and how to prevent static tension) is practiced. Lastly, sitting and standing postures during working are analyzed.

The third lesson is a practical application of previous lessons. Carrying and lifting techniques are instructed using different devices and weights in various trunk postures. The patients perform all types of working conditions and try to resolve each participant's main problem. They are instructed to reduce the back load by getting close to the object, bending both knees during heavy lifting, advice of self managements by resting in the semi-Fowler position during acute back pain.

The fourth lesson is emphasized on increasing level of physical activity in spite of their pain. Various types of activities and sport are encouraged to improve psychological and physical tolerance of pain and stress. At the end of the program, a summary of the principal contents of the back school curriculum is provided to the patients**.**

2.7.2 Research on back school program

Following the successful results of Swedish back school, the program became widely used by more than 300 back care institutions in the Scandinavian countries including hospitals, industries and schools (55). Research related to back school program varied widely in terms of content, duration of the program, and outcome measures. Contents of back school program varied from mini back school that teaches only body mechanics to multidisciplinary team approach that includes orthopedic surgeons, psychiatrists, physical therapists and occupational therapist. Duration of back school program can be divided into high and low intensities (56). The original Swedish back school provided four sessions once a week for 4 consecutive weeks is an example of low intensity back school. The high intensity programs vary from 21 outpatient sessions to 3-5-week inpatient program in a back clinic or rehabilitation center (56). Outcome measurements differed between studies. Most common outcomes measured are pain intensity, recurrent rate, perceived recovery, functional status, disability, sick leave, and quality of life (QoL).

Back school research started back in 1980s. Since then, new research evidence is continuously emerged. In the first decade, between 1980-1990, most research on back school programs were constructed by physical therapists (57-59). The content of back school at that time consisted of anatomy and back function, pathology, biomechanics, ergonomic, postural correction, relaxation exercise, back and abdominal exercises, heat or electrotherapy. Only one research applied behavior therapy plus the original back school program (60).

The length of back school also varied among previous studies. Four studies applied low intensity back school program (55, 57, 58, 61) that varied from 3 sessions of 1.5 hours in 1 week to 4 sessions during 2 weeks plus 5 sessions during 2 months. On the other hand, two high intensity back school programs were reported: one of three weeks of Inpatient Department (IPD) (59) and another of 8 hours per day for 5 weeks period (60).

The common outcome measures of back school research during the first decade were pain and disability index. Two low intensity back school researches reported an improvement in pain and disability index in short duration (58, 61). One study reported a reduction in work absenteeism, however, similar effects were found when compared to manual therapy (54). One study reported similar incidence of low back pain episodes when compared to waiting list (57). For the high intensity back school, improvement in pain (59, 60) and disability index (59) was found only for short duration (59).

Back school research during 1980s mainly focused on pain reduction when exposed to increase mechanical stress. Main outcome of the research was physical status, however, HRQoL depended on functional status and psychological factors more than simple physical impairment (62). Although, one study added behavior therapy with back school program, similar result was found compared to waiting list (60). Back school research published during 1980s are summarized in Table 2.1

Table 2-1 Summary of back school research during 1980-1990

Trial	Intervention	Effectiveness
Forssell, 1981(55)	**Population:** Acute LBP **Swedish back school (I1):** anatomy, pathology, treatment method and healing process, biomechanics, ergonomic, correct posture, relaxation exercise, practical application, exercise (4 x 45 min. in 2 wks) **Reference treatment (R1):** Manual therapy **Reference treatment (R2):** Placebo	I1, R1 > R2 **I1 reduced work absenteeism**
Moffett et al, 1986 (58)	**Population**: CLBP **Swedish back school (I):** anatomy and body mechanics, semi-Fowler position, ergonomic counseling, and exercises aimed at strengthening the abdominal muscles (3x1.5 h in 1 wk) **Reference treatment (R)**: exercises only (3x0.5 h in 1 wk)	**Pain and disability 8, 16 weeks**: I>R

