Movement quality within a physiotherapy perspective years after scoliosis surgery

A descriptional cross-sectional study using Body Awareness Rating Scale

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Forord

Jeg ønsker å takke min veileder Professor Jan Magnus Bjordal ved Institutt for Global Helse og Samfunnsmedisin, Universitetet i Bergen, for å ha foreslått å bruke måleinstrumentet Body Awareness Rating Scale i evalueringen av bevegelseskvalitet hos skolioseopererte. Han har gjennom hele prosessen gitt veloverveide råd og vist en solid fagkompetanse som har bidratt til å trygge meg i egne vurderinger.

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Mest av alt ønsker jeg å takke alle deltagerne som stillte opp uten noen form for kompensasjon, flere kom fra andre deler av landet, og gjorde det mulig å gjennomføre denne studien.

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Tables and figures

Abstract

Background: Scoliosis surgery with spinal fusions is today the dominant treatment for correcting a scoliosis deformity and avoiding progression. The major focus for outcome analysis in the scientific literature has been angle measurements in pre- and postoperative radiographs of the spine, while there remains a paucity of data on physical function, movement quality, and psychosocial characteristics in patients who have undergone scoliosis surgery.

Objective: Examine movement quality in patients with idiopathic scoliosis after scoliosis surgery, and to see if there were any associations between the variables patient characteristics including surgical data, movement quality, health related quality of life (HRQoL), and coping strategies.

Design: Descriptional cross-sectional study.

Methods: 35 patients were included and examined with the physiotherapeutic assessment tool Body Awareness Rating Scale (BARS), Scoliosis Research Society – 22 (SRS-22) questionnaire, and Antonovsky's Sense of Coherence -13 (SOC-13) questionnaire. Descriptive data and statistical interrelationship between variables were studied.

Results: Movement quality measured by BARS was lower in patients who had undergone scoliosis surgery (BARS mean sum score 41,3 ±5,5) compared to normative data in healthy subjects. BARS scores were significantly correlated with HRQoL. Several significant correlations were found between surgical characteristics, movement quality, and HRQoL ($p<0,05$).

Conclusion: BARS is a generic movement quality assessment tool which captured movement aberrations in patients many years after they had scoliosis surgery. Still, there seems to be a need to develop a more specific movement assessment tool to measure functional changes in movement after scoliosis surgery.

Key words: Idiopathic scoliosis, spinal fusion, movement quality.

Abstrakt

Bakgrunn: Skoliosekirurgi med spinal fusjon er i dag den dominerende behandling for å korrigere en skoliose og unngå progresjon. Hovedfokus i utfallsanalyser i den vitenskapelige litteraturen har vært vinkelmålinger i pre- og postoperative røntgenbilder av ryggraden, mens det fortsatt er sparsomt med data på fysisk funksjon, bevegelseskvalitet og psykososiale karakteristika hos pasienter som har gjennomgått skoliosekirurgi.
Mål: Å undersøke bevegelseskvalitet hos pasienter med idiopatisk skoliose som har gjennomgått skoliosekirurgi, og å undersøke innbyrdes assosiasjon mellom variablene pasient-karakteristika inkludert kirurgiske data, bevegelseskvalitet, helserelatert livskvalitet og mestringsstrategier.
Design: Deskriptiv tverrsnittsstudie.
Metode: 35 pasienter ble inkludert of undersøkt med det fysioterapeutisk kartleggingsverktøyet Body Awareness Rating Scale (BARS) og spørreskjemaene Scoliosis Research Society - 22 (SRS-22) og Antonovskys Sense of Coherence -13 (SOC-13). Deskriptive data og statistiske sammenhenger mellom variablene ble beregnet.
Resultater: Bevegelseskvalitet målt ved BARS var lavere hos pasienter som hadde gjennomgått skoliosekirurgi (BARS gj.snitt sum score: 41,3 ±5,5) sammenlignet med normative data hos friske personer. BARS score var i tillegg signifikant korrelert med helserelatert livskvalitet. Flere signifikante korrelasjoner ble funnet mellom kirurgiske data, bevegelseskvalitet og helserelatert livskvalitet ($p<0,05$).
Konklusjon: BARS er et generisk vurderingsverktøy for bevegelseskvalitet som fanget opp bevegelsesavvik hos pasienter flere år etter at de hadde gjennomgått skoliosekirurgi. Likevel synes det å være et behov for å utvikle mer spesifikke vurderingsverktøy for bevegelse enn BARS for å måle funksjonelle endringer i bevegelse etter skoliosekirurgi.
Stikkord: Idiopatisk skoliose, spinal fusion, bevegelseskvalitet

Abbreviations:

AIS	Adolescent idiopathic scoliosis
BARS	Body Awareness Rating Scale
BBAT	Basic Body Awareness Therapy
COM	Centre of mass
CSVL	Central sacral vertical line
HRQoL	Health related quality of life
HUS	Haukeland University Hospital
IS	Idiopathic scoliosis
MQ	Movement quality
RIN	Ryggforeningen i Norge
SOC	Sense of coherence
SOSORT	Society on Scoliosis Orthopaedic and Rehabilitation Treatment
SRS	Scoliosis Research Society
SSE	Scoliosis specific exercises
UIB	University of Bergen

1 INTRODUCTION

Idiopathic Scoliosis (IS) is a complex three-dimensional deformity of the spine that occurs in apparently healthy children, and approximately 80% of all occurrences of scoliosis are idiopathic (Negrini, Aulisa, Aulisa, Circo, de Mauroy & Durmala, 2012). The ratio of girls to boys is equal for minor curves, but rises for girls as the curve magnitudes, reaching a ratio of 8:1 for those requiring treatment (Adobor, Riise, Sorensen, Kibsgard, Steen & Brox, 2012). The most frequently measured long term sequela in adulthood of untreated IS are curve progression, back pain, cardiopulmonary problems, and psychosocial concerns due to the deformity (Weinstein, Dolan, Cheng, Danielsson, & Morcuende, 2008). The size of the curve has a tendency to increase over the entire lifetime, but the degree of progression and the time at risk for progression varies with many factors (Weinstein, Dolan, Cheng, Danielsson & Morcuende, 2008).

In patients with curvatures above a certain threshold, scoliosis surgery by spinal fusion is the recommended treatment (Schimmel, Groen, Weerdesteyn, & de Kleuver, 2015). The primary objectives of surgical treatment is to stop the progression, achieve maximum permanent correction of the deformity, improve appearance, and reduce complications related to the deformity (Weinstein et al., 2008).

The correction of the scoliosis curvature by spinal fusion is obtained at the expense of removing intervertebral motions that exists in the scoliotic spine. The effect this reduction in intervertebral motions has on basic human movements are not well documented. Some studies have investigated the range of motion in the trunk and the quality of gait before and after scoliosis surgery, but the results are inconsistent. To optimize the quality on the local treatment of patients who have had scoliosis surgery, it is important to gain more knowledge on how the movement quality is in this group. If it turns out that some patients have dysfunctional movement patterns, it is still not certain that they are reflected in subjective health complaints. It may therefore be of interest to determine whether there are correlations between patient charachteristics including surgical data, movement quality (MQ), health related quality of life (HRQoL), and coping strategies of the individual.

This research project is about movement MQ, health related quality of life (HRQoL) and coping strategies in women with idiopathic scoliosis who have undergone scoliosis surgery.

In order to give a basis for the study, the next sections will present some theory, mainly from a biomechanical perspective, covering treatment options and outcome measurements for IS. Theory on the physiotherapeutic movement awareness modality Basic Body Awareness Therapy (BBAT) which BARS has roots in, is then further described. BBAT and BARS represent a multiperspective view on human movement and function. The methods used in this study are described before the results are presented. In the last chapters, the results will be discussed before the conclusions of the study are presented.

1.1 Idiopathic scoliosis

IS is a structural condition and the spine rotates around its own axis while it curves laterally. The usual classification of IS is based on the age of onset. Adolescent idiopathic scoliosis (AIS) is the most common form of IS, and is defined when the onset is between the age of 10-16 years or untill the end of growth (James, 1954; Weinstein, Dolan, Wright, & Dobbs, 2013). AIS is often associated with rapid growth of the spine. Progressive AIS is attributed to relative anterior spinal overgrowth during the adolescent growth spurt, but the mechanisms of this growth asymmetry are not well understood and IS can be progressive in relation to multiple factors in any period of rapid growth or later in life (Weinstein et al., 2008). The severity of the scoliosis is most often measured by the Cobb angle (O'Brien, Kuklo, Blanke & Lenke, 2005). The Cobb angle is the angle between lines drawn on the superior endplate of the upper end vertebra and the inferior endplate of the lower vertebra measured in the fronal plane (Figure 1).

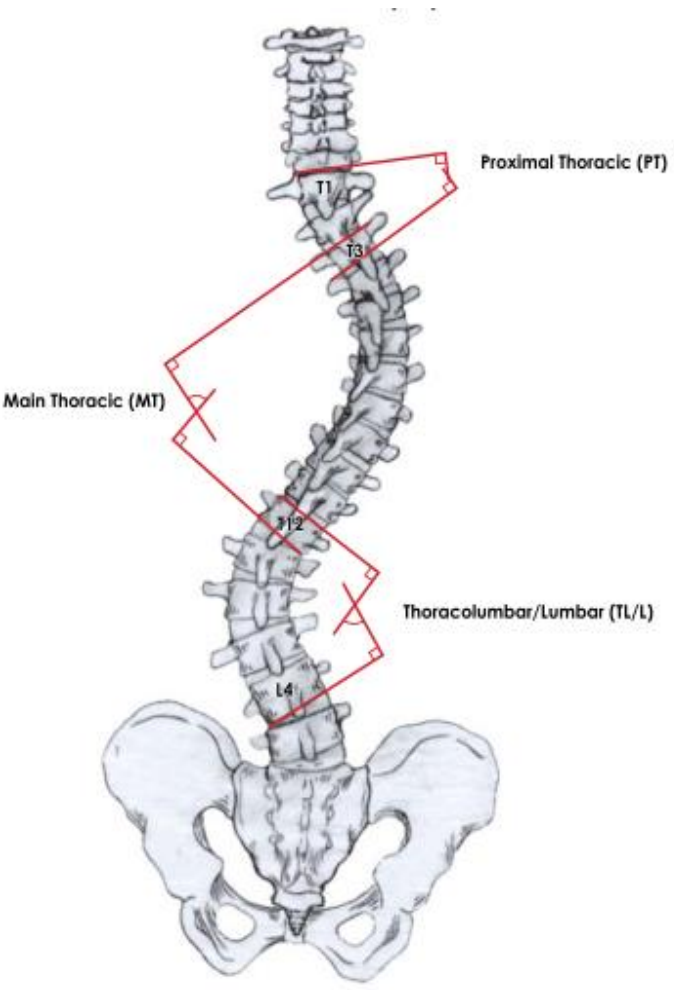

Figure 1 Frontal Cobb measurement (O'Brien, 2005, p. 49)

Prevalence of curves over 20° Cobb is between 0.3 and 0.5%, while curvatures over 40° Cobb are found in less than 0.1% of the population (Weiss et al., 2006). The severity of long term sequela of untrated AIS and their effect on overall health and function is very variable (Weinstein et al., 2008). Other parameters than progression of the curve has an effect for the patient, but these are less explored. For instance, curve pattern may be associated with increased pain, and double curves seems less painful than toracolumbar curves (Weinstein & Ponseti, 1983). IS might also have an effect on postural balance, and a study on AIS patients has shown that they have impaired postural balance measured by increase in the postural sway area and centre of pressure (COP) excursion compared to healthy controls (Beaulieu et al., 2009).

If the final curvature of the spine exceeds a critical threshold of approximately 50° Cobb angle, the risk of further curve progression is increased (Weinstein et al. 2003). Curves larger than 50°Cobb are associated with a high risk of continued worsening through adulthood and thus usually indicate the need for surgery (Weinstein S.S., Ponseti I.V., 1983).

1.2 Treatment options

The treatment of IS is based on the knowledge on the risk of curve progression and patient maturity. The main goal for treatment of IS, is to reduce the progression of scoliosis and to decrease the risk of back pain, disability, breathing problems and cosmetic deformities that might develop with progression of the scoliosis during adulthood (Bunnell, 1988; Weinstein & Ponseti, 1983). The number of adolescents in Norway treated for scoliosis was 122 in 2012, of which 51(42%) were braced and 71(58%) had surgery, with about 10% of them having both brace and surgery (Adobor et al., 2012).

A report about living with scoliosis in Norway, describes that many with scoliosis are experiencing a lack of knowledge about the treatment of scoliosis among health workers and physiotherapists (Bjørke, Van den Bergh, & RIN, 2012). Many seek guidance on treatment for their scoliosis, and little information is available for persons with scoliosis about treatment options except for surgery (Bjørke et al., 2012). Section 1.2.1 – 1.2.4 presents the main treatment options for IS.

1.2.1 Observation

For immature patients with Cobb < 25°, observation with regular x-ray examinations is commom, and follow-ups depend on the patient’s rate of growth (Adobor, 2015). Due to the concerns of radiation exposure, the Society on Scoliosis and Rehabilitation Treatment (SOSORT) has reached a consensus with recommendations to reduce the x-ray exposure in patients with scoliosis (Knott, Pappo, Cameron, Demauroy, Rivard et Kotwick, 2014).

1.2.2 Physiotherapy

Use of physical exercises to treat scoliosis dates back to the time of Hippocrates. The nature of todays physiotherapy is to provide services to develop, maintain and restore maximum of movement and functional ability throughout the lifespan. Interaction between the physiotherapist and the patient is necessary to develop a mutual understanding, and to change positively the body awareness and movement behavours that might promote health and wellbeing (World Confederation for Physical Therapy, 2011).

The two main international societies clinically dealing with idiopathic scoliosis are the Scoliosis Research Society (SRS), founded in 1966 in USA, and the international Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT), founded in 2004 in Europe. Inside the SRS, the Non-Operative Management Committee (SRS-NOC) has the same clinical interest of SOSORT (Negrini, Hresko, O'Brien, & Price, 2015). SRS and SOSORT have recently reached a consensus and recommend ongoing high quality research and development focused on innovative non operative treatments for scoliosis, and pointed out the strong need to continue research on the effectiveness of braces and Scoliosis Specific Exercises (SSE) (S. Negrini et al., 2015). Until recently there has been a lack of high evidence research studies on physiotherapy to treat scoliosis, but growing evidence supports effectiveness of SSE in the treatment of AIS (Choi, Kim, Kim, Lee, Jeon & Chung, 2013; Kuru, Yeldan, Dereli, Ozdincler, Dikici & Colak, 2016; Monticone, Ambrosini, Cazzaniga, Rocca, & Ferrante, 2014). The lack of high level evidence studies can be related to difficulties in organising randomized controlled trials and unethical considerations to allocate a control group to observation in view of the progressive nature of AIS (Sy, Bettany-Saltikov, & Moramarco, 2016).

SSE differs from general physiotherapy exercises being individually adapted and tailored specifically to reduce the spinal deformities (Sy et al., 2016). Among scoliosis specific exercise approaches, the Schroth method is among the most studied and widely used (Shreiber, Parent, Moez, Hedden, Hill & Moreau, 2015). A fundamental component in the Schroth method is auto-correction defined as the patient’s ability to reduce the spinal deformity through active postural realignment of the spine in three dimension. Auto-correction is achieved through self-elongation and postural corrections in all three planes that are specific for each curve pattern, and is eventually integrated in daily activities (Fusco, Zaina, Atanasio, Romano, Negrini & Negrini, 2011). A randomized controlled trail on the effect of Schroth exercises combined with the standard care, have shown to improve pain, self-image and back muscle endurance in patients with AIS compared to only standard care (Schreiber et al., 2015). Standard care consisted of observation, or bracing if the SRS bracing criteria were met. The same study demonstrated a high prevalence of ceiling effects and best scores on quality of life outcomes on SRS-22 questionnaire (Schreiber et al., 2015).

In adult patients, SSE are aimed to recover postural collapse, postural control and vertebral stability through an active postural correction. There is growing evidence supporting SSE as a treatment for progression of AIS for patients reluctant to surgery, and some studies have shown improvement in Cobb values (A. Negrini et al., 2015).

1.2.3 Bracing

Treatment with rigid braces (thoracolumbar-sacral orthosis) is the most common non-operative treatment for the prevention of curve progression (Weinstein et al., 2013). When the scoliosis curve exceeds 20° Cobb angle and the patient has a growth potential, a spinal orthosis is recommended (Weiss, Negrini, Rigo, Kotwicki, Hawes & Grivas, 2006). Rigid braces are significantly more effective than soft flexible brace, and asymmetric braces like the Chêneau style have shown to produce higher correction than the symmetric Boston braces (Sy et al., 2016). A study among 28 patients above 10 years who had at least one curvature between 45°-58° Cobb angle, has even shown that rigid braces in combination with SSE can reduce the scoliotic curvature, given sufficient clinical expertise to apply good braces and achieve great compliance (Negrini, Negrini, Fusco, & Zaina, 2011).

The recommendation of bracing has been controversially until recently, as it has been difficult to determine the effect of bracing due to uncertainties in compliance in brace wear. In 2013, the BRAIST study was conducted in 25 institutions across the USA and Canada (Weinstein et al., 2013). Compliance was measured in wear time determined by means of a temperature logger. The study showed that duration of brace wear was positively associated with the rate of success. Between 0 to 6.0 mean hours brace wear per day was associated with a success rate of 42%, whereas brace wear for an average of 12.9 to 17.6 hours per day was associated with success rates of 90 %. Success was defined as avoiding progression of the scoliosis curvature to above Cobb angles of 50° (Weinstein et al., 2013).

School scoliosis screening programs were discontinued in Norway from 1994 due to lack of evidence that the programs improved the outcome in addition to the costs involved. The proportion of the average number of patients operated each year in the period with screening was 32% compared to 62% during the period without screening (R. D. Adobor et al., 2012). The absence of scoliosis screening results in that the scoliosis is detected randomly, and patients are presented with a mean Cobb angle approaching the upper limit for brace treatment indications. There are concerns that screening can involve unnecessary costs by over-referrals, but studies have reported higher rates of bracing and reduced surgical rates during the period of screening (R. D. Adobor, Joranger, Steen, Navrud, & Brox, 2014; Bunge, Juttmann, de Koning, and the Steering Committee of the Nescio Group, 2006). Screening has shown to be cost saving when performed in girls only, and when it leads to reduced treatment rates.The economic gain of screening increases when it leads to higher rates of bracing and reduced surgical rates (R. D. Adobor et al., 2014).

1.2.4 Surgery

Spinal fusions are still the primary means of correcting a scoliosis deformity and avoiding progression (Lenke et al., 2001). The first spinal fusion for scoliosis was performed in 1914 by Hibbs (Newton & O'Brien, 2011). In the United States in 2009, the total cost for spinal surgery to correct AIS ranked secondly only to appendicitis among children 10 to 17 years of age (Weinstein et al., 2013).

