Musculoskeletal Disorders (MSD) in School Students as a Risk Factor for Adult MSD: A Review of the Multiple Factors Affecting Posture, Comfort and Health in Classroom Environments

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Abstract

Adult musculoskeletal disorders (MSD) such as neck and low back pain have been widely reported as being of significant health and economic concern in industrialised countries. Recent literature has indicated that these disorders are also prevalent amongst school students. Student posture in classroom environments has been implicated as a risk factor for spinal MSD, but the relationship between student classroom postures and the development of subsequent adult MSD is unknown. Thus, this review examined the literature on school student (pupil) posture (five year olds through to university) in classroom environments, and its potential for predisposing adults to musculoskeletal conditions (particularly neck and low back pain) in their working life. The review is presented under the following five headings: student posture, anthropometrics and furniture; computer use; pain reporting; vision. The review indicated that all of these factors could influence the prevalence of MSD amongst pupils and suggested that any attempts to reduce MSD amongst school children should include an integrated ergonomics approach involving micro and macro ergonomic factors such as classroom furniture design, posture education, backpack weight and load carriage, learning systems re-organisation and general organisation of school activities. Although there was strong evidence that all five of the main factors examined in this review are related to MSD amongst school students, none of the papers reviewed provided any specific evidence that student MSD was related to subsequent MSD in adult life. It is therefore concluded that there was no clear objective evidence to support the view that there is a relationship between poor school posture and the development of neck and/or low back pain in adult working life.

Key words: back pain, neck pain, children, posture, school.

Introduction

The purpose of this review is to examine the literature on school student (pupil) posture (five year olds through to university) in classroom environments, and its potential for predisposing adults to musculoskeletal disorders (MSD) or conditions (particularly neck and low back pain) in their working life. It does not address the separate (but also important) question of whether MSD in adolescents can impair learning in the classroom. Low back pain has been widely reported as being of significant health and economic concern in industrialised countries (Troup et al. 1987, Trevelyan and Legg 2003). Some authors of papers that have been included in this review were of the opinion that a poor sitting posture at school may produce back and/or neck pain in adult working life (Floyd and Ward 1969, Bruynel and McEwan Stotter 1985), while others commented that the school classroom is also a workplace; its workers i.e. its pupils are the adult workers of tomorrow (Yeats 1997). Ergonomic seating and proper positioning during certain work tasks is a major focus in the adult workplace, but is typically ignored in school classrooms.

The relationship between poor working postures and the development of neck and low back pain has been widely studied, but whether this can be related back to school sitting posture is unknown (Trevelyan and Legg 2003). It has been suggested that some adolescent’s experience of low back pain may relate to similar pain in adulthood. Surprisingly, no clear defi-
nition of posture can be found in the ergonomics literature. The usual postural advice given (possibly based on aesthetics and military standards) is to ‘sit up straight and don’t slouch’. A functional definition is the position adopted in relation to the task being performed. This definition opens the possibility than an inappropriate posture can lead to discomfort.

School pupils’ primary tasks require them to sit for the majority of their classroom lessons and education years. Their seated classroom tasks include reading, writing, listening and computer use. As different postures are usually adopted for some of these tasks (e.g. writing compared with listening), chair and desk features may be contrary to recognised safe sitting postures. Furthermore, an uncomfortable body posture can destroy a student’s learning interest, even during the most stimulating and interesting lesson (Hira 1980). With the expectation and emphasis (in some sectors) on greater educational achievements, the duration of sitting is likely to increase.

Although this review focuses on posture, many of the papers cited also include reference to the prevalence of reported neck or back pain in school children (Knight and Noyes 1999, Evans et al. 1992, Trevelyan and Legg, Whittfield et al. 2001). In doing so, authors were seeking to establish evidence of a possible link between furniture mismatch and low back pain, or as a predictor of low back pain health outcomes. The factors influencing school pupils’ posture are multifactorial. This has possible implications during adulthood. The epidemiology and etiology of pain in children and adolescents is not well documented, but it warrants exploring as it may contribute towards a better understanding of the origins of adult pain problems.

The papers reviewed have been examined under the following headings: Posture, anthropometrics and furniture; Computer use; Pain reporting; Vision. The papers examined in this review were obtained by searching the following: Medline (1966–September 2001), AMed (1975–2001), Cinahl (1975–2001), Health Starr (1975–2001) and New Zealand Department of Labour databases.