Härkäpää et al, 1989 (63)	**Population:** chronic or recurrent LBP **Modified Swedish Back school (I1)**: inpatient group (3 wk), 4 sessions modified Swedish back school, 15 sessions back exercises, 9 sessions relaxation exercises, heat or electrotherapy and massage, refresher course 2 weeks after 1.5 years **Modified Swedish Back school (I2):** outpatient group(15 x 2 months), twice a week in groups of patients: 4 sessions modified Swedish back school, 15 sessions back exercises, 9 sessions relaxation exercises, refresher course 8 sessions after 1.5 years **Reference treatment (R):** no treatment	**Change in pain index and disability index after 3-month follow-up:** I1, I2 >R **At 2.5 year follow-up:** no different
Linton et al, 1989 (60)	**Population:** CLBP **Back school treatment (I)**: ergonomic education, Individual physical therapy programs, behavior therapy techniques, exercise activities (walking, swimming, jogging, cycling) (25 x 8 h in 5 wks, 4 h/day education) **Reference treatment (R):** waiting list	**Pain intensity (VAS) at 6 weeks and 6 month follow-up**: I>R **Fatigue, anxiety, sleep quality** : I = R
Donchi et al, 1990 (57)	**Population:** CLBP **Back school treatment (I):** education and exercises for back and abdominal muscles (4 x 90 min. in 2 wks , 5 session in 2 months) **Reference treatment (R1):** calisthenics, flexion and pelvic tilt exercises in order to strengthen the abdominal muscles, expanding spinal forward flexion (2 x 45 min. in 3 months.) **Reference treatment (R2):** waiting list	**Incidence of LBP episodes (mean of painful months during 12 months follow-up):** R1> I=R2

In the second decade, most back school research included the various forms of psychological approaches in the contents such as anger management, relaxation, sickness behavior, lifestyle changes and coping mechanisms to prevent recurrences (64-66). Both low and high intensities were used. Low intensity varied from 4 sessions in 5 hours to 3 sessions in 1.5 hours over 8 weeks. The result of low intensity back school program demonstrated a greater improvement of knowledge, exercise performance and work absenteeism compared to medication plus physical therapy (64, 66). High intensity back school demonstrated an improvement in pain, disability, sick leave and recurrent of back pain during three years follow up (65).

Back school program during years 1991-2000 was modified to deal with working compensation and prevention of recurrence. The main outcomes assured that back school program is an active implementation strategy that had long term effect to increase knowledge, improve pain and exercise performance, reduce sick leave and prevent recurrence of LBP more than passive implementation strategies or no treatment. Details of the above research are summarized in Table 2.2

Table 2-2 Summary of back school research during 1991-2000

Trial	Intervention	Effectiveness
Indahl et al, 1995 (64)	**Population:** LBP with or without radiation **'Mini' Back school treatment (I)**: stiffness, pain, stay active, emotion, anger management, sickness behavior, causes of low back pain, mobility, gait, lifting exercise (4 sessions in 5 h.: 2 h. in group plus 3 h. individual sessions and follow up:2 wks, 3 and 12 months) **Reference treatment (R):** Usual care	**Sickness leave at 200 days and 5 year follow-up**: I > R
Leclaire et al, 1996 (66)	**Population:** Acute LBP **Back school (I)** : R + back school; anatomy and pathophysiology of the low back, lifestyle changes and coping mechanisms to prevent recurrences and home exercises (30 + (3 x 90 min. in 8 wks)) **Reference treatment (R):** rest, analgesics, NSAIDs and daily physiotherapy (hot/cold packs, massage, ultrasound, TENS, flexion and isometric hip, back and abdominal exercises, instruction to repeat the exercises each day for the rest of their lives (30 min)	**Knowledge, Exercise performance after 8 wks, 6 and 12 months:** I > R
Lonn et al, 1999 (65)	**Population:** least one episode of LBP **Active Back school (ABS) (I):** anatomy, biomechanics, pathology, ergonomic principles, ergonomic, functional exercise, strength and stretching exercises of upper body, pelvis and leg muscles and joints, simulation of home and work activities (20 x 1 h in 13 wks :20 min education + 40 min practical training and exercises) **Reference treatment (R):** No treatment.	**Recurrence at 5 month, 1 and 3 years:** I > R **Pain and disability 5 months**: I = R **Pain and disability 1, 3 years**: I > R **Sickness leave at 1 and 3 years:** I > R

In the third decade, most back school program performed in multidimensional approaches by multidisciplinary team such as PhD level educator, clinical psychologist, rheumatologist and physiotherapist. Therefore, QoL and functional status were added to usual outcome measures. Again, duration of back school varied widely from 3 hours to 21 sessions in 10 weeks. Nonetheless, low intensity back school still improved pain (56, 67, 68), QoL (56, 69), functional status (68, 69) and reduce sick leave (56) and recurrent rate in CLBP (56). High intensity with extra meeting improved QoL, spinal strength and VO_2max in 6-12 months follow-up (70).

In the last decade, several contents of back school were added such as McKenzie, individual circuit training, functional overload, social and mental factors in LBP, stabilization exercise, extra meetings containing physical training, social intercourses, work simulating. The main concept of back school program remained unique, however, innovation of back school program give precedence to the highest levels of functioning possible in view of their disease and treatment. Details of the above research are summarized in Table 2.3.