Several classification systems have evolved during the treatment of scoliosis. John R. Cobb described the first systematic classification for scoliosis in 1948. Cobb’s major descriptions of major and minor curves, structural curves, types of scoliosis and etiological classifications still influence classification and treatment of scoliosis today (Newton & O'Brien, 2011). The Lenke classification system (Figure 2) is most commonly used today, and was developed as a project by Lawrence Lenke and Harms Study Group (Newton & O'Brien, 2011). Its purpose was to enhance the ability to accurately compare similar types of spinal curves among different treatment centres and to develop standardized treatment protocols. The Lenke Classification technique for analysis and classification of operative AIS is a three step system (O'Brien, 2005). The first step is to identify the primary curve among six types. The second step is the assignment of the lumbar modifier, which is defined by the location of the central sacral vertical line (CSVL) on the apical vertebra of the lumbar curve. The third step is assignment of the sagittal thoracic modifier by evaluating the sagittal Cobb measurement between T5 and T12.

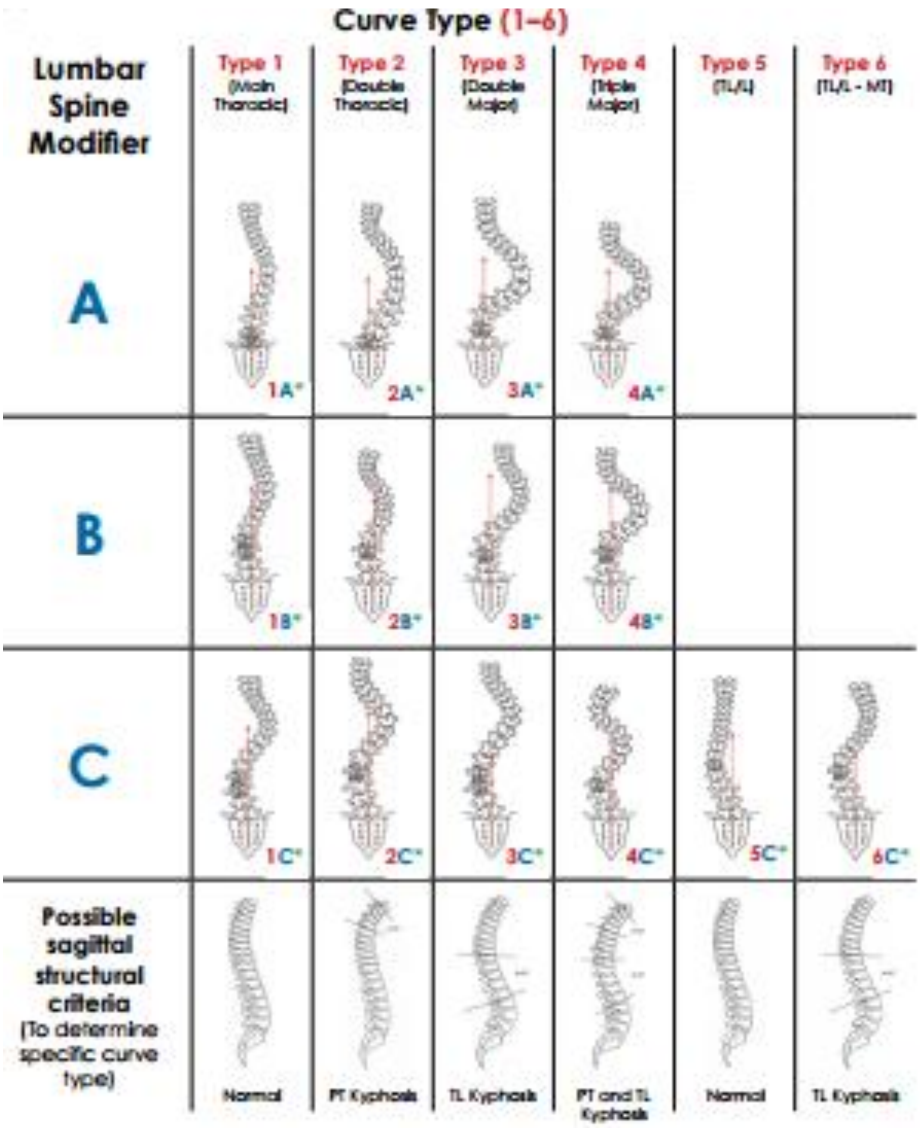

Figure 2 The Lenke Classification (O'Brien, 2005, p. 42)

The indication for surgery in AIS is a major curve > 45-50° (Asher & Burton, 2006; Weinstein et al., 2008). The main objectives of spinal surgery is to stop the progression of the scoliosis and obtain correction of the deformity in three planes, balance the trunk and reduce complications in the short and long terms (Asher & Burton, 2006; Weinstein et al., 2008). The present main surgical treatment is the posterior instrumentation, but anterior surgery is usually performed on thoracolumbar and lumbar major curves (Asher & Burton, 2006; Weinstein et al., 2008).

Modern third-generation instrumentation has evolved from the Cotrel-Dubousset system in the 1980s, and much progress have improved multiplane correction and stability with extended use of many segmental pedicle screws as seen in Figure 3 (Weinstein et al., 2008). There are on the other hand some disadvantages with the improved corrections, as steep learning curves for the patient and difficulties associated with accurately placing pedicle screws within dysplastic pedicles. Neither is there any present conclusive evidence existing showing that improved radiographic outcomes correlates with improved function, self-image or health (Weinstein et al., 2008). In most patients, the fusion extends from the thoracic region into varying portions of the lumbar spine. Understanding of the Lenke classification system shown in Figure 3, is essential before determining the vertebral levels for spinal fusion avoiding postoperative complications including decompensation (O'Brien, 2005).

Figure 3 Spinal fusion (Weinstein et al., 2008, p. 1532)

In the last two decades, there has been many developments in the surgical treatment of AIS, but little high-evidence data is available to support these changes and guide treatment (de Kleuver et al., 2014). One example is that 7-12 years ago there were multiple reports of anterior approaches, whereas today there is a strong preference for posterior approach (de Kleuver et al., 2014). Recent advances in instrumentation technology has brought a large increase in the number of options in the surgical management of AIS. A study among six spinal deformity surgeons of the SRS society with a well-established experience in spinal surgery, showed a large variability in AIS instrumentation strategy and planning assessing the same patient. They were provided with the following information on each five patients: age, gender, preoperative standing posterior-anterior and lateral radiographs, supine side bending radiographs and Cobb angles measurements of each curve (Aubin, Labelle, & Ciolofan, 2007). Due to the lack of clearly defined strategies of rational rules based on validated biomechanical studies with modern multi-segmental instrumentation systems, an international consensus has recently been found of what does and does not constitute optimal operative care for adolescents with AIS in more than 60 aspects (de Kleuver et al., 2014).

1.3 Outcome after surgery

Short-term results of the surgical treatment of people with AIS demonstrate the ability of surgery to improve various outcome measures. There are on the other side very few published studies on the outcome after scoliosis surgery with longer time spans than 20-25 years, and most patients are then only in their 30’s or early 40’s (Simony, Hansen, Carreon, Christensen, & Andersen, 2015) (Bettany-Saltikov et al., 2015). The long-term effects of surgical treatments for AIS are poorly understood since there most often is a gap between the paediatric spine surgeon who may initially operate on the adolescent patient and the adult spine surgeon who cares for the same patient later in adulthood. It is a strong need to bridge this gap in the future (Newton & O'Brien, 2011, p. 281). Most studies on outcome after surgery are done on radiographic outcomes of the spine in the frontal plane. A systematic literature search was done by Negrini et al. (2006) in the database Medline and a bibliometric search on the topic IS, have shown that only 1,48% of the papers related to HRQoL, 6.9% to posture, 4.5% to balance and 4.1% to movement. The search included data up to the year of 2004 (Negrini et al., 2006).

The following sections 1.3.1. to 1.3.4 presents some studies on outcome of scoliosis surgery on HRQoL, trunk range of motion (ROM), gait, and postural balance.

1.3.1. Outcome of surgery on Health Related Quality of Life

Patient-reported outcomes have gained importance in medical research, and the current attention to patient oriented medicine has shifted interest from pathophysiological measurements to patient oriented measurements to impact on functioning, perceived health and quality of life (Vet, 2011). HRQoL in AIS populations is often measured by the disease specific patient-based questionnaire SRS-22, also applied in this study, see Appendix 3.

Asher & Burton (2006) did a series of studies on 20 to 28 years follow-up on both braced and operated patients with AIS. Although most patients are satisfied with surgery, follow-up at 20+ years showed significant, clinically relevant decrease in function and increase in pain compared to healty controls (Asher & Burton, 2006).

A 25-year follow-up study on the quality of life of patients in Denmark treated with surgery or Boston brace during adolescence, measured by SRS-22, showed results within the range described as normal for the general population. The average age of the patients at follow-up was 37,6 years for the surgically treated, and 41,4 years for the brace treated (Simony et al., 2015). The same study suggests longer follow-up term studies when patients are in their fifth and sixth decade to determine if these patients will have similar quality of life outcomes, pulmonary function and spine related problems as the general population.

1.3.2 Outcome of surgery on trunk range of motion

Partial correction of the scoliosis curvature by spinal fusion is obtained at the expense of removing normal intervertebral motions. One way of evaluating the effect surgery has on movement ability, is by measuring the range of motion (ROM) in the trunk. In a prospective study on trunk ROM, data were collected preoperatively and 12- and 24-month postoperatively on a group of 28 female and two male adolescents with IS undergoing spinal fusion (Engsberg et al., 2002). Evaluation of trunk ROM was measured by reflective surface markers. They found that the post-operative global range of motion 12 and 24 months after surgery was reduced in the frontal, sagittal, and transverse planes. They found no significant correlations between the lowest instrumented vertebra and range of motion in the unfused region below the fusion level. Surprisingly, they also found reduced motion in the unfused areas and continued postoperative asymmetries in right and left lateral flexion ROM. The authors point out that clinical implications suggests early postoperative therapy to facilitate motion in the unfused regions. Whether the results are temporary or are persistent through life of the patients are unknown (Engsberg et al., 2002).

1.3.3 Outcome of surgery on gait

Very few studies have addressed the effect of scoliosis surgery on basic activities, and the effects of fusion on balance are poorly understood (Mahaudens, Detrembleur, Mousny, & Banse, 2010). The knowledge on the effect of spinal fusion on gait is scarce, and studies are not consistent. Although gait pathology is not a common complaint among AIS patients (Paul et al., 2014), studies are done on gait parameters before and after surgery.

A prospective study on 30 adolescents with IS undergoing spinal fusion showed slightly decreased gait speed 2 years postoperative (Lenke et al., 2001), whereas another prospective study on 31 adolescents with IS who underwent either an anterior or a posterior spinal fusion indicated no change in gait results after surgery regardless of group (Engsberg, Lenke, Uhrich, Ross, & Bridwell, 2003). However, a third prospective study on 19 adolescents with IS showed increased step length and reduced cadence one year postoperative (Mahaudens et al., 2010). Spinal fusion surgery did not cause asymmetric gait or significant differences in gait variables between anterior and posterior spinal fusion, despite the large discrepancy in number of fused levels between the two surgical operation methods. This study also showed that the mechanical work performed by the body muscles to move in its surroundings increased by 6% one year after surgery as compared to before. The energy cost remained globally excessive, probably due to the excessive co-contraction of the lumbar-pelvic muscles (Mahaudens et al., 2010). They explain the findings of improved gait parameters after surgery, with the persistence in both posterior and anterior surgical approaches of at least two-to-three free spinal joints from the spino-pelvis joint. A fourth prospective study that investigated sixteen adolescents with IS requiring surgical correction, measured gait in 3-dimentional motion before and one year after surgery (Paul et al., 2014). The patients used self-selected speed. The data presented in the study showed that the surgical correction of AIS deformity reduced the sway of the Centre of Mass (COM) in the frontal plane during gait. The author is uncertain if the reduction the mediolateral COM excursion after surgery is suggested to reflect an attempt to reduce kinetic demands in the context of improved alignment of the spine, or if it represents an overly rigid but well balanced spine (Paul et al., 2014).

None of the above-mentioned studies informed if the patients had postoperative rehabilitation that included gait training. This could be expected to have an effect on the outcome of gait variables. In gait the body is not asked to perform at its maximum, and the surgical changes may have reduced the limits, but not to gait limit thresholds (Lenke et al., 2001). This could also explain some of the differences in outcomes in gait analysis after surgery.

1.3.4 Outcome of surgery on postural balance

The asymmetry in the upper body postural alignment caused by the scoliosis curvature might affect postural balance, and some studies report improved postural balance after spinal fusion. As for studies on gait, they are not consistent. Lenke et al. (2001) report that patients with AIS undergoing spinal fusion showed improved spinal–pelvic balance parameters in the frontal plane and unchanged in the sagittal plane radiographically and during standing posture 2 years post-operative. Another study on postural balance in AIS patients scheduled for surgery, showed that they had similar results to healthy age matched controls, except for a poorer reaching capacity which was suspected to be related to their reduced range of motion of the spine (Schimmel et al., 2015). The study of Shimmel et al. (2015) showed that postural balance one year after surgery did not improve as a result of the better spinal alignment, neither did the reduced range of trunk motion inherent to fusion negatively affect postural balance.

1.4 Movement awareness in physiotherapy

1.4.1 Basic Body Awareness Therapy

Basic Body Awareness Therapy (BBAT) is a physioterapeuthiv movement awareness training. BBAT has been used in physiotherapy in Scandinavia for more than 30 years (Skjaerven, Kristoffersen & Gard, 2010). Enhancing body awareness has been described as a key element or a mechanism of action for therapeutic approaches. Body awareness can be defined as “an inseparable aspect of embodied self-awareness realized in action and interaction with the environment and world, being an innate tendency of our organism for emergent self-organization and wholeness” (Mehling, Wrubel, Daubenmier, Price, Kerr & Silow, 2011, p. 1).

BBAT offers a structured therapy with a movement awareness-training program for promoting movement quality. Movement awareness can be described as to be attentive to a multi-perspective span of movement nuances along the continuum between health and pathological movement aspects (Skjaerven, Gard, Sundal, & Strand, 2015). The approach in BBAT carries a potential of giving patients insight into their own movement resources, by learning concrete strategies to implement more functional and economic patterns in their day-to-day routines. The movement awareness training includes daily-life movements in lying, sitting, standing, and walking as well as relational movements (L. H. Skjaerven et al., 2015). BBAT implements basic movement principles integrated into some basic coordination in the trunk, such as postural stability, adjustment of energy used in the movements, free breathing, and movement coordination (Skjaerven, Kristoffersen, and Gard, 2008).

There are different types of movement learnings. In learning by being in movement, the emphasis is on movement development as a process to be experienced by and integrated by the person. In order to change movement habits and improve self-awareness, this type of learning is valuable (L. H. Skjaerven et al., 2010). BBAT focuses on the whole person, creating a therapeutic learning situation for the patient to explore and integrate unity, flow and rhythm in their own movement to gain more functional movement quality as well as new movement habits (L. H. Skjaerven, Kristoffersen, & Gard, 2008).

Movement quality (MQ) in general represents a global impression of how a person moves. Movement observation in BBAT builds on three elements of dynamic balance; postural stability, free breathing, and mental awareness and how these elements are integrated and expressed in the movement quality. In practice, the focus is directed on how the person relates to the ground, to the vertical axis, to the breathing and movement centre, and how the awareness is integrated in the body as a whole (Skjærven, 2015). The movement centre in BBAT merges from physical and mental elements. The physical centre refers to the centre of Solar Plexus at the level of Diaphragm, the area of the main drive of the breathing mechanism. The mental centre refers to the process of centring the mind in the same area

(Skjærven, 2015). Figure 4 illustrates The Movement Quality Model, which intends to give an overview of the essence of a whole. MQ can be seen as interacting process related to the four themes; space, time, energy and to the person (L. H. Skjaerven et al., 2008).

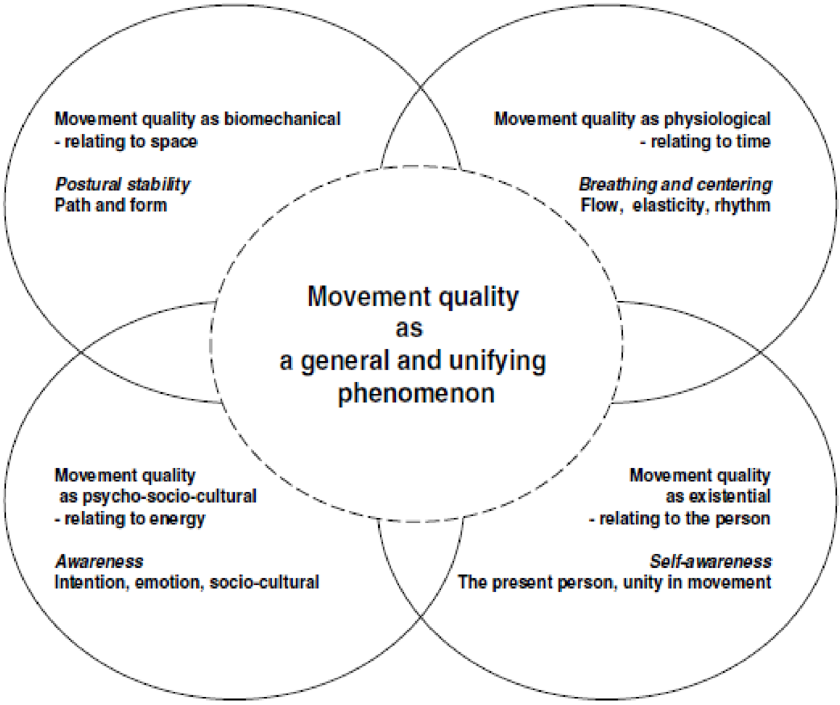

Figure 4 The Movement Quality Model (L. H. Skjaerven et al., 2008, p. 21)

Clinical physical therapy is a practical process that includes motivating patients to get involved in the learning processes. In recent years, physiotherapists have dedicated increasing attention to body awareness to promote movement quality (L. H. Skjaerven et al., 2010). Specific skills and attitudes are used by physical therapists to promote movement quality in their clinical practice. A phenomenological study on how MQ can be promoted in clinical practice was carried out on a group of physical therapist experts from various fields (L. H. Skjaerven et al., 2010). The study demonstrated specific attitudes and skills used by physiotherapists including three main themes; the therapist's own movement awareness, a platform for promoting MQ, and action strategies for promoting movement quality. Promoting MQ in clinical practice is described in the Movement Awareness Learning Cycle in Figure 5 (L. H. Skjaerven et al., 2010).

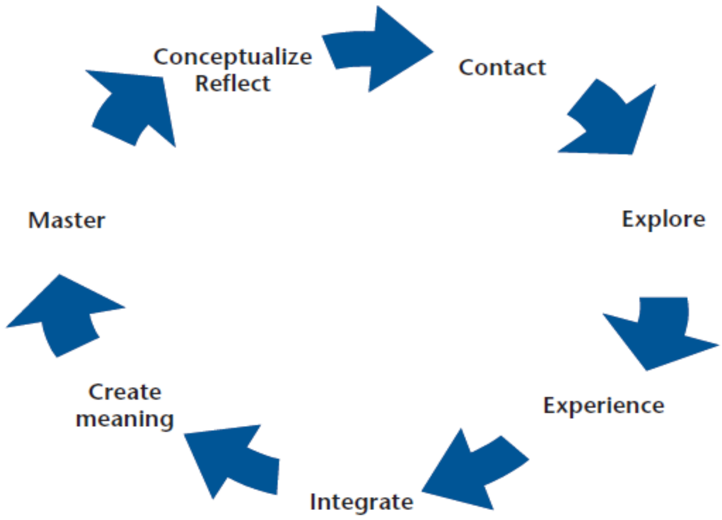

Figure 5 Movement awareness learning cycle (L. H. Skjaerven et al., 2010, p. 1487)

A physiotherapeutic assessment tool, Body Awareness Rating Scale (BARS), has been developed to examine quality in general movement co-ordinations and movement habits, observing compensations and healthy movement resources. BARS has roots in BBAT. When assessing BARS, the patients' general movement quality is evaluated and scored according to the way 12 different movements are performed, relating to space, time and energy (Skjærven, 2015). The assessment tool is further described in section 3.2.1.

2 OBJECTIVES

Partial correction of the scoliosis curvature by spinal fusion is obtained at the expense of removing normal intervertebral motions that exists in the scoliotic spine and realigning the trunk. Radiographs have been the major form for outcome analysis of scoliosis fusions, and current use of segmental spinal instrumentation systems has improved radiographic results. Although improvements in static alignment of the spinal column assessed by radiographic pictures quantify changes in structure, they do not quantify changes in MQ. There is little knowledge on how the MQ is in persons with spinal fusion. A person's movement centre which is in the level of Diaphragm according to BBAT theory, will in most of the scoliosis operated patients be in an area that is fused and has restricted movement. However, if some persons have dysfunctional movement patterns, it is still not certain that they are reflected in subjective health complaints. It is therefore a need to increase the knowledge base and at the same time to identify and systematize how the spinal fusions may have implications for daily life movements expressed in MQ and also investigate if there are associations between MQ, patient characteristics including surgical factors, HRQoL, and coping strategies of the individual.

The purpose of the present study was to examine:

1. *How is the movement quality in patients with IS who have had scoliosis surgery?*
2. *Is there interrelationship between the variables patient characteristics including surgical data, movement quality, health related quality of life, and coping strategies?*

3 METHOD

A descriptive cross-sectional study was used to answer the research questions. The patients were tested on several different variables, and the statistical interrelationship among the variables were studied. The variables were patient charachteristics including surgical data, MQ, HRQoL, and coping strategies. Surgical data was primarily obtained from medical records from HUS and in some cases from the patients. Examination of MQ was assessed with BARS (figure 6). HRQoL was measured with SRS-22 questionnaire (appendix 3) and coping strategies were measurd by Antonovsky's Sence of Coherence -13 (SOC-13) questionnaire (appendix 4).
The project was carried out in cooperation with the University of Bergen, (UIB), Bergen University Hospital (HUS) and the Spinal Association in Norway (RIN).

3.1 Participants

Participants were recruited from the Orthopedic Department of HUS and from RIN. The total number of patients that were recruited in the study was 36. One of these patients did not meet the inclusion criteria. This is further explained in section 4.

Inclusion criteria:

- Sex: Female with IS
- Performed scoliosis surgery at 10 years or older
- Minimum one year after surgery
- Age: minimum 18 years
- Language: Norwegian
- Adequate cognitive function
- No other major disorders that has a significant impact on movement or surgical failure.

Haukeland University Hospital

Patients from HUS were recruited from the hospitals database that was coded primary idiopathic scoliosis surgery. The head physician in the Orthopedic Department was in charge of searching up the patients in the database. Due to changes in the journal system in 1997, it was difficult to search for patients who had surgery before this year. Therefore, the patients recruited from HUS had their primary scoliosis surgery in the years 1997 to 2014.

118 patients met the inclusion criteria. Letter of invitation to participate in the study with informed consent (Appendix 1) was sent by mail to all those who met the inclusion criteria. The letter included information that the aim of the study was to examine movement quality, HRQoL, and coping strategies in persons with IS who had scoliosis surgery. The subjects were informed on how the data would be saved and stored. They were also informed that they were welcome to withdraw from the study at any time. They were asked to sign a consent form on the information paper. This was delivered at the test day. 23 patients from HUS responded and participated in the study. 22 were included in the analysis.

Spinal Association in Norway

RIN has a Scoliosis Group, which consists of about 600 members nationwide. To recruit participants from RIN, the leader of the Scoliosis Group sent e-mail with attatchment of the letter of invitation (Appendix 1) to all their members with invitation to participate in the study. This resulted in 13 participants.

3.2 Assessment tools used in the study

3.2.1 Body Awareness Rating Scale

MQ was observed, described and scored by the physiotherapeutic assessment tool BARS. It consists of two assessment parts; observation and assessment of MQ in 12 individual movements (Figure 6) and interview with the patient about the movement experiences immediately after each of the 12 movements. (The interview is not presented in this study.). BARS was developed to examine quality in general movement co-ordinations and movement habits, observing compensations and healthy movement resources (L. H. Skjaerven et al., 2015). In clinical practice, BARS is used to determine the therapeutic intervention and the effect of therapy.

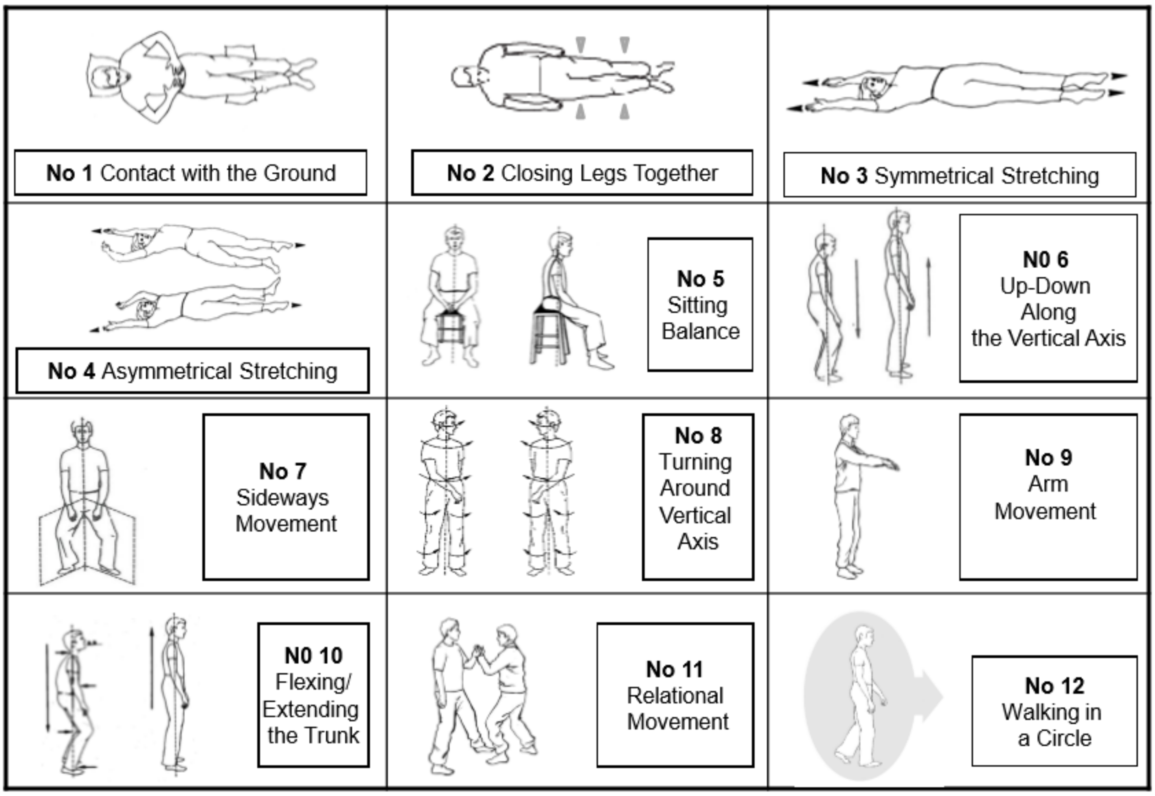

Figure 6 Movements in the Body Awareness Rating Scale (L. H. Skjaerven et al., 2015, p. 2)

When performing BARS, the physiotherapist guides the patients in specific movement coordinations and the patient is invited to explore the movements. All the 12 movements are part of daily-life movements, and they relate to the ground, the vertical axis, movement center, breathing and awareness. The movements are in supine, sitting, standing, walking and between two people. The movements are evaluated and scored, and the focus on the movements is balance, free breathing and awareness.

There are three steps when scoring in the scale. First, the therapist focus on how the person relates to the ground, the vertical axis, and the movement center. Second, on how the persons movement characteristics are expressed in the movements, like the path and form in the movement, the flow, elasticity, rhythm, the intention, and the personal aspects. Third focus is on the level of unity or integration of the elements in the movement (Skjærven, 2015).

The BARS movements are scored from 1 to 7, and the sum scores ranges from 12 to 84. Score 7 is defined as the most healthy, functional MQ, described as balanced, free, centered, unified, rhythmic, and synchronous. A score of 1 is defined as the most pathological, dysfunctional MQ, described as unstable, mechanical stiff, un-rhythmical and with lack of unity. The scale includes scores of 0,5 to make it more sensitive and clinical useful (L. H. Skjaerven et al., 2015) The midpoint of the scale (4) is where the movement quality changes from being stiff and staccato to being stable, free, and unified. The shift from weak functional MQ is when breathing and awareness starts to be integrated in the movements. Appendix 2 explains the movement quality scores of BARS. Simplified, the scorings can be described like:

1. Dysfunctional MQ
2. Mostly dysfunctional MQ
3. Weak functional MQ
4. Some MQ
5. Moderate functional MQ
6. Good functional MQ
7. Very good functional MQ (L. H. Skjaerven et al., 2015)

The test is process-oriented and the most healthy, functional movement is scored. In the examination situation with BARS, the therapist implements a standardized pedagogy to guide the patient in performing the movements (Skjærven, 2015, p. 19)
BARS has been examined for reliability and construct validity, and showed high internal consistency, high inter-tester and test-retest reliability, and low measurement error when BARS was used by qualified testers (L. H. Skjaerven et al., 2015).

Qualifying for use of BARS and calibration of the test.
Specific attitudes and skills are used by physical therapist and serve as preconditions for promoting and evaluating movement quality. Three main preconditions and orientations for practice are the physical therapists‘ embodied presence and movement awareness, being able to create a platform for promoting movement quality, and action strategies for promoting movement (Skjaerven, Kristoffersen and Gard, 2010). Part of this study was therefore to qualify the author to use BARS. This was a process through gaining knowledge about the theoretical framework in BBAT and BARS, practicing own movement awareness, development of perception for own movement, learning to promote movement quality, and to develop experience with instructing and scoring of the BARS.

The scoring of BARS was calibrated before the start of the study by the author and two physiotherapy experts in BARS; person (A) working in the rheumatic field and person (B) working in the mental health field. The author instructed both BARS assessments on two persons with IS who had undergone scoliosis surgery. The scorers had no relationship to the participants. A, B and the author, scored the first patient. B and the author scored the second patient. BARS was scored separately and the scorers were blinded for pre- and postoperative data about the patient and the other scorers' results. The scores were discussed between the scorers immediately after the BARS assessment. The results in the scorings were mostly homogenous, but the author had some deviations from the experts. These deviations were thoroughly discussed and explained to the author.

Table 1 Qualification for the author's use of BARS

Qualifying the author for using BARS:	hours
Being a hospitant with A at the rheumatic division of HUS. *Observing assessment of BARS, participation in BARS movements, scoring of BARS, and discussion on the BARS scores.*	10
Introduction in BARS movements. *Guidance from B in promoting own movement awareness in the 12 BARS movements.*	4
Being an active participant during the education of BARS and BBAT at HIB. *Practice in assessing BARS and promoting movement quality and movement awareness in oneself and other students. Discussions after classes with the BARS teaching group.*	70
Calibration of BARS with A and B. Performed on 2 patients who had scoliosis surgery.	4
Self-study. *Reading literature in BBAT and BARS. Watching BARS documentary and tutorial film (L. H. Skjaerven, Kobbe, Else Martens, 2013). Self practice of the 12 BARS movements and verbal guidance in assessing BARS. Training on obtaining own movement awareness.*	40

3.2.2. Scoliosis Research Society -22 questionnaire

HRQoL was measured by SRS-22 (Appendix 3). SRS-22 is a self-reported questionnaire which is currently accepted internationally for assessment of health-related quality of life for AIS (R. D. Adobor, Rimeslatten, Keller, & Brox, 2010).

The SRS-22 covers 5 domains of the patiens perceived:

- Function/activity (5 questions)
- Pain (5 questions)
- Self-appearance (5 questions)
- Mental health (5 questions)
- Satisfaction with treatment (2 questions)

Each question has 5 possible answers ranging from 1 (worst) to 5 (best). Results are usually expressed as the mean for the different domains.

Internal consistency for the function/activity domain has shown to be lower than reported to the original version and has been traced to question 15 (Are you and/or your family experiencing financial difficulties because of your back?) and question 18 (Does your back condition limit your going out with friends/family?). Social aspects as economy and participation are reflected in these question, and they differ from function in terms of ability to perform activities of daily living. Question 15 might neither be applicable for countries with a public health care system as in Norway (R. D. Adobor et al., 2010).

The Norwegian version of the SRS-22 has shown acceptable repeatability, internal consistency and reliability. SRS-22 has been validated against EuroQol, which is a short form generic health-related quality of life questionnaire used for patients with back pain. Poor validity compared with EuroQol support the use of a specific questionnaire for assessment of AIS. (R. D. Adobor et al., 2010).

3.2.3 Antonovsky's Sense of Coherence Questionnaire -13

Coping strategies have been measured by SOC-13. According to Antonovsky, health is seen as a movement in a continuum on an axis between total ill health (dis-ease) and total health (ease). The person's ability to comprehend the whole situation and its capacity to use the resources available is called sense of coherence (SOC) (Lindström & Eriksson, 2005). This capacity is a combination of peoples' ability to assess and understand the situation they are in (comprehensibility), to find a meaning to move in a health promoting direction (meaningfulness), also having the capacity to do so (manageability). SOC questionnaire is a life orientation questionnaire to measure SOC, and consists of 29 items. A shorter form of 13 items (SOC-13) was later developed by Antonovsky (Antonovsky, 1987) (Appendix 4). The SOC-13 was used in this study. Antonovsky developed the questionnaire primarily to analyze people SOC, but it is also used as an overall measurement for coping strategies (Eriksson & Lindstrom, 2007).

The SOC-13 scale is a 7-point scale with 5 items for comprehensibility, 4 for manageability, and 4 for meaningfulness, with each item rated on a scale from 1 (never) to 7 (very often) and a sum score ranging from 13 to 91. Higher scores indicate stronger SOC.

Findings from cross-sectional studies on various illnesses support an influence of the SOC on the Quality of Life (QoL), the stronger the SOC, the better the perceived QoL in general (Eriksson & Lindstrom, 2007). The SOC scale seems to be a reliable, valid, and cross culturally applicable instrument measuring how people manage stressful situations and stay well (Eriksson & Lindstrom, 2005).

3.3 Procedure for data collection

3.3.1 Data collection of assessment tools

The setting for the study was a room at Section of Physiotherapy Science, UIB of about 20sqm. The examination was adapted to after work or school for participants when it was necessary. The participants were all given written information about the examination procedure in advance of the examination, and they were informed that the aim of the study was to investigate movement quality in persons with IS who had scoliosis surgery. The participants were registered with a number consecutively as they were examined. The assessment tools and the informed consent was marked with the participant number. The informed consent was kept separately in a sealed envelope in order to ensure anonymity of the participants.

The examination of BARS was done before answering the two questionnaires SRS-22 and SOC-13. The assessment of BARS inclusive completion of the questionnaire took approximately 1hr 15min. Prior to the examination, all the participants were asked to use clothes that were comfortable to move in like a t-shirt and training pants during examination. Before the BARS examination situation, the room was prepared with two gym mats that were placed on the floor for the first 4 movements, and two chairs for movement number 5. The mats and chairs were removed after the first 5 movements to give enough space for the remaining movements.

The patients were informed that BARS has roots in BBAT, which is a physiotherapeutic approach focusing on MQ and movement awareness rather than speed and range of motion. They were provided with some basic information about BARS, and informed that the 12 BARS movements were part of daily life movements, performed in lying, sitting, standing, relational and walking. They were informed that they would be guided in the movements, and after each movement, notes would be made about the findings within the BARS-form. After scoring each movement, the participants were asked how the movement was for them and/or what they experienced while being in the movement. Their answers, which are qualitative descriptions, were written in the BARS formula, but the data is not part of this study.

Apart from the four movements on the floor, all the movements were done together entering the movement with the patient and inviting the patient to explore experience and integrate the movement elements. They were given enough time to explore and experience the movements to enter the state of coming into motion. The patients were supported in moving in a way of being comfortable and at ease focusing on quality more than quantity.

The movements lying on the floor were observed by the examiner sitting at the right side of the participant, at the level of the waist. Focus for observation was the movement centre in the region of Diaphragm, enabling the periphery vision to observe the whole person.

The sitting and standing movements were performed face to face with the participant a little to the left so that the eyes could rest above the patient’s right shoulder. The examiner initiated the movements inviting the patient to be in it. When the participant had explored the movement and was in motion, the examiner walked around to observe from different sides, but always returned to continue and end the movement with the participant.

After the BARSs examination, the patient answered the SRS-22 questionnaire and the SOC-13 questionnaire.

3.3.2 Data collection of surgical data

The examiner was blinded for surgical data prior to the examination to avoid bias in scoring of the BARS. Surgical data included the following:

- Age of patient
- Year of primary scoliosis surgery
- Location of fused vertebras (from-to)
- Cobb angle of largest curve pre-operatively
- Cobb angle of largest curve post-operatively
- Operation method (All screw, hybrid, anterior approach)
- Scoliosis classification pattern (Lenke)

For the patients recruited from HUS, the surgical data was collected from the medical records by the chief physician at the orthopaedic department after all patients were examined. Patients recruited from RIN brought their medical journal to the test, but the examiner was blinded for these data prior to the examination. Information about operation method and scoliosis classification pattern was only obtained from patients recruited from HUS.

3.4 Analysis

The statistical analysis was performed in IBM SPSS Statistics version 23.0.
The patient characteristics were examined by descriptive statistics calculating the mean, minimum, maximum and standard deviation for the variables:

- Age
- Pre-operative largest curve
- Post-operative largest curve
- Number of fused vertebras
- Unfused vertebras cranial to the fused area

- Unfused vertebras caudal to the fused area
- Years since scoliosis surgery
- BARS sum score
- BARS item score
- SRS sum score
- SRS sub-domain score
- SOC sum score

The variables operation method and Lenke classification pattern were not included in the analysis as this information only was gained from patients recruited from HUS. Aslo, the Lenke Classification (see Figure 3) distiguises among many curve classifications, leaving few patients in each group, even though some patterns are more common than other.

In cases that surgical date were missing, the respective data were considered missing at random, and cases were excluded pairwise in the correlation analysis.