Table 2-3 Summary of back school research during 2001- to present

Trial	Intervention	Effectiveness
Hodselmans et al, 2001 (69)	**Population:** CLBP **Back school program (I):** McKenzie, individual circuit training, functional overload, social and mental factor (12 x 1 ± 8.2 h. in 3.6 ± 2 months) **Reference treatment (R):** Waiting list	**Functional capacity, functional health status** : I > R
Hsieh et al, 2002 (67)	**Population:** Acute LBP **Back school treatment (I):** education (spine anatomy, causes of LBP, body mechanics for daily activities) and practice (exercises for sitting and standing, lumbar flexion, extension, stretching, stabilization and walking) (3 x 3 wks) **Reference treatment (R1)**: Myofascial Therapy Program including intermittent Fluori-Methane sprays, 5-10 stretches of isometric contraction, ischemic compressions, stripping massage, hot packs (9 x 3 wks) **Reference treatment (R2):** Joint Manipulation, including high velocity and short amplitude manipulations ("Diversified" technique) (9 x 3 wks) **Reference treatment (R3):** combined Joint manipulation and Myofascial Therapy (9 x 3 wks)	**Pain scores at baseline, 3 weeks, 6 month :** I= R1 = R2 = R3 **RDQ scores at 3 weeks and 6 months:** I = R1 = R2 = R3 **Overall, no statistical differences between the 4 treatment groups**
Pettinen et al, 2002 (70)	**Population:** Non specific LBP **Back school treatment (I):** Swedish type of back school including fitness training (muscle force, endurance and stretching exercises for upper and lower back, trunk flexors, upper arm and leg muscles and ergonomic work techniques), group discussions (structure, functioning and strain of the back, lifting, principles of physical exercises during leisure-time and at work) and extra meetings containing physical training and social intercourses (21 sessions of 85 minutes each, in 10 weeks) **Reference treatment (R):** same as the index intervention without the extra meetings (10 sessions of 1 hour each in 5 weeks)	**Significant differences in favor of I for Oswestry disability questionnaire, Quality of life, spinal strength and VO2max.**
Shirado, 2005 (68)	**Population:** CLBP **Back school treatment :** anatomy of spine and related tissue, the mechanism of LBP, quantitative functional evaluation (flexibility of trunk and hamstrings, trunk muscle strength and endurance), therapeutic exercise (trunk muscle strength and stretching), psychological assessment Classified by pain intensity after treatment program :pain improve, did not change and aggravated pain(3 h in a day and follow up:1 w,6 m, 12 m)	**VAS score**: before = 6.2, after = 2.8 The pain improved 80.8%, did not change 15.4%, and was aggravated in 3.8%. Significantly different in finger-floor distance, trunk muscle strength, and endurance in pain relieved gr. and the compliance with the exercise

Trial	Intervention	Effectiveness
Heymans, 2006 (56)	**Population:** nonspecific low back pain **Back school treatment (I1):** low intensity; discussed activity and coping, strength training and home exercise(4 x 4 wks, 2 h.: 30 min. education, 90 min. practical) **Back school treatment (I2):** high intensity; individual exercise, work simulating and strengthening exercise (16 x 1 h. in 8 wks) **Reference treatment (R):** Usual care (16 x 1 h in 8 wks)	**Return to work:** I1>I2,R **Sickness leave:** I1>I2,R **Functional status, kinesiophobia in 3 months.:** I1>I2,R Pain and perceive recovery: no different
Tavafian et al, 2007 (71)	**Population:** CLBP **Back school treatment (I):** multidimensional and interdisciplinary(clinical psychologist, PhD-level educator, rheumatologist, physical therapist, exercise (5 x 4 days and 3 months follow up) **Reference treatment (R):** Clinic group	**Quality of life(SF-36)**: I>R
Tavafian et al, 2008 (72)	**Population:** CLBP **Back school treatment (I):** multidimensional and interdisciplinary(clinical psychologist, PhD-level educator, rheumatologist, physical therapist, exercise, (5 sessions/4 days and 3 months follow-up) **Reference treatment (R):** Clinic group	**Quality of life(SF-36)**: I>R

In summary, research of back school program is moving toward the combination of multidimensional and disciplinary approach in order to solve back problems. All research was carried out in general population with low back pain. While back pain is one of most common complaints in weightlifters, back school has never been applied to this group of population. Therefore, it is anticipated that weightlifter with LBP may have the benefit of a novel back school using multidisciplinary team approach.