For distributions that are markedly non-normal or samples that are small, the non-parametric tests are recommended (Polit & Beck, 2012) p. 412. The non-parametric Mann-Whitney U-test was used to see if there were differences between the two group centres of HUS and RIN. Significance level was set at p=0,05. The sample variables tested for the independent groups HUS and RIN were:

- Age
- BARS sum score
- SRS sum score
- SOC sum score

For correlation between the patient characteristics and the results of the assessment tools, Pearson's rho (r) was used. The strength of association is indicated by the absolute value of the correlation. As a rule of the thumb, the strength of the correlation coefficient is described as (Gerber & Finn, 2005):

0-0,30	weak correlation
0,31-0,60	moderate correlation
> 0,61	high correlation

3.6 Ethical considerations

The study was approved by the Regional Committee for Medical and Health Research Ethics in Norway (Appendix 6). Since women are strongly overrepresented among persons with IS, this study was limited to include only women. The examination including answering the two questionnaires was considered to be little stressful for the patient with a duration of about 75 minutes. The examination was neither considered to have any risks nor known side effects. The patients were informed about the purpose of the study in advance of the examination, and written informed consent was obtained before the patients were examined. The patients volunteered to participate, and were informed that they could withdraw from the study at any time, without having to explain why. After conclusion of the study, all written material connecting the patients' names or identification numbers to obtain data were destroyed.

4 RESULTS

35 of the 36 subjects were included in the results. One patient showed to be an extreme outlier in most of the analysis. HUS was therefore asked to search the medical journals in case important information was missed concerning her meeting the inclusion criterias. This led to information that she had surgical failure, and her data is therefore excluded in the presentation of the results. Appendix 5 illustrates scatterplots and correlation analysis with her in the calculations.

4.1 Descriptive results

The patient characteristics are presented in Table 2. Table 2-4 presents results of the three assessment tools; BARS, SRS-22 and SOC-13. All results are presented by the mean, minimum, maximum and standard deviation. Histograms of the data of the assessment tools are presented in Figure 7-9.

Table 2 Descriptive data for patient characteristics

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Age	35	18	65	36,5	14,3
Years since operation	34,0	2	49	15,6	13,8
Fused vertebras	35	3	14	9,8	2,5
Caudal unfused vertebras	35	1	7	2,9	1,3
Cranial unfused vertebras	35	6	19	11,3	2,7
Preoperative largest curve	34	35	102	56,9	14,2
Postoperative largest curve	32	5	76	25,9	14,5
Largest curve correction	32	10	52	31,3	9,8
Valid N (list wise)	32				

Table 2 shows that the mean age for the patients were 36,5 years (±14,3). Mean years since scoliosis surgery was 15,6 years (±13,8). The mean number of fused vertebras was 9,8 (±2,5). Number of unfused vertebras caudal to the fused area had a mean of 2,9 (±1,3), whereas the number cranial unfused vertebras had a mean of 11,3 (±2,7). The mean preoperative largest curve measured by Cobb angle was 56,9° (±14,2) and the postoperative largest curve 25,9° (±14,5). The mean correction of the largest curve was 31,3° (±9,8) Cobb angle.

Table 3 Descriptive data for BARS item- and sum score

	N	Minimum	Maximum	Mean	Std. Deviation
BARS 1	35	2,0	5,5	3,7	,9
BARS 2	35	2,5	5,0	3,5	,8
BARS 3	35	2,0	5,0	3,4	,7
BARS 4	35	2,5	5,5	3,3	,8
BARS 5	35	3,0	5,0	3,9	,7
BARS 6	35	2,5	5,0	3,5	,8
BARS 7	35	2,5	5,0	3,4	,6
BARS 8	35	2,0	5,0	3,3	,6
BARS 9	35	2,0	4,5	3,4	,6
BARS 10	35	2,0	3,5	2,9	,5
BARS 11	35	1,5	5,0	3,3	,7
BARS 12	35	2,5	5,0	3,6	,8
BARS sum score	35	32,50	52,50	41,3	5,5
Valid N (list wise)	35				

Table 3 shows a mean BARS sum score of 41,3 (±5,5), ranging between 32,5 and 52,5. None of the patients scored lower than 1,5 or higher than 5,5 in the 12 movements. The highest mean score was found in BARS 5 with a score of 3,9 (±,7) and the lowest in BARS 10 with a score of 3,9 (±,5).

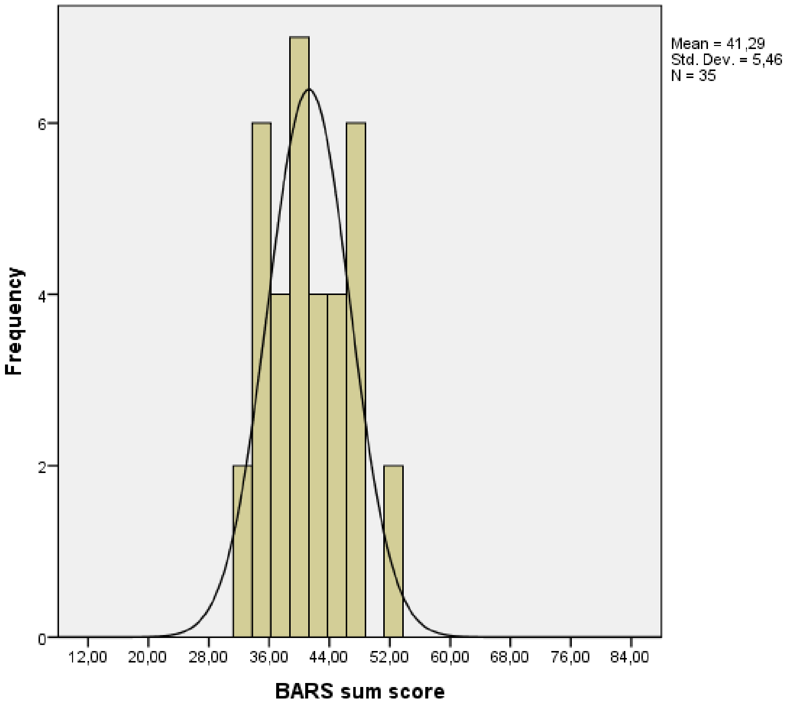

Figure 7 Distribution of BARS sum score of the patients

Figure 7 shows approximately normal distribution of BARS sum score.

Table 4 Descriptive data for SRS-22 domain and SRS-22 score.

	N	Minimum	Maximum	Mean	Std. Deviation
SRS function/activity	35	1,6	4,8	3,9	,7
SRS pain	35	1,4	5,0	3,8	,9
SRS self-appearance	35	1,6	4,8	3,6	,7
SRS mental health	35	2,2	4,6	3,9	,7
SRS satisfaction with treatment	35	1,5	5,0	4,1	,9
SRS score	35	2,0	4,7	3,8	,6
Valid N (list wise)	35				

As seen in table 4, the mean SRS score was 3,8 (±0,6), ranging between 2,0 and 4,7. The five subomains in the SRS score were: function/activity 3,9 (±,7), pain 3,8 (±,9), self-appearance 3,6 (±,7), mental health 3,9 (±,7), and satisfaction with treatment 4,1 (±0,9).

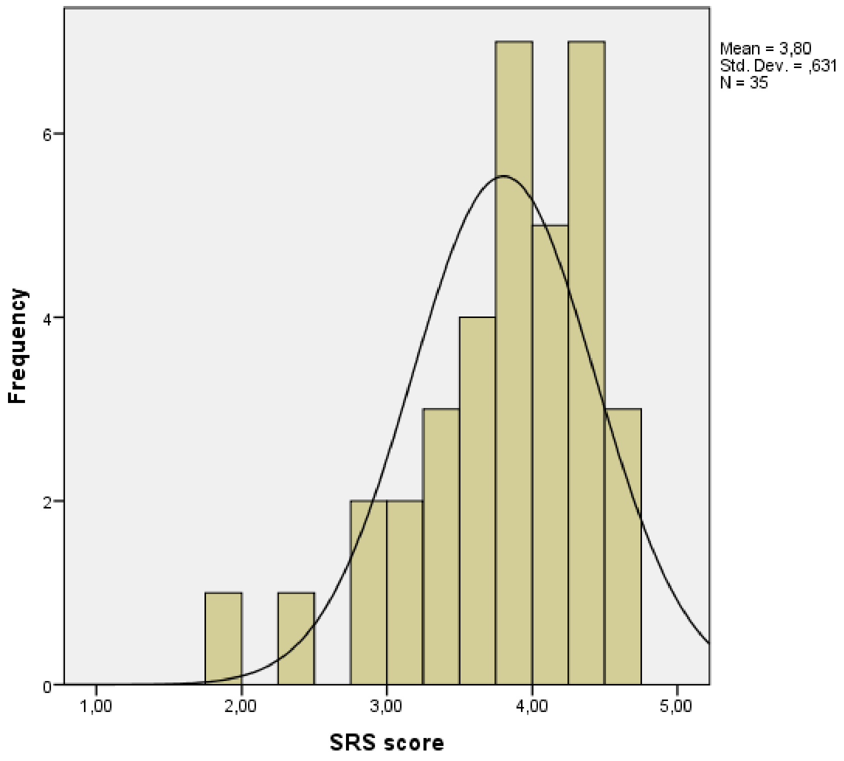

Figure 8 Distribution over the patients SRS-22 sum score

Figure 8 shows that the mean score of the SRS-22 sum scores were negatively skewed.

Table 5 Descriptive data for SOC-13 sum score

	N	Mean	Minimum	Maximum	Std. Deviation
SOC score	35	65,4	33	83	11,8
Valid N (list wise)	35				

The mean SOC score was 65,4 (±11,8), ranging between 33 and 83.

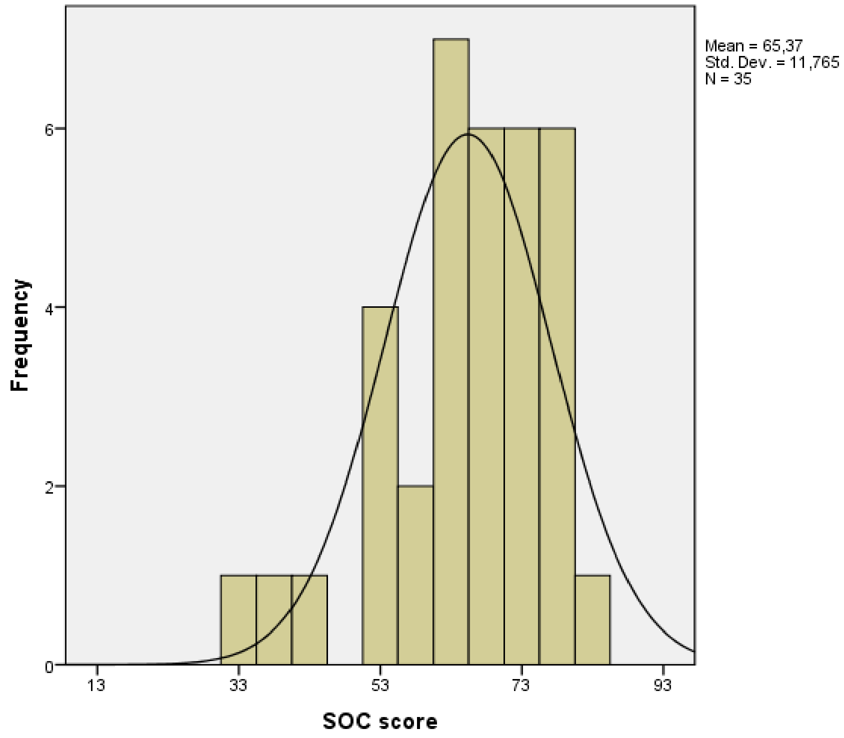

Figure 9 Distribution over the patients SOC-13 score

Figure 9 shows that the SOC-13 sum scores were negatively skewed.

4.2 Difference between groups

We would like to see if the relevant variables from the two recruitment groups HUS (N=22) and RIN (N=13) were equally distributed, i.e. we would like to test H0: equal centres vs H1:not equal centres. Distributions of the variables Age, BARS sum score and SRS-22 score, and SOC-13 score are shown in figure 10-13.

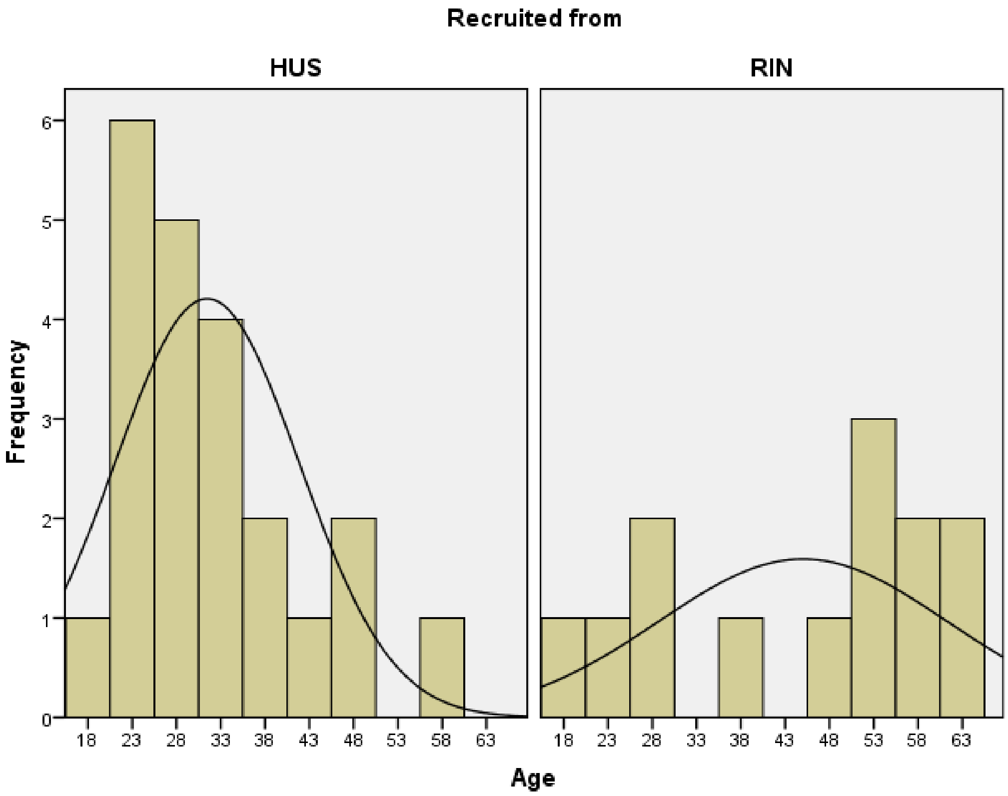

Figure 10 Distribution of age in HUS and RIN

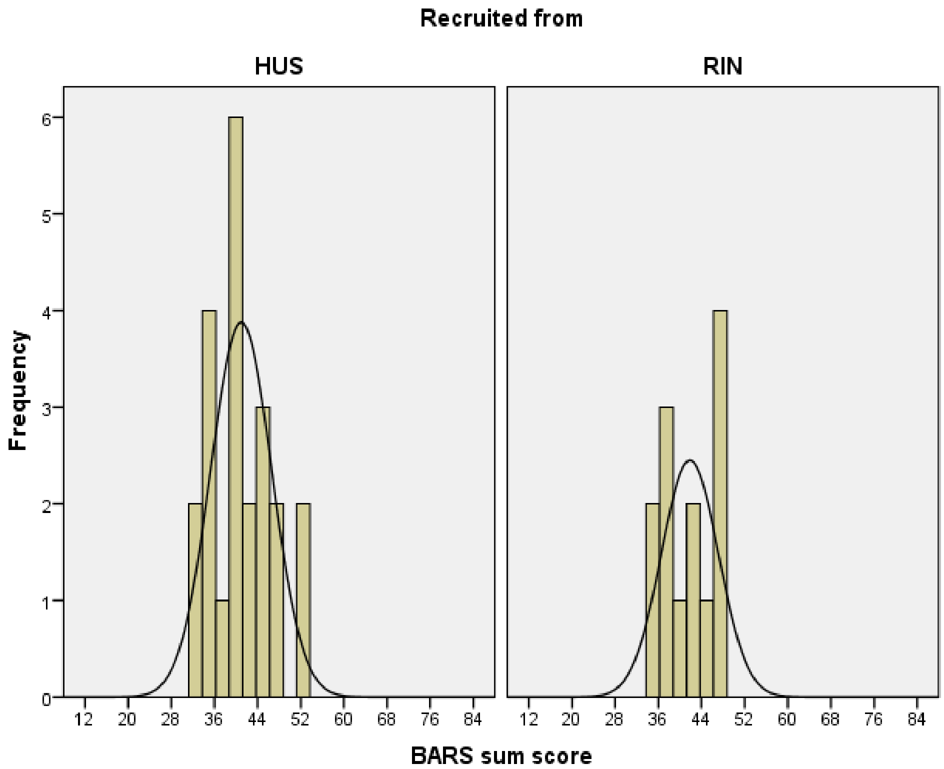

Figure 11 Distribution of BARS sum score in HUS and RIN

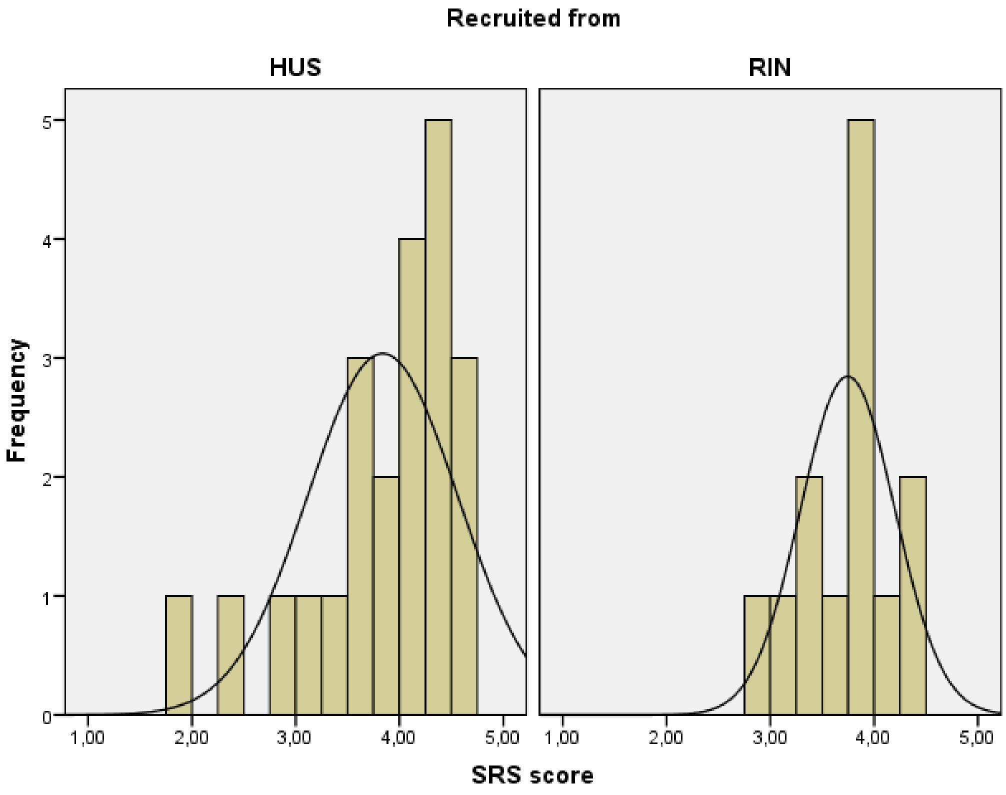

Figure 12 Distribution of SRS score in HUS and RIN

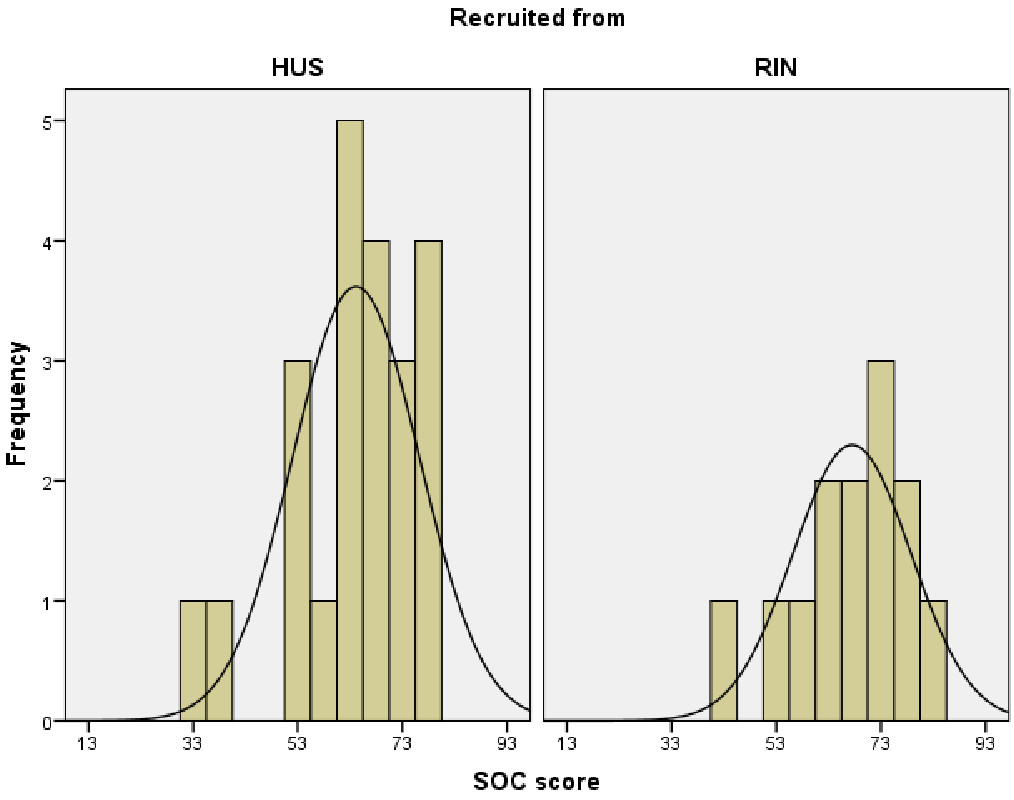

Figure 13 Distribution of SOC score in HUS and RIN

The sample sizes are relatively small in the two groups, and the distributions seems markedly non-normal particularly in age (RIN), see figure 10. The nonparametric Mann-Whitney U-test is a more robust test than the t-test, and does not require that the data are normally distributed (Aalen & Frigessi, 2006, p. 198). The Mann-Whitney U-test is therefore used to see if the data in the two groups are equally distributed.

Table 6 Group statistics for patients recruited from HUS (N=22) and RIN (N=13)

Variable	Group	Mean	STD	p	Test	Results
Age	HUS RIN	31,5 45,0	10,4 16,3	0,022	Mann-Whitney U-test	Different group means
BARS sum score	HUS RIN	41,0 41,8	5,9 5,3	0,555	Mann-Whitney U-test	Equal group means
SRS-22 score	HUS RIN	3,8 3,7	0,8 0,5	0,389	Mann-Whitney U-test	Equal group means
SOC-13 score	HUS RIN	64,1 67,5	12,4 11,3	0,448	Mann-Whitney U-test	Equal group means

Table 6 shows significantly differences in age between patients recruited from HUS and RIN, with mean ages of respectively 31,5 years and 45,0 years. The p value is lower than 0,05. The two groups show different STD for age. The scores of the assessment tools BARS sum score, SRS-22 score, and SOC-13 score shows p values greater than 0,05, and we accept that groups are similar.

4.3 Association between patient characteristics and the results of the assessment tools

Significant moderate and high correlations are extracted from the correlation matrixes in table 7-13, and later discussed in section 5.3. The correlations in the correlation matrixes in table 7-13 are marked * when significant at the 0,05 level, and ** at the 0,01 level (two-tailed). The coefficient of determination is r^2, and indicates how much the variability in one variable that can be attributed to variability in another variable.

Due to scarcity of information on the association between age and HRQoL for the IS population, special attention is given to the independent variable age against SRS-22 outcomes. Figure 15-18 illustrates the associations with scatter plots and regression lines.

4.3.1 Association between patient characteristics and movement quality

Table 7 Association between patient characteristics and BARS sum score

		BARS sum score
Age	Pearson Correlation	-,282
	Sig. (2-tailed)	,100
	N	35
Years since operation	Pearson Correlation	-,093
	Sig. (2-tailed)	,602
	N	34
Fused vertebras	Pearson Correlation	-,421*
	Sig. (2-tailed)	,012
	N	35
Caudal unfused vertebras	Pearson Correlation	-,011
	Sig. (2-tailed)	,952
	N	35
Cranial unfused vertebras	Pearson Correlation	,391*
	Sig. (2-tailed)	,020
	N	35
Preoperative largest curve	Pearson Correlation	-,310
	Sig. (2-tailed)	,075
	N	34
Postoperative largest curve	Pearson Correlation	-,163
	Sig. (2-tailed)	,374
	N	32
Major largest correction	Pearson Correlation	-,208
	Sig. (2-tailed)	,254
	N	32

Table 7 shows that negative and moderate correlation was found between number of fused vertebras and BARS sum score (r:-,41). Moderate correlation was found between number of cranial unfused vertebras and BARS sum score (r: ,391).

Table 8 Association between patient characteristics and BARS movement 1-12 score

		1	2	3	4	5	6	7	8	9	10	11	12
Age	Pearson Correlation	-,135	-,053	-,296	-,329	-,189	-,110	-,171	-,271	,080	-,002	-,349*	-,268
	Sig. (2-tailed)	,440	,762	,084	,054	,277	,530	,325	,115	,647	,990	,040	,120
	N	35	35	35	35	35	35	35	35	35	35	35	35
Years since operation	Pearson Correlation	-,075	-,016	-,314	-,343*	,080	,048	,034	-,153	,197	,095	-,091	-,041
	Sig. (2-tailed)	,673	,927	,071	,047	,651	,790	,849	,387	,263	,591	,607	,816
	N	34	34	34	34	34	34	34	34	34	34	34	34
Fused vertebras	Pearson Correlation	-,319	-,391*	-,197	-,156	-,264	-,327	-,480**	-,202	,010	-,240	-,397*	-,275
	Sig. (2-tailed)	,062	,020	,256	,372	,125	,055	,004	,244	,955	,165	,018	,110
	N	35	35	35	35	35	35	35	35	35	35	35	35
Caudal unfused vertebras	Pearson Correlation	-,357*	,056	,034	,166	-,085	,089	-,135	,000	,162	,106	,107	-,116
	Sig. (2-tailed)	,035	,751	,848	,341	,627	,611	,439	,998	,351	,543	,540	,508
	N	35	35	35	35	35	35	35	35	35	35	35	35
Cranial unfused vertebras	Pearson Correlation	,466**	,330	,164	,061	,283	,255	,505**	,185	-,088	,168	,311	,308
	Sig. (2-tailed)	,005	,053	,346	,726	,099	,139	,002	,287	,614	,336	,069	,072
	N	35	35	35	35	35	35	35	35	35	35	35	35
Preoperative largest curve	Pearson Correlation	-,213	-,229	-,178	-,239	-,135	-,206	-,248	-,387*	,057	-,237	-,136	-,220
	Sig. (2-tailed)	,227	,192	,313	,173	,445	,241	,157	,024	,748	,177	,442	,211
	N	34	34	34	34	34	34	34	34	34	34	34	34
Postoperative largest curve	Pearson Correlation	-,143	-,200	-,296	-,220	-,058	-,146	-,095	-,265	,375*	,046	,031	-,140
	Sig. (2-tailed)	,434	,274	,101	,226	,754	,425	,604	,142	,034	,804	,866	,445
	N	32	32	32	32	32	32	32	32	32	32	32	32
Largest curve correction	Pearson Correlation	-,118	-,039	,206	-,008	-,130	-,086	-,227	-,179	-,429*	-,440*	-,242	-,128
	Sig. (2-tailed)	,520	,833	,258	,967	,479	,641	,212	,327	,014	,012	,182	,484
	N	32	32	32	32	32	32	32	32	32	32	32	32

As seen in Table 8, moderate correlation was found between patient characteristics and seven of the BARS movements:

BARS 1 “Contact with the Ground” was moderately negatively correlated with the number of caudal unfused vertebras (r:-,357) and moderately correlated with the number of cranial unfused vertebras (r:,466). BARS 2 “Closing Legs Together” was moderately negatively correlated with total number of fused vertebras (r:-,391). BARS 7 “Sideways Movement” was moderately negatively correlated with total number of fused vertebras (r:-,480) and moderately correlated with the number of cranial unfused vertebras (r:,505). BARS 8 “Turning Around Vertical Axis” was moderately negatively correlated with the preoperative largest curve (r:-,387). BARS 9 “Arm Movement” was moderately correlated with the postoperative largest curve (r:,375) and moderately negatively correlated with the largest curve correction (r:-,429). BARS 10 “Flexing/Extending the Trunk” was moderately negatively correlated with the largest curve correction (r:-,440). BARS 11 “Relational Movement” was moderately negatively correlated with age (r:-349) and the number of fused vertebras (r:-,397).

4.3.2 Association between patient characteristics and health related quality of life.

Table 9 Association between patient characteristics and SRS score

		SRS score
Age	Pearson Correlation	-,528**
	Sig. (2-tailed)	,001
	N	35
Years since operation	Pearson Correlation	-,142
	Sig. (2-tailed)	,423
	N	34
Fused vertebras	Pearson Correlation	-,159
	Sig. (2-tailed)	,360
	N	35
Caudal unfused vertebras	Pearson Correlation	,204
	Sig. (2-tailed)	,240
	N	35
Cranial unfused vertebras	Pearson Correlation	,046
	Sig. (2-tailed)	,793
	N	35
Preoperative major curve	Pearson Correlation	-,214
	Sig. (2-tailed)	,223
	N	34
Postoperative major curve	Pearson Correlation	-,221
	Sig. (2-tailed)	,224
	N	32
Major curve correction	Pearson Correlation	,010
	Sig. (2-tailed)	,955
	N	32

Moderately and negatively correlation was found between SRS-22 scores and age (r -,528), as seen in table 9. The scatterplot in Figure 14 presents the correlation.

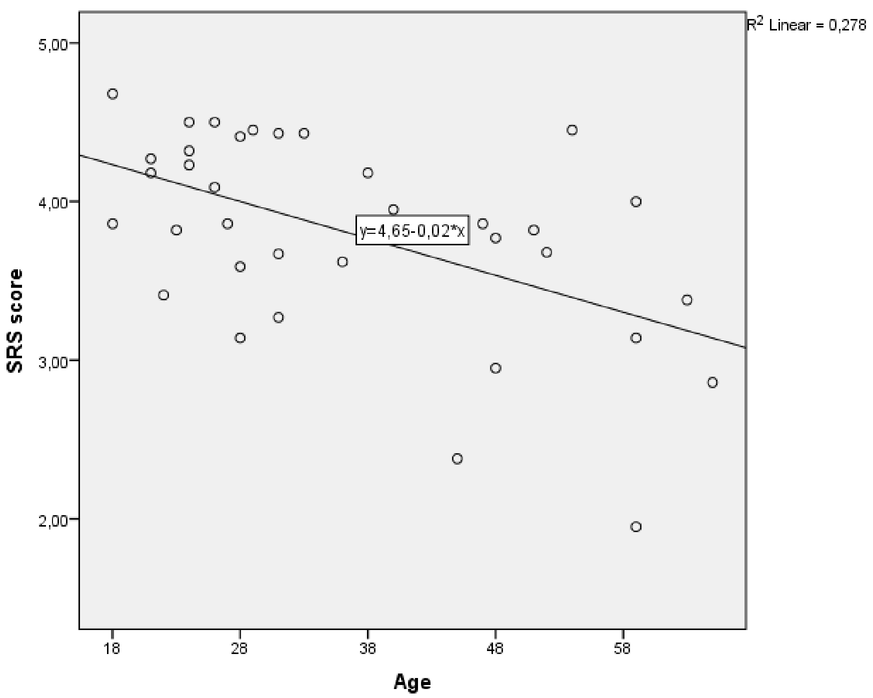

Figure 14 Scatter plot showing negative correlation between age and SRS sum score

Table 10 Association between patient characteristics and SRS sub.domains score

		Function/ activity	Pain	Self-appearance	Mental health	Satisfaction with treatment
Age	Pearson Correlation	-,671**	-,427*	-,426*	-,253	-,358*
	Sig. (2-tailed)	,000	,011	,011	,142	,035
	N	35	35	35	35	35
Years since operation	Pearson Correlation	-,229	-,081	-,131	-,027	-,201
	Sig. (2-tailed)	,192	,650	,459	,879	,254
	N	34	34	34	34	34
Fused vertebras	Pearson Correlation	-,205	,046	-,218	-,311	-,015
	Sig. (2-tailed)	,238	,792	,208	,069	,933
	N	35	35	35	35	35
Caudal unfused vertebras	Pearson Correlation	,202	-,089	,212	,466**	,047
	Sig. (2-tailed)	,243	,613	,221	,005	,791
	N	35	35	35	35	35
Cranial unfused vertebras	Pearson Correlation	,088	,001	,096	,056	-,009
	Sig. (2-tailed)	,614	,996	,585	,748	,958
	N	35	35	35	35	35
Preoperative largest curve	Pearson Correlation	-,157	-,115	-,303	-,295	,017
	Sig. (2-tailed)	,374	,517	,081	,090	,922
	N	34	34	34	34	34
Postoperative largest curve	Pearson Correlation	-,196	-,298	-,207	-,097	-,053
	Sig. (2-tailed)	,282	,098	,256	,596	,773
	N	32	32	32	32	32
Largest curve correction	Pearson Correlation	,073	,247	-,125	-,299	,108
	Sig. (2-tailed)	,693	,172	,494	,096	,556
	N	32	32	32	32	32

Table 10 illustrates correlation between patient caracheristics and the SRS sub-domain scores. High and negative correlation was found between age and function/activity (r:-,671). Moderate and negative correlation was found between age and pain (r:-,427), age and self-appearance (r:-,426), and age and satisfaction with treatment (r:-358). The number of caudally unfused vertebras was moderately correlated with mental health (r:,466). The scatterplots in figure 15-18 illustrates the associations between age and the SRS sub-domains.

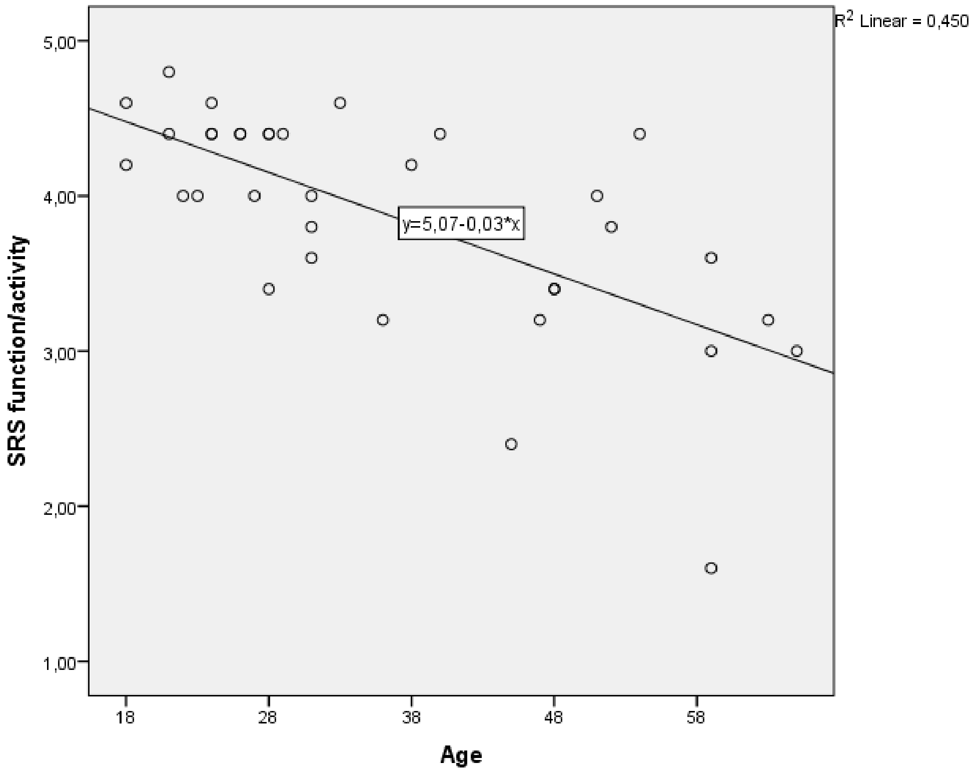

Figure 15 Scatter plot showing negative correlation between age and SRS function/activity

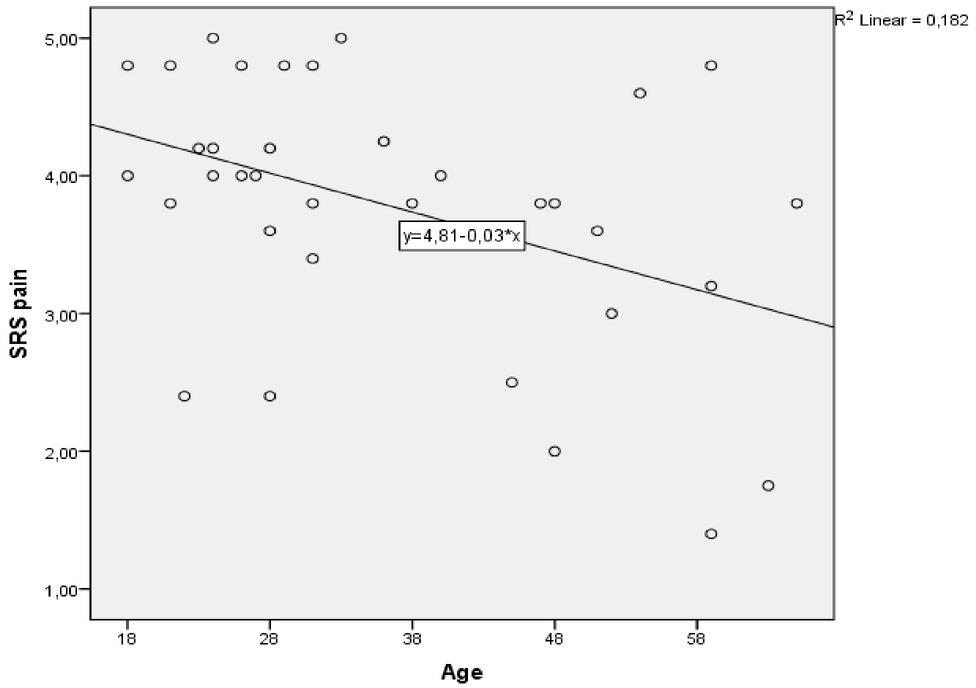

Figure 16 Scatter plot showing negative correlation between age and SRS pain

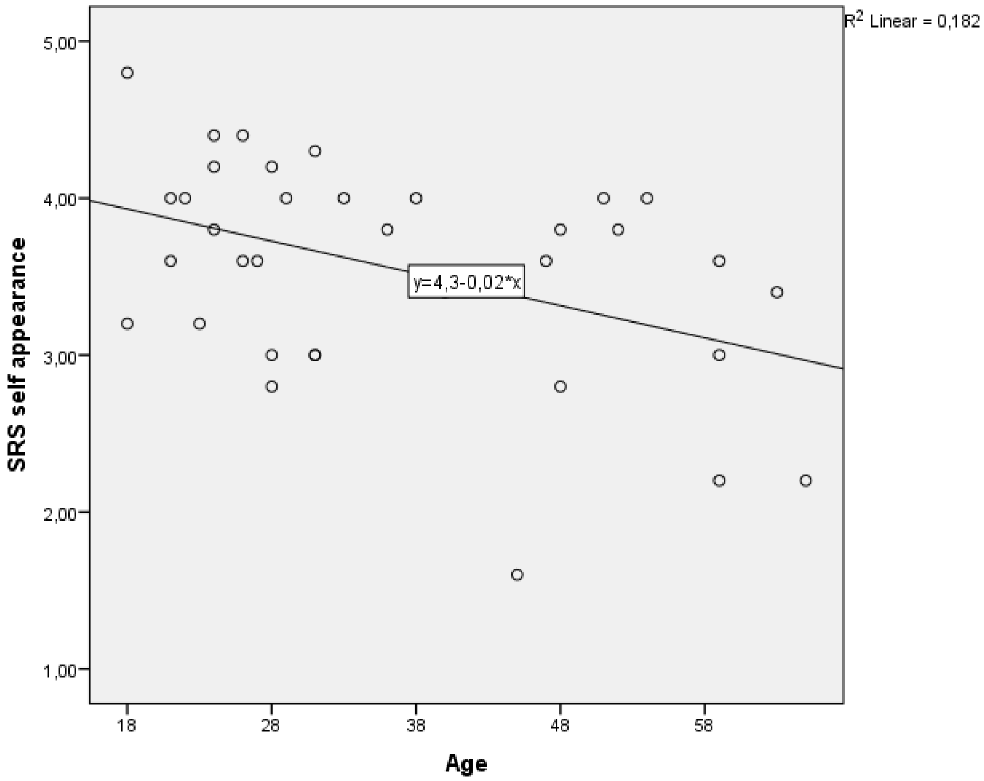

Figure 17 Scatter plot showing negative correlation between age and SRS self-appearance

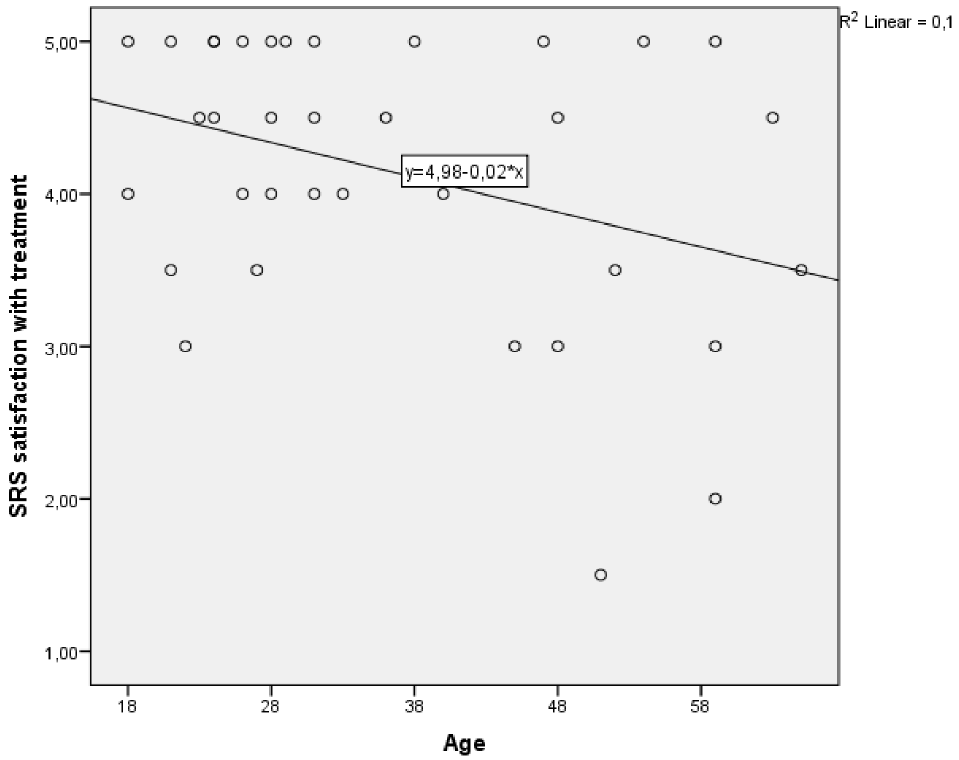

Figure 18 Scatterplot showing negative correlation between age and satisfaction with treatment

4.3.3 Association between patient characteristics and coping strategies.

Table 11 Association between patient characteristics and SOC score

		SOC score
Age	Pearson Correlation	-,207
	Sig. (2-tailed)	,234
	N	35
Years since operation	Pearson Correlation	-,013
	Sig. (2-tailed)	,941
	N	34
Fused vertebras	Pearson Correlation	-,014
	Sig. (2-tailed)	,937
	N	35
Caudal unfused vertebras	Pearson Correlation	,331
	Sig. (2-tailed)	,052
	N	35
Cranial unfused vertebras	Pearson Correlation	-,149
	Sig. (2-tailed)	,392
	N	35
Preoperative major curve	Pearson Correlation	-,094
	Sig. (2-tailed)	,596
	N	34
Postoperative major curve	Pearson Correlation	,064
	Sig. (2-tailed)	,728
	N	32
Major curve correction	Pearson Correlation	-,200
	Sig. (2-tailed)	,272
	N	32

As seen in Table 11, there were no significant associations between patient characteristics and coping strategies.

4.3.4 Association between movement quality and health related quality of life.

Table 12 Association between BARS and SRS-22

		SRS-22 score	Function/ activity	pain	Self-appearance	Mental health	Satisfaction with treatment
BARS sum score	Pearson Correlation	,349*	,466**	,157	,418*	,278	,088
	Sig. (2-tailed)	,040	,005	,367	,012	,105	,617
	N	35	35	35	35	35	35

Moderate correlation was found between BARS sum score and the SRS-22 score (r:,349). Within the SRS sub-domains, moderate correlation was found between BARS sum score and function/activity (r:,466), and between BARS sum score and self-appearance (r:,418).

4.3.5 Association between movement quality and coping strategies.

Table 13 Association between SOC-13 and BARS sum score

		BARS sum score	SOC score
BARS sum score	Pearson Correlation	1	,164
	Sig. (2-tailed)		,348
	N	35	35

No significant correlation was found between movement quality and coping strategies.

5 DISCUSSION

The questions posed initially were how the movement quality is in patients who have had scoliosis surgery and if there were any interrelationships between the variables patient characteristics including surgical data, MQ, HRQoL, and coping strategies.
The patients included in this study demonstrated MQ, measured by the mean BARS sum scores, under the midpoint of the scale. Several significant associations were found between MQ, patient characteristics, and HRQoL. There were not found any significant associations between SOC and the other variables.

5.1 Descriptive results

The age distribution for all the patients was bimodal with two peaks. All patients recruited from HUS except for one, had their scoliosis surgery after 1996. There were no limitation on years since operation for the RIN group, the first patient had her operation in 1967. This can explain the difference in mean age between the groups HUS and RIN of respectively 31,5 and 45 years (table 6).

The mean BARS sum score in this study was 41,3 (table 3). This demonstates lower MQ measured by BARS sum scores in women who have undergone scoliosis surgery, compared to a study among two groups of healthy persons with average ages of respectively 48 years (BARS score: 55,4) and 49 years (BARS score: 56,2) (L. H. Skjaerven et al., 2015). None of the women with scoliosis surgery scored higher scores than 52,5 of 84 maximum, compared to 75,5 and 68,0 in the two healthy groups in the study of Skjaerven et al. (2015). The movement BARS 10, “Flexing/Extending the trunk”, had the lowest mean score among the 12 BARS movement being 2.93. MQ score of 3 is defined in appendix 2 as:

> *Weak functional movement quality*: The vertical axis has an uncertain balance, little stability, firmness and freedom. Movement characteristics: somewhat dysfunctional in form, somewhat mechanical, staccato, stiff, a-rhythmical and lifeless. The movements are characterised by some weakness in the intention and direction. The amount of energy in the movement is more discordant with the task, being smaller and more closed or larger and more open or having too much or too little energy. The

movements originate more from the periphery than from the centre in the trunk. The movements are characterised by a weak unity and integration. They express weak movement harmony. (Skjærven, 2015, p. 4)

The movement BARS 5, "sitting", had the highest mean score among the 12 BARS movement being 3,9. MQ score 4 is defined in appendix 2 as:

Some functional movement quality: The vertical axis has some balance, stability, firmness and freedom. Movement characteristics: Some glimpses of functional form, flow, elasticity and rhythm; some glimpses of intention and direction of the movements. The amount of energy expressed in the movement is somewhat appropriate to the task. There are some signs of movement originating from the centre in the trunk. The movements in the person as a whole are characterized by some glimpses of unity and integration. They express some movement harmony. (Skjærven, 2015, p. 4)

There is limited information on normative date of HRQoL for the IS population in Norway. A study on HRQoL measured by SRS-22 among 57 IS patients whith with a mean age of 21 years, included various treatment options (R. D. Adobor et al., 2012). 22 of the patients had scoliosis surgery, 12 of the patients had previously been treated with a brace, 6 were currently braced, and 17 were scheduled for surgery. The mean SRS score for the whole group of patients was 3,9 compared to 3,8 in the present study. The sub-domain scores were respectively function/activity (4,1), pain (4,0), self-appearance (3,5) mental health (3,9), and satisfaction with treatment (4,0). The domain function/activity and pain scores have highest discrepancies compared to the present study, and the present study shows lower scores in these domains. An explanation of higher scores in the study of Adobor et al. (2010) can be the different inclusion criterias in treatment, and the lower average age in the patient group, 21 years versus 36,5 in the present study. Age was shown to be significantly negatively correlated with all the SRS sub-domains in the present study, exept for mental health (see table 9.).

A 25 year follow-up study in Denmark among 97 patients with an average age of 38 years who had undergone spinal fusion, showed higher sub-domain scores (except for "pain") measured by SRS-22 than in both the present study and in the study of Adobor et al.

(2010). The scores were: function/activity (4,3), pain (3,9), self-appearance (3,8), mental health (4,1), and satisfaction with treatment (4,3). In Denmark, idiopathic scoliosis over 20° are entitled to physiotherapy free of charge (Sundhetsstyrelsen, 2016). This is not the case in Norway, and might have an effect on the higher scores on HRQoL for patients in Denmark compared to Norway.

A cross-sectional study on lumbar spine mobility and HRQoL after posterior spinal fusion and instrumentation measured by SRS-22 was performed on 172 patients (128 females, 44 males) in China (Fan et al., 2016) The mean age of the patients was 17.8 years and approximately 2,5 years after surgery. The results of the various SRS sub-domains for this age group was: function/activity (4,0), pain (4,5), self-appearance (3,9), mental health (4,1) and satisfaction with treatment (4,1). This age group scored lower in function compared to the patients in Denmark with average age of 38 years (4,0 vs. 4,3).

Previous studies on coping strategies measured by SOC, have been performed among professional Scandinavian health workers and American students using SOC-29, scoring respectively 146,1 and 133,1 (Antonovsky & Sjøbu, 2012). Since the SOC-13 questionnaire is a short version of the SOC-29 questionnaire, a score of 65,4 on SOC-13 would equivalent to a score of 145,9 on SOC-29. Hence, the SOC scores in the present study are almost similar compared to professional health workers in Scandinavia and higher than compared to American students.

5.2 Difference between groups

The mean age was the only variable tested that was significantly different between patients recruited from the two groups RIN and HUS. Mean age of the patients recruited from HUS (31 years) was significantly lower than of those recruited from RIN (45 years). All of the patients recruited from HUS had their operation done after 1996 due to changes in the journal system and difficulties to find patient journals before 1997. For patients recruited from RIN, there were no limitations in number of years since operation and one patient was operated as early as in 1967. The limitation in years since operation for patients recruited from HUS can explain the differences in mean ages between the two groups.

5.3 Association between the patient characteristics and the results of the assessment tools

Moderate significant correlations were found between the variables in patient characteristics and MQ. Moderate significant correlations were found between patient characteristics and HRQoL. Moderate correlations were found between MQ and HRQoL. All the correlations that are mentioned in section 5.3.1 – 5.3.4 are significant ($p<0,05$).

The primary objectives for scoliosis surgery are to stop progression, achieve maximum permanent correction of the deformity in three dimensions, improve appearance by balancing the trunk, and keep short-term and long-term complications to a minimum (Weinstein et al., 2008). We would have anticipated that smaller post-operative curves measured by Cobb's angle would be associated with higher scorings in the assessment tools. But surprisingly, no significant correlations were found between the postoperative largest curve and any of the assessment tools.

5.3.1 Association between patient characteristics and movement quality

Associations between patient charachteristics and MQ were reflected in seven of the BARS movements. In BARS 1 "Contact with the ground", a higher number of caudal unfused vertebras was surprisingly negatively associated with MQ, whereas higher number of cranial unfused vertebras was positively associated with higher MQ. The ability to handle free breathing and giving away to gravity when laying on the floor were aspects evaluated in this movement (Skjærven, 2015, p. 22).

Having a higher number of fused vertebras was associated with lower MQ in BARS 2 "Closing Legs Together". The movement is laying on the floor, and MQ is examined and evaluated by the exchange between tension and release in the movement when closing legs together towards the midline and in the way of releasing them (Skjærven, 2015, p. 23).

The total number of fused vertebras was negatively associated with BARS 7 "Sideways Movement", and higher number of cranial, but not caudally, unfused vertebras was associated with higher scores. The ability to move sideways with a free and stable balance challenges mediolateral control of balance. In the weght transference between right and left side, contact with the ground and the vertical axis is some of the qualities evaluated in BARS 7 (Skjærven, 2015, p. 28)

Havin a larger curve pre-operatively measured by Cobb angle was negatively associated with BARS 8 “Turning Around Vertical Axis”. This movement is simultaneous torsion/rotation around the whole vertical acis and the eyes are intended to follow the coordination (Skjærven, 2015, p. 29)

Having a larger postoperative curve was associated with higher scores in BARS 9 “Arm Movement”. This association was unanticipated. A large curve correction was associated with lower MQ in this movement. The integration of upper and lower body around the center in the body, as well as the arm coordination, are some aspects evaluated in this movement (Skjærven, 2015, p. 23) .

The ability to flex and extend the trunk in a zig-zag movement in the saggital plane was examined in BARS 10 “Flexing/Extending the Trunk”. From a physiological perspective, the closing and opening in the trunk is claimed to be deeply connected to the emotional life through the connection with the breathing (Skjærven, 2015, p. 31). A large curve correction was associated with lower MQ in this movement. It would be anticipated that a higher number of fused vertebras would play a larger role role in the way this movement was performed, as the movement includes flexion and extension in the spine. However, there was no correlations between BARS 11 and number of fused vertebras.

Higher age and higher number of fused vertebras was associated with lower MQ in BARS 11 “Relational Movement”. This movement has a similarity to BARS 7 as they both are performed with a wide stance and by moving the centre of gravity towards the borders of a fixed base of support, keeping a stable vertical axis perpendicular to the transversal plane. BARS 11 includes the element of relating to another person in the movement, and searches for a light flowing movement coordination between the two (Skjærven, 2015, p. 32).

Studies on physical function after scoliosis surgery are performed on gait analysis (Lenke et al., 2001) (Mahaudens et al., 2010) (Paul et al., 2014), postural balance in standing (Lenke et al., 2001; Schimmel et al., 2015), and trunk range of motion (Fan et al., 2016) (Engsberg et al., 2002). These studies have evaluated if there has been associations between physical function and primarily how many free spinal joints there were caudal to the spinal fusion. These results have not been consistent. This study showed that total number of fused vertebras and number of cranial unfused vertebras were higher associated with MQ in daily life movement than how many free spinal joints there were left caudal to the fusion. It should be mentioned that none of the patients in the present study were fused lower than L4, leaving at least one unfused vertebrae. The mean number of unfused vertebras in the lumbar area was three (table 2).

5.3.2 Association between patient characteristics and health related quality of life.

Higher age was associated with lower HRQoL measured by SRS-22 score. When looking at the sub-domains in the SRS-questionnaire, age was negatively associated with four out of the five sub-domains; function/activity, pain, self-appearance, and with satisfaction with treatment.

Weinstein et al. (2008) pointed out that there was no present conclusive evidence showing that improved radiographic outcomes correlates with improved function, self-image or health. This was also the case in this study, as no significant correlations were found between the largest postoperative curve and any of the SRS sub-domains.

In this study, higher numbers of unfused vertebras caudal to the fused area was associated with higher scores in mental health. Fan et al. (2016) however, did not find any significant correlations in their study between unfused caudal vertebras and any of the SRS sub-domains.

5.3.3 Association between patient characteristics and coping strategies.

No significant associations between patient characteristics and coping strategies measured by SOC were found in this study.

5.3.4 Association between movement quality and health related quality of life.

The moderate correlation found between movement quality assessed with BARS and health related quality of life assessed SRS-22 provides evidence that those patients with higher MQ had better HRQoL. This association is supported with the position statement of World Confederation for Physical Therapy (2011) stating that functional movement is central to what it means to be healthy, and that BARS is an assessment tool consisting of 12 functional daily-life movements.

5.4 Strengths and limitations

5.4.1 Design

A descriptive cross-sectional research design was used to answer the research questions. Numeric descriptions gave an overview over the patient characteristics and the results of the assessment tools, and the possibility to compare them to normative data. By establishing relationships among variables without researcher manipulation, areas for future experimental studies have been identified. The research design does not allow to infer causal relationships between the variables, but the correlation analysis performed in this study has revealed relationships between variables in patient charachteristics and assessment tools enlightening areas for future studies.

It strengthens the study that the examiner was blinded for patient characteristics including the surgical information prior to the assessments. Blinding avoids biases of the researcher perceiving in ways that can distort the truth of the results (Polit & Beck, 2012, p. 211) . The fact that the examiner, who also was the researcher, was blinded for patient characteristics including surgical data prior to the assessment strengthens the reliability of the correlational results.

The tester had calibrated the BARS score on two occasions with two other experienced BARS testers, and this strengthens the reliability of the BARS data results.

The number of patients in the study was rather small, being 35 patients who met the inclusion criteria and fulfilled the tests. It is not certain if there are any biases in whom chose to participate in the study. By having a larger sample size, the probability of getting a markedly deviant sample diminishes and it would provide the opportunity to counterbalance atypical values, even though a large sample is not always an assurance of accuracy. The sample size in the present study was however as large as feasible.

5.4.2 Statistics

Calculation of association is done by use of the Pearson's r, which depends on three major assumptions (Domholdt, 2005) p. 355. The first assumption is that the relationships between the variables are assumed linear. This may not always be the case. For the independent variable age, the relationships can sometimes be curve-linear, like when a very young age and very high age affect the results of the assessment tools negatively. In this study, the patient's age ranged from 18-65 years, and we assumed linear relationship in this range of age. The second assumption is homoscedasticity, meaning that for each value of one variable, the other variable has equal variability. Widely varying variances at different levels will distort the calculated value of r. Scatterplots, particularly in Figure 16, 17, and 18, shows that with higher age, larger distances from the regression line is found for scores in function/activity, pain, and satisfaction with treatment. The significance of the calculated values of r can therefore be somewhat distorted. The third and last assumption for calculation of r, is that both variables have enough variability to demonstrate a relationship. If one or both the variables calculated have restricted range, the correlation coefficient will be artificially low and uninterpretable. This might be the fact when it comes to MQ assessed with BARS, where the results in scorings of the 12 movements had a narrow range. None of the patients scored outside the interval between 1,5 and 5,5 when the possible scoring ranged was between 1 and 7.

The importance of the associations that were found in the correlation matrixes can be evaluated the coefficient of determination, r^2 which is the square of the correlation coefficient r. The coefficient of determination is an indication of percentages of variance that is shared by two variables. For the relationship between age and function/activity, 45% of the variability in function/activity can be accounted for by age ($-0{,}672^2$). The interpretation of the correlation coefficients in this study should not be extended beyond the range of the original data. Correlation is only a numerical measure of whether two sets of data may fluctuate. That something may fluctuate does not mean there is a causal relationship.

5.4.3 Assessment tools

As the tester was not a BBAT instructor, some effort was needed to learn to assess BARS and calibrate the scorings with physiotherapy experts in the field. Once this skill was achieved, BARS showed to be user-friendly to administer. No laboratory equipment was needed, only a room of about 15 m², a gym mat, and a chair. It had a functional approach and captured MQ in daily life movements. Assessing MQ with BARS was process oriented, and it was experienced as meaningful for the author to direct the focus towards the patients' healthy movement recourses and act on this, instead of only towards pathology. Additionally, by using simple movements from everyday life seemed to support the patient to experience trust and calmness when moving during the assessment.

BARS assessment tool managed to capture association between patient characteristics and MQ in daily life movements. BARS Part 2 revealed qualitative descriptions of the patients' comments to how it was to perform the movements immediately after each movement. Valuable qualitative information in the patients expression about bodily sensations of own movement potentials is left out by only evaluating the numeric BARS scores. However, this stuy was limited to examine only the quantitative results in BARS.

SRS-22 questionnaire revealed associations between patient characteristics and HRQoL. A higher specificity on the domain function/activity would probably increase the validity of the scores for this domain. The 5 questions that were included in the function/activity domain were quite generic and not very specific about movements. The questions were: no. 5 (What is your current level of activity?), no. 9 (What is your current level of work/school activity?), no. 12 (Does your back limit your ability to do things around the house?), no. 15: (Are you and/or your family experiencing financial difficulties because of your back?), and no. 18 (Does your back condition limit your going out with friends/family?), see Appendix 3. Question 15 and 18 seems to reflect social aspects as economy and participation, which may differ from function in terms of the ability to perform activities of daily living. There is also a perception that question 15 might not be applicable for countries with a public health care system as in Norway. Still, all the questions are weighted equally in the calculation of scores in function/activity. To the author's opinion, an evaluation of a person's ability to perform activities of daily living is not reflected in all these question. According to International Classification of Functioning, Disability and Health (ICF), function is and umbrella term encompassing all body functions, activities and participation (World Health Organization, 2001). The body component comprises of body functions and –structures. The activities and participation component covers the complete range of domains denoting aspects of functioning from both an individual and a societal prospective. Most of the questions in SRS-22 in the function/activity domain is related to the person's activity or participation in society according to ICF, and a more precise measure of a person's level of specific body functions is lacking in the SRS-22.

5.4.4 Ethical considerations

The professional-client relationship is based on the principle of beneficience (Domholdt, 2005, p. 40), and patients usually will not come to health care professionals unless they believed that the professional could help them. Many of the patients in this study spontaneously expressed initially that they wanted to participate in the study because of the lack of knowledge within health care professionals in the field. In this study beneficiance was put aside for the sake of new knowledge that eventually may translate into benefits in the future for patients with IS. However, as BARS is process oriented and directed towards the patients' healthy movement recources, eventually some of the patients might have experienced benefit from the assessment in form of increased movement awareness.

5.5 Clinical implications

When doing research in health science, the main aim is often that the study has some sort of clinical relevance. An important question in this study is how the findings may have an influence on the management and treatment of IS and the adequacy of common outcome measurement in a user perspective. Previous studys on the topic IS are mainly done with radiographic pictures as measurements, but HRQoL measurements have increased lately.

The results in this study showed that MQ in women who had undergone scoliosis surgery deviated negatively from normative data (L. H. Skjaerven et al., 2015) in daily life movements. When performing movements with a wide stance and when balance was challenged, was significantly negatively associated with the number of fused vertebras. Physiotherapeutic interventions including movements that challenge perturbation reaction should be considered in rehabilitation after scoliosis surgery. Further studies on the negative association between age and HRQoL, especially on physical function is needed. If this association is higher than for the normal population, and if balance problems and functional loss develops earlier in life, special attention should be made to prevent this.

The significant positive association between higher number of unfused vertebras caudal to the fused area and mental health is an area that needs to be enlightened with further studies. In case future studies support this association, adapted physiotherapy interventions can be developed for this group. Physiotherapy is one of a few professions, which have specific health and mental health training to bridge the gap between physical and mental health needs.

Radiographic post-operative measurements were not significantly associated with any of the following scores: BARS sum score, SRS-22 sum and domains scores, or SOC-13 scores. Future studies should address the question of whether the restoration of harmonious alignment after spinal fusion surgery optimizes functional movement. It will be informative if future studies evaluate the effect of scoliosis surgery on movement quality and physical ability under more demanding circumstances, such as over uneven ground, physical exertion and sporting activities, and the development of reliable and specific assessment tools to evaluate this. SRS-22 seems to only capture a minor part of IS movement abberations and seemed incomplete for measuring physical functional outcome. Further development of functional test for this group seems to be needed.

6 CONCLUSION

This study aimed to investigate MQ in patients with IS who have had scoliosis surgery, and to see if there were any interrelationships between the variables patient characteristics including surgical data, MQ, HRQoL, and coping strategies.

MQ measured by BARS showed lower scores in patients who had undergone scoliosis surgery compared to normative data. BARS scores were significantly correlated with HRQoL measured by the disease-specific questionnaire SRS-22. Several significant correlations were found between surgical characteristics, MQ, and HRQoL.

BARS is a generic movement quality assessment tool which captured movement aberrations in patients many years after they had scoliosis surgery. Still, there seems to be a need to develop a more specific movement assessment tool than BARS to measure functional changes in movement after scoliosis surgery. Such a tool will have the potential to guide more targeted and individualized exercise interventions.

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APPENDIX

APPENDIX 1 Letter of invitation with informed consent

APPENDIX 2 BARS Movement quality scores

APPENDIX 3 Scoliosis Research Society-22 questionnaire

APPENDIX 4 Sense of Coherence-13

APPENDIX 5 Excluded case

APPENDIX 6 Approval by the Regional Committees for Medical and Health Research Ethics

APPENDIX 1 Letter of invitation with informed consent

Forespørsel om deltakelse i forskningsprosjekt

"Skolioseopererertes bevegelseskvalitet"

Bakgrunn og hensikt

Dette er et spørsmål til deg om du vil delta i en forskningsstudie som går ut på å undersøke hvordan bevegelseskvaliteten er hos personer med idiopatisk skoliose som er skolioseoperert. Samtidig vil spørreskjema om helserelatert livskvalitet og dine mestringsstrategier bli benyttet. Siden du har fått utført skoliosekirurgi faller du innenfor målgruppen for denne studien. Studien blir gjort i regi av Universitet i Bergen, Høgskolen i Bergen og Haukeland universitetssjukehus. Studien inngår som en del av en masterstudie i fysioterapivitenskap.

Hva innebærer studien?

Studien er en tverrsnitt studie hvor vi bruker en fysioterapeutisk undersøkelse på bevegelseskvalitet kalt Body Awareness Rating Scale sammen med to spørreskjema. Undersøkelsen har ikke vært brukt på skolioseopererte før. Spørreskjemaene heter Scoliosis Research Society–22 og Sense of Coherence–13. Den kliniske undersøkelsen vil bli utført av en fysioterapeut i lokaler ved Institutt for Global Helse og Samfunnsmedisin, Kalfarveien 31, 5018 Bergen.

Body Awareness Rating Scale (BARS):

BARS er en fysioterapeutisk målemetode som vurderer bevegelseskvalitet. Metoden ble utviklet for å undersøke kvalitet i generell bevegelseskoordinasjon og bevegelsesvaner, og for å observere kompensasjoner og sunne bevegelsesressurser.

Undersøkelsen består av 12 grunnleggende bevegelser som benyttes i hverdagen. Bevegelsene uføres i liggende, sittende, stående, gående og i par. Bevegelseskvaliteten vurderes ved å observere hele personen i bevegelsene i stedet for separate deler av kroppen. Å fokusere på helheten gir mulighet til å observere hvordan det dynamiske samspillet mellom postural balanse, pust og mentalt nærvær påvirker bevegelsene.

Spørreskjema Scoliosis Research Scociety–22 (SRS-22):
SRS-22 er et spørreskjema bestående av 22 spørsmål som ble utviklet for å analysere helserelatert livskvalitet hos personer med idiopatisk skoliose. Skjemaet dekker 5 områder. Disse er funksjon/aktivitet, smerte, eget selvbilde, mental helse og tilfredshet med behandlingen av skoliosen.

Spørreskjema Sense of Coherence–13 (SOC-13):
SOC-13 er et spørreskjema bestående av 13 spørsmål. Det benyttes som et mål for mestring. Fra et helsefremmende perspektiv dreier det seg om å ha fokus på hva som gir bedre helse og å styrke vedkommendes ressurser. Spørsmålene er fordelt mellom kjernebegrepene forståelse, håndterbarhet og mening.

Mulige fordeler og ulemper

Til nå er det ingen kjente ulemper, fordeler eller helserisiko ved den undersøkelsen som foretas. Å svare på spørreskjemaene og selve testen krever maksimalt 1t 15 min av din tid.

Hva skjer med informasjonen om deg?

Informasjonen som registreres om deg skal kun brukes slik som beskrevet i hensikten med studien. En kode knytter deg til dine opplysninger og prøveresultat gjennom en navneliste. Alle opplysningene vil anonymiseres og bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger i de statistiske analysene som skal gjennomføres. Det vil ikke være mulig å identifisere deg i resultatene av studien når disse publiseres.

Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten og som eventuelt kan finne tilbake til deg. Sletting av koden for innsamlede data vil skje etter at studien har blitt avsluttet i juni 2016.

Frivillig deltakelse

Det er frivillig å delta i studien. Du kan når som helst, og uten å oppgi noen grunn trekke ditt samtykke til å delta i studien. Dette vil ikke få konsekvenser for behandlingen av dine helseplager.

Dersom du ønsker å delta, ta kontakt med Nora Moe-Nilssen på telefon 91357957 eller via email på moe-nils@online.no.

Samtykkeerklæringen på siste side signeres og tas med til undersøkelsen. Om du nå sier ja til å delta, kan du senere trekke tilbake ditt samtykke. Dersom du senere ønsker å trekke deg eller har spørsmål til studien, kan du kontakte Nora Moe-Nilssen på telefon 91357957 eller via email på moe-nils@online.no. Hvis du vil, kan du gjerne få tilgang til resultater fra studien etter at prosjektet er avsluttet i juni 2016.

Samtykke til deltakelse i studien

Jeg er villig til å delta i studien.

(Signert av prosjektdeltaker, dato)

Jeg bekrefter å ha gitt informasjon om studien.

(Signert, prosjektleder, dato)

APPENDIX 2 BARS Movement quality scores

MQ Score 7	*Very good functional movement quality*: The vertical axis is very well balanced, stable, firm and free. Movement characteristics: Very good functional form, flow, elasticity and rhythm; a very good intentional clarity and direction in the movements. The amount of energy expressed in the movement is very appropriate to the task. The movements originate very clearly from the centre in the trunk. The movements in the person as a whole are simultaneous; they are congruent and in accordance with each other, and are characterized by very good unity and integration. They express a very good movement harmony.
MQ Score 6	*Good functional movement quality*: The vertical axis is well balanced, stable, firm and free. Movement characteristics: Good functional form, flow, elasticity and rhythm; a good intentional clarity and direction in the movements. The amount of energy expressed in the movement is appropriate to the task. The movements originate clearly from the centre in the trunk. The movements in the person as a whole are characterized by good unity and integration. They express a good movement harmony.
MQ Score 5	*Moderate functional movement quality*: The vertical axis is moderately well balanced, stable, firm and free. Movement characteristics: Moderate functional form, flow, elasticity and rhythm; a moderate clarity in the intention and direction of the movements. The amount of energy expressed is moderately appropriately to the task. There are moderate signs of movement originating from the center in the trunk. The movements are characterized by a moderate and variable amount of unity and integration. The movements in the person as a whole are characterized by moderate unity and integration. They express moderate movement harmony.
MQ Score 4	*Some functional movement quality*: The vertical axis has some balance, stability, firmness and freedom. Movement characteristics: Some glimpses of functional form, flow, elasticity and rhythm; some glimpses of intention and direction of the movements. The amount of energy expressed in the movement is somewhat appropriate to the task. There are some signs of movement originating from the centre in the trunk. The movements in the person as a whole are characterized by some glimpses of unity and integration. They express some movement harmony.
MQ Score 3	*Weak functional movement quality*: The vertical axis has an uncertain balance, little stability, firmness and freedom. Movement characteristics: somewhat dysfunctional in form, somewhat mechanical, staccato, stiff, a-rhythmical and lifeless. The movements are characterized by some weakness in the intention and direction. The amount of energy in the movement is more discordant with the task, being smaller and more closed or larger and more open or having too much or too little energy. The movements originate more from the periphery than from the centre in the trunk. The movements are characterized by a weak unity and integration. They express weak movement harmony.
MQ Score 2	*Mostly dysfunctional movement quality*: The vertical axis is mostly lacking balance, stability, firmness and freedom. Movement characteristics: Mostly dysfunctional form, staccato, mechanical, stiff, a-rhythmical, lifeless, mostly lacking elasticity. The movements are characterized by a mostly lacking intention and direction. The amount of energy in the movements is mostly in discord with the task, either being far too small and closed or far too large and open or using far too much or far too little energy. The movements originate mostly from the periphery. There is mostly a lack of unity between upper and lower body. The movements are mostly lacking unity and integration. They express a lack of movement harmony.
MQ Score 1	*Dysfunctional movement quality*. The vertical axis is unstable and fragmented. Movement characteristics: Dysfunctional form, staccato, mechanical, stiff, a-rhythmical, lifeless, lacking elasticity. The movement is characterized by lacking intention and direction. The movements originate from the periphery and are disconnected to each other. The movements in the whole person are in discord, incongruent and counteract each other. They express movement disharmony.

APPENDIX 3 Scoliosis Research Society-22 questionnaire Pasient nr: ___________

Del 1: Besvares av alle pasienter.

1. Hvilket av de følgende utsagn passer best til din smerte opplevelse de siste 6 månedene?

☐ Ingen

☐ Mild

☐ Moderat

☐ Moderat til sterk

☐ Sterk

2. Hvilket av de følgende utsagnene beskriver din smerte opplevelse den siste måneden?

☐ Ingen

☐ Svak

☐ Moderat

☐ Moderat til sterk

☐ Sterk

3. Har du vært nervøs i løpet av de 6 siste månedene?

☐ Aldri

☐ Litt av tiden

☐ Noe av tiden

☐ Mesteparten av tiden

☐ Hele tiden

4. Hva ville du synes om å måtte tilbringe resten av livet med ryggen slik den er nå?

☐ Svært tilfreds

☐ Ganske tilfreds

☐ Verken tilfreds eller utilfreds

☐ Litt utilfreds

☐ Svært utilfreds

5. Hva er ditt nåværende aktivitetsnivå?

☐ Sengeliggende/rullestol

☐ Hovedsakelig ikke i aktivitet

☐ Lett arbeid, slik som daglige gjøremål i hjemmet

☐ Moderat manuelt arbeid og moderate sportsaktiviteter, som gå-turer og sykling

☐ Full aktivitet uten begrensinger

6. Hvordan tar du deg ut i klær?

☐ Svært godt

☐ Godt

☐ Akseptabelt

☐ Dårlig

☐ Svært dårlig

7. Har du følt deg så nedfor de 6 siste månedene at ingenting kan muntre deg opp?

☐ Veldig ofte

☐ Ofte

☐ Noen ganger

☐ Sjelden

☐ Aldri

8. Har du vondt i ryggen i hvile?

☐ Svært ofte

☐ Ofte

☐ Noen ganger

☐ Sjelden

☐ Aldri

9. Hva er ditt nåværende aktivitetsnivå, jobb eller skole?

☐ 100%

☐ 75%

☐ 50%

☐ 25%

☐ 0%

10. Hvilket av disse utsagnene beskriver best utseende av overkroppen din, definert som kroppen med unntak av hodet, bena og armene?

☐ Svært godt

☐ Godt

☐ Akseptabelt

☐ Dårlig

☐ Svært dårlig

11. Hvilke medisiner tar du for tiden mot ryggsmertene? (marker alle relevante)

☐ Jeg tar ingen medisiner

☐ Reseptfrie medisiner ukentlig eller sjeldnere (Feks Ibux eller Paracet)

☐ Reseptfrie medisiner daglig

☐ Sterke medisiner ukentlig eller sjeldnere (Feks Paralgin Forte / Pinex Forte / Nobligan)

☐ Sterke medisiner daglig

☐ Andre (angi nedenfor)

Medisiner:

____

Hvor ofte:(Brukt ukentlig/sjeldent/daglig)

____

12. Begrenser ryggen deg med hensyn til aktiviteter og gjøremål hjemme?

☐ Aldri

☐ Sjelden

☐ Av og til

☐ Ofte

☐ Veldig ofte

13. Har du følt deg rolig og harmonisk de siste 6 månedene?

☐ Hele tiden

☐ Nesten hele tiden

☐ Noe av tiden

☐ Litt av tiden

☐ Ingen følelse av ro og harmoni

14. Føler du at helsetilstanden din innvirker negativt på ditt forhold til andre mennesker?

☐ Nei

☐ Ubetydelig

☐ Lett grad

☐ Moderat grad

☐ Betydelig grad

15. Har du eller din familie økonomiske problemer som følge av din rygg?

☐ Betydelig

☐ I moderat grad

☐ I lett grad

☐ Ubetydelig

☐ Ingen

16. Har du følt deg nedstemt og deprimert i løpet av de 6 siste månedene?

☐ Aldri

☐ Sjeldent

☐ Noen ganger

☐ Ofte

☐ Veldig ofte

17. Hvor mange dager har du vært borte fra jobb eller skole på grunn av ryggsmerter de siste 3 månedene?

☐ 0
☐ 1
☐ 2
☐ 3
☐ 4 eller flere

18. Går du ut like mye som dine venner?

☐ Mye mer
☐ Mer
☐ Like mye
☐ Mindre
☐ Mye mindre

19. Føler du deg attraktiv med ryggen slik den er?

☐ Ja, svært
☐ Ja, litt
☐ Verken attraktiv eller ikke
☐ Nei, ikke særlig
☐ Nei, overhodet ikke

20. I løpet av de siste 6 måneder: Har du vært glad?

☐ Aldri
☐ Litt av tiden
☐ Noe av tiden
☐ Mesteparten av tiden
☐ Hele tiden

<u>Del 2: Besvares kun dersom du har fått behandling.</u>

21. Er du fornøyd med resultatet av behandlingen?

☐ Svært godt fornøyd

☐ Ganske fornøyd

☐ Verken fornøyd eller misfornøyd

☐ Litt misfornøyd

☐ Veldig misfornøyd

22. Ville du ønsket samme behandling på nytt dersom du hadde de samme plagene?

☐ Definitivt ja

☐ Sannsynligvis ja

☐ Usikker

☐ Sannsynligvis ikke

☐ Definitivt ikke

APPENDIX 4 Sense of Coherence-13 Pasient nr: __________

MESTRING.

Dette er en serie spørsmål som er rettet til forskjellige aspekter ved våre liv. Hvert spørsmål har syv mulige svar. Vær snill å merke av det tallet som uttrykker best ditt svar, tallene 1og 7 er de mest ytterliggående. Dersom utsagnet under tall 1 er det rette for deg, lag en sirkel rundt tallet 1. Dersom utsagnet under tall 7 er det rette for deg, lag en sirkel rundt tallet 7. Hvis du føler noe annet, lag en sirkel rundt det tallet som best uttrykker det du føler. Vær vennlig å gi bare ett svar til hvert spørsmål.

1. Føler du i bunn og grunn at du ikke bryr deg om hva som skjer rundt deg?

1	2	3	4	5	6	7
svært sjelden eller aldri						svært ofte

2. Har det hendt at du var overrasket over hvordan personer som du trodde du kjente godt, oppførte seg?

1	2	3	4	5	6	7
aldri						alltid

3. Har det hendt at du ble skuffet over personer som du stolte på?

1	2	3	4	5	6	7
aldri						alltid

4. Inntil nå har livet ditt hatt:

1	2	3	4	5	6	7
Ingen klare mål eller						meget klare mål

hensikt og hensikt

5. Føler du at du blir urettferdig behandlet?

1 2 3 4 5 6 7

svært ofte svært sjelden eller aldri

6. Hvor ofte føler du at du er i en uvant situasjon og at du ikke vet hva du skal gjøre?

1 2 3 4 5 6 7

svært ofte svært sjelden eller aldri

7. Å utføre dine daglige gjøremål er:

1 2 3 4 5 6 7

en kilde til stor glede og tilfredsstillelse

en kilde til smerte og kjedsomhet

8. Har du svært motstridende følelser og tanker?

1 2 3 4 5 6 7

svært ofte svært sjelden eller aldri

9. Hender det at du har følelser inni deg som du ikke ønsker å ha ?

1 2 3 4 5 6 7

svært ofte	svært sjelden eller aldri

10. Mange mennesker, selv karaktersterke, føler seg noen ganger som tapere i visse situasjoner. Hvor ofte har du følt det slik?

1	2	3	4	5	6	7
aldri						svært ofte

11. Når noe har hendt, har du vanligvis oppdaget at du:

1	2	3	4	5	6	7
overvurderte eller undervurderte betydningen av det.						du vurderte det riktig

12. Hvor ofte føler du at det er liten mening i de tingene du gjør daglig ?

1	2	3	4	5	6	7
svært ofte						svært sjelden eller aldri

13. Hvor ofte har du følelser som du ikke er sikker på at du kan holde under kontroll ?

1	2	3	4	5	6	7
svært ofte eller aldri						svært sjelden

APPENDIX 5 Excluded case

Correlations between age with excluded case and results of the assessment tools are presented in the correlation matrixes in table I-V. and scatterplots in Figure A-D

Table I Association between age and BARS sum score

		BARS sum score
Age	Pearson Correlation	-,206
	Sig. (2-tailed)	,228
	N	36

Table II Association between age and BARS movement 1-12 score

		1	2	3	4	5	6	7	8	9	10	11	12
Age	Pearson Correlation	-,102	,014	-,272	-,282	-,138	-,060	-,113	-,247	,102	,029	-,265	-,212
	Sig. (2-tailed)	,555	,936	,109	,096	,422	,728	,511	,146	,552	,867	,119	,214
	N	36	36	36	36	36	36	36	36	36	36	36	36

Table III Association between age and SRS score

		SRS score
Age	Pearson Correlation	-,425**
	Sig. (2-tailed)	,010
	N	36

Table IV Association between age and SRS domains score

		Function/ activity	Pain	Self appearance	Mental health	Satisfaction with treatment
Age	Pearson Correlation	-,616**	-,327	-,347*	-,198	-,251
	Sig. (2-tailed)	,000	,052	,038	,247	,139
	N	36	36	36	36	36

Table V Association between age and SOC score

		SOC score
Age	Pearson Correlation	-,144
	Sig. (2-tailed)	,402
	N	36

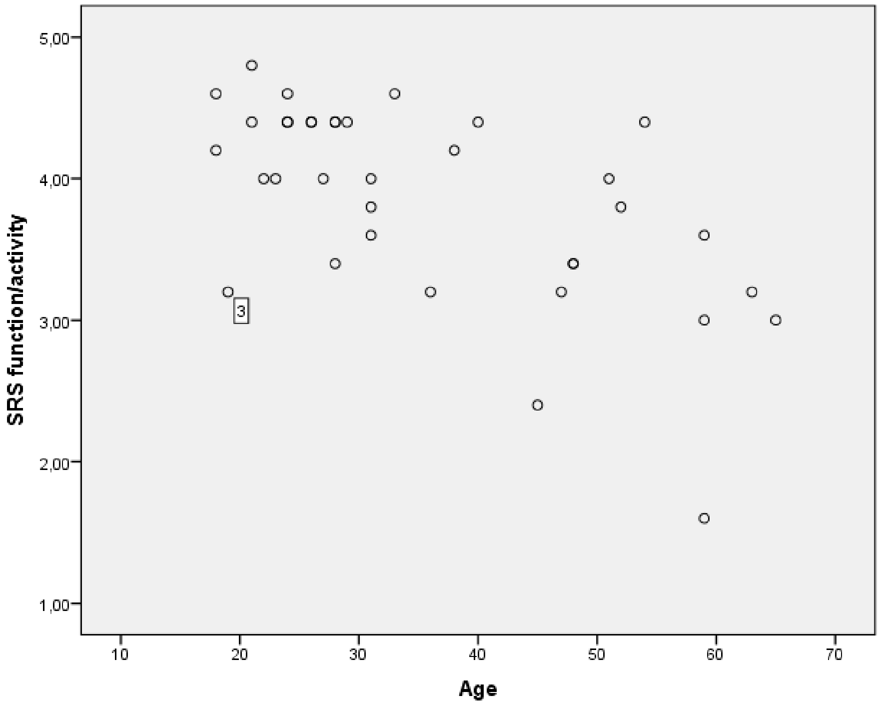

Figure A Scatter plot showing negative correlation between age and SRS function/avtivity (case #3 marked)

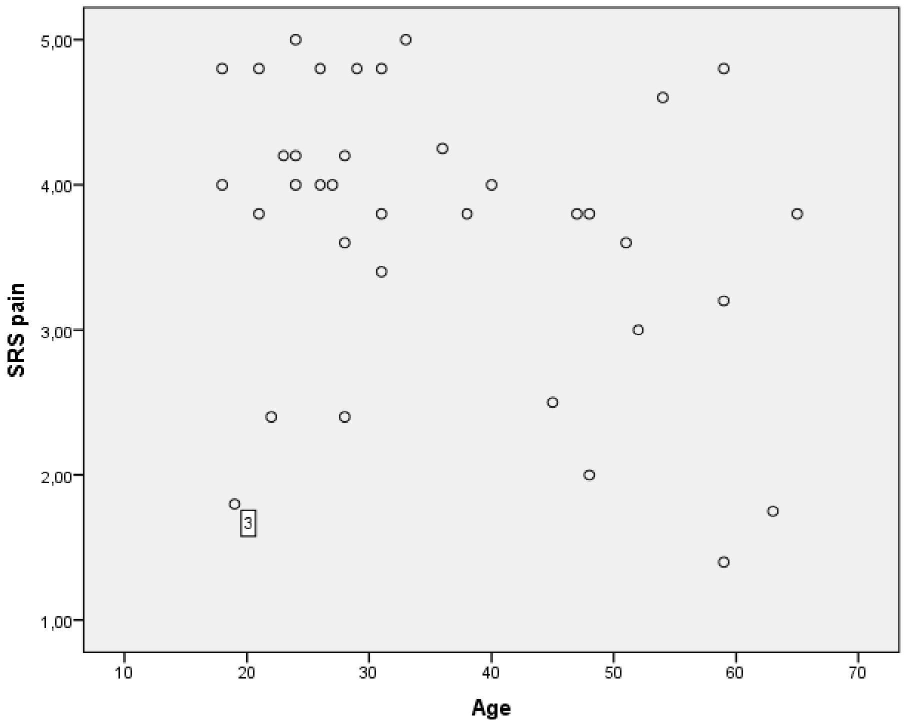

Figure B Scatter plot showing negative correlation between age and SRS pain (case #3 marked)

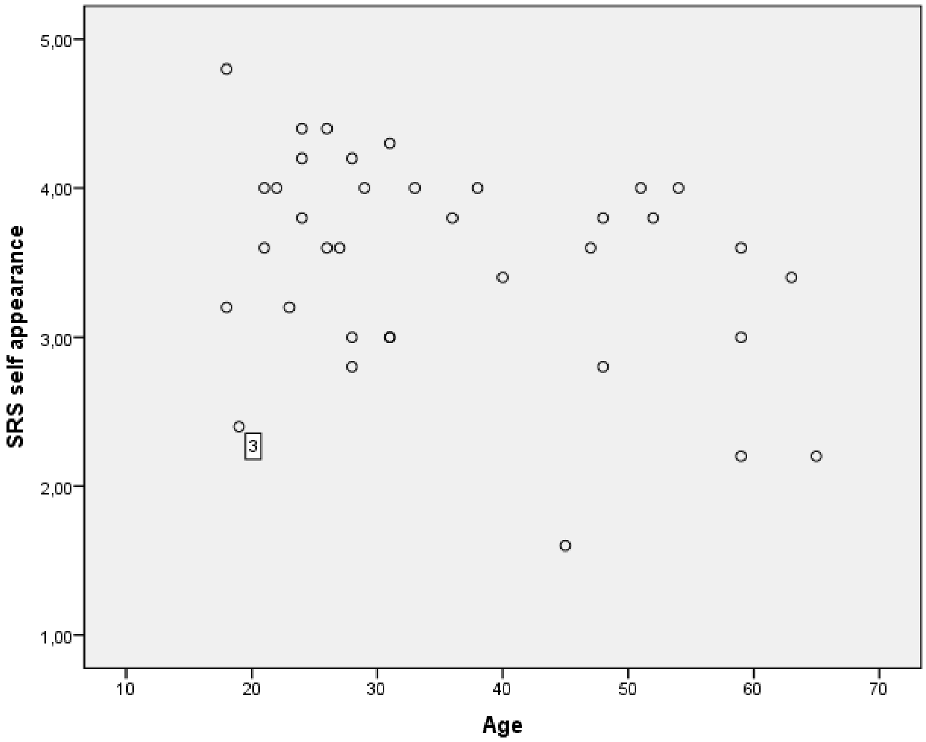

Figure C Scatter plot showing negative correlation between Age and self appearange (case #3 marked)

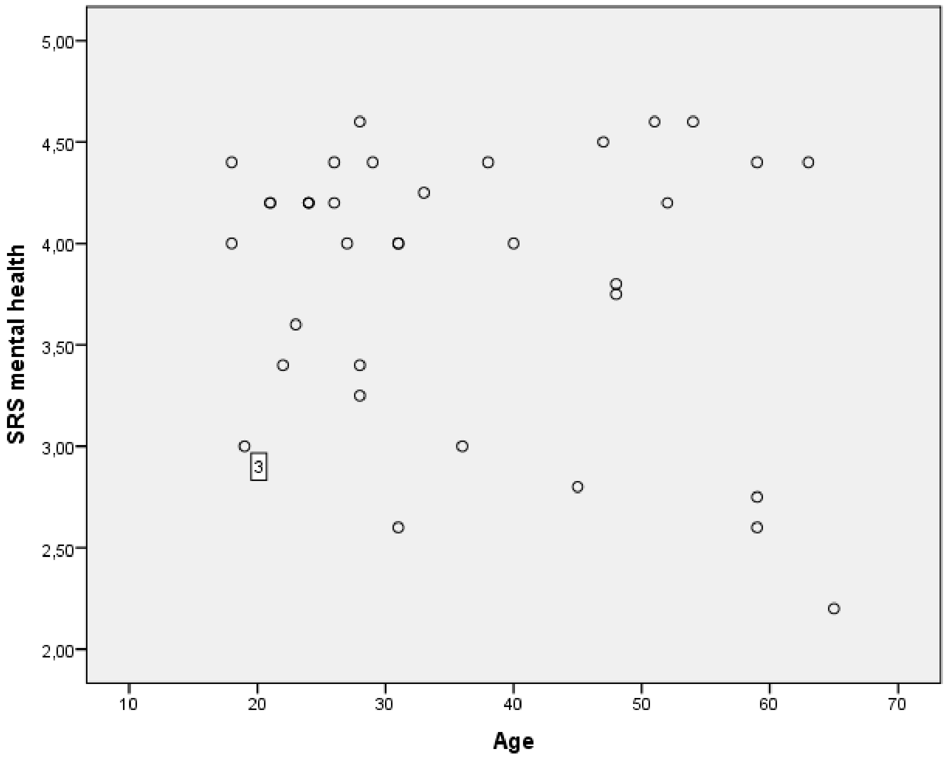

Figure D Scatter plot showing negative correlation between age and mental health (case #3 marked)

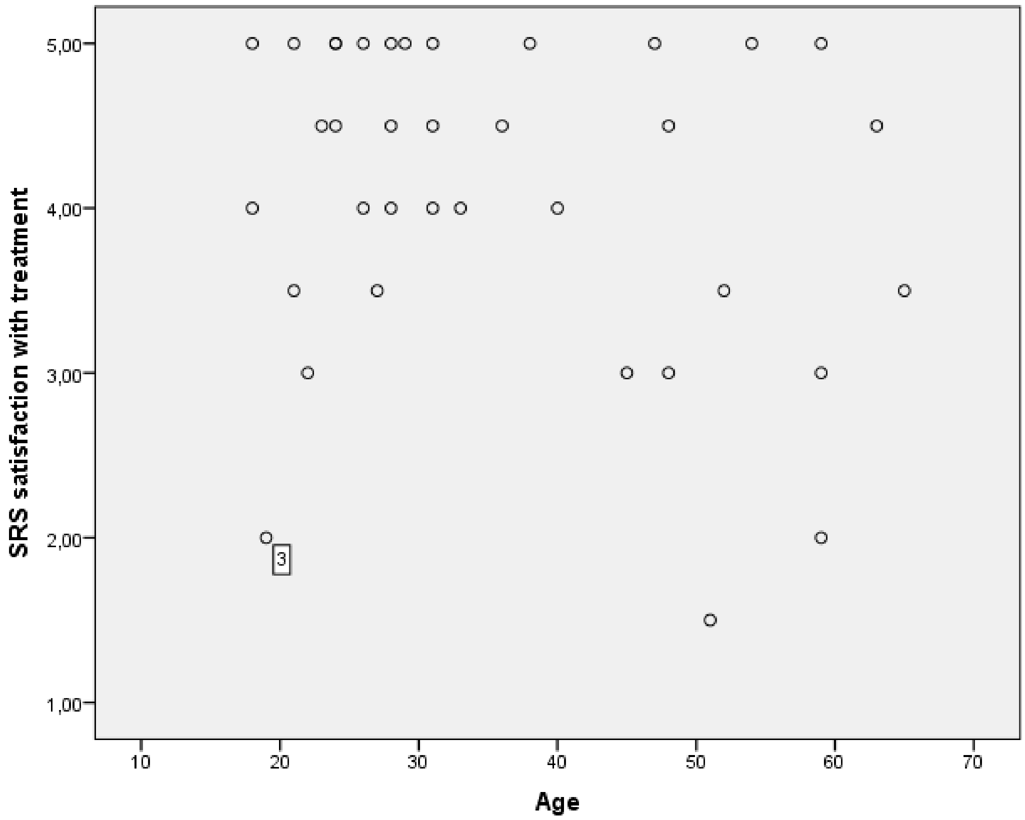

Figure E Scatter plot showing negative correlation between age and satisfaction with treatment (case #3 marked)

APPENDIX 6 Approval by the Regional Committees for Medical and Health Research Ethics

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK vest	Camilla Gjerstad	55978499	24.11.2015	2015/1736/REK vest
			Deres dato:	
			20.11.2015	

Vår referanse må oppgis ved alle henvendelser

Jan Magnus Bjordal
Universitetet i Bergen

2015/1736 Skolioseopererertes bevegelseskvalitet

Forskningsansvarlig: Universitetet i Bergen
Prosjektleder: Jan Magnus Bjordal

Vi viser til søknad om forhåndsgodkjenning av ovennevnte forskningsprosjekt. Søknaden ble behandlet av leder av Regional komité for medisinsk og helsefaglig forskningsetikk (REK vest) på fullmakt. Vurderingen er gjort med hjemmel i helseforskningsloven (hfl.) § 10, jf. forskningsetikkloven § 4.

Prosjektomtale
Formålet med studien er å vurdere bevegelseskvalitet hos skolioseopererte og studere assosiasjon mellom bevegelseskvalitet, helserelatert livskvalitet og mestringsstrategier. 50 personer vil bli rekruttert fra Haukeland universitetssjukehus sitt pasientregister og Ryggforeningen i Norge. Samtykke vil bli innhentet.

Tilbakemelding fra prosjektleder
I tilbakemeldingen fremgår det at man vil gå bort fra å begrense antall til 30 personer for masteroppgaven og inkluderer istedenfor 50 personer. Informasjonsskrivet er revidert i tråd med merknadene til komiteen.

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Vurdering
REK vest har vurdert tilbakemeldingen og har ingen ytterligere merknader til studien.

Vedtak
REK vest godkjenner prosjektet i samsvar med forelagt søknad og tilbakemelding.

Sluttmelding og søknad om prosjektendring
Prosjektleder skal sende sluttmelding til REK vest på eget skjema senest 31.12.2016, jf. hfl. § 12. Prosjektleder skal sende søknad om prosjektendring til REK vest dersom det skal gjøres vesentlige endringer i forhold til de opplysninger som er gitt i søknaden, jf. hfl. § 11.

Klageadgang
Du kan klage på komiteens vedtak, jf. forvaltningsloven § 28 flg. Klagen sendes til REK vest. Klagefristen er tre uker fra du mottar dette brevet. Dersom vedtaket opprettholdes av REK vest, sendes klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag for endelig vurdering.

Med vennlig hilsen

Ansgar Berg
Prof. Dr.med
Komitéleder

Camilla Gjerstad
rådgiver

Kopi til: postmottak@uib.no