Posture, anthropometrics and furniture

Typical Postures

Pupils’ typical classroom tasks of reading, writing, listening and computer use are performed in sitting, this typically being static (Murphy et al. 2003). These positions are often adopted for prolonged periods, and there is often limited opportunity for changes. Making regular postural changes is considered one method of preventing neck and low back pain (de Loose et al. 2003). Grimes (1992) informally observed the sitting posture of some Wellington pri-

mary, intermediate and secondary students, noting that prolonged and slouched postures were the norm. Correct sitting posture should allow for dynamic behaviour with many postural changes (Freudenthal et al. 1991, Yeats 1997). Leaning back against the chair was recommended, as a method of avoiding excessive cervical flexion, and sitting erect for most of the time was favoured. This contrasts with Mandal (1984), who studied the “single” and “ideal” sitting postures, verifying that there is a significant gap between theory and reality. Mandal’s major point focuses on the 90° hip flexion that is promoted for the “ideal” sitting posture, whereas he sees 60° as being more appropriate. Mandal’s measurements of hip/pelvic and back joints show that only 60° of the flexion occurs from the hip joint, whereas the remaining 30° comes from the flattening of the lumbar lordosis. Mandal (1984) stated that “…(children) sit for many hours hunched over their tails in postures extremely harmful to the back”, observing that they often sit for 4–5 hours each day. Mandal (1981) suggested that exposure to improper posture early in life is related to injury in adulthood.

It is natural for pupils to frequently change their posture, and no single posture constitutes an ideal sitting position (Karvonen et al. 1962). Changing posture is a characteristic of a comfortable posture (Mandal 1981, Hira 1980, de Loose et al. 2003). A backward-leaning position e.g. looking at the blackboard or watching the teacher is one of the frequently adopted postures. Arms are supported on the desk (a horizontal surface) for high percentages of the time, and chair backrests are not routinely used (Blöte and van der Heijden 1988, Karvonen and Hira 1980, Koskela and Noro 1962). Of the total seated time, Storr-Paulsen and Aagaard-Hansen (1994) found that approximately 43% of classroom time was spent in a backward-leaning position, whereas 57% was spent leaning forwards e.g. reading or writing. Floyd and Ward’s (1969) study of 84 secondary school pupils (mean age 17.2 years) did not differentiate between specific postures, but they did record the percentage of various postures adopted for writing, reading and listening tasks. These were 30%, 10–15% and 35–40% respectively. Up to 80% of the pupils’ time was, therefore, spent slumped on the desktop. It is reasonable to conclude that the sit up straight and don’t slouch’ is not the typical pupil sitting posture.

Sitting Duration

The duration of sitting is consistently high throughout pupils’ education. Children spend a large part of their school days in the classroom, and yet the effect of the design of school furniture on their behaviour and health has received limited attention.
(Knight and Noyes 1999). Additionally, teachers expect pupils to adopt certain postures during lessons (Storr-Paulsen and Agaard-Hansen 1994). In their survey of 194 Danish pupils (aged 5–15 years), their significant findings were as follows: a) the average period during which teachers wanted pupils to work sitting (without interruption) varied significantly in the age groups, with some of the mid-high school pupils being expected to sit constantly for periods of 90 minutes, b) averages of more than 60 minutes were often noted, with authors commenting that they found these durations of sitting “highly inexpedient”, considering that breaking after approximately 45 minutes is generally recommended, c) as children progress through their education years, the percentage of time they are expected to be physically active i.e. not sitting, reduced from 73% in the preschool category to 19% in the mid-high school years, d) as schoolchildren spend most of their time at chairs and desks, the relationship between their anthropometric measurements and the physical design of their chairs and desks is therefore as essential as a correct workspace design feature (Jeong and Park 1990). School children may spend approximately 30% of their waking hours at school, much of that sitting (Linton et al. 1994). With the unavoidable classroom feature of prolonged sitting, particularly as in the last years of school when students are approaching adulthood, other aspects of sitting posture require addressing to ensure pupils’ sound back health.

Spinal Anatomy

A sustained flexed posture causes soft tissue stresses on the spine. In a child’s early life, postural deviations are likely to be functional and fully reversible (Grimes 1992). Children’s bones are particularly soft during their school years, hence they can be easily deformed by long-term stretching (Mandal 1981). According to Mellin and Poussa (1991), lumbar lateral flexion was significantly greater in girls aged 8–14 compared with boys and, with increasing age, a lumbar lateral flexion shift to the right was found in girls.

Significant latissimus dorsi and trapezius activity, and the finding that erector spinae was most active in the erect, upright position is of anatomical importance in analysing sitting postural behaviour (Floyd and Ward 1969). These authors stated that further myography studies may be valuable in determining what features should be considered for the design and dimensions of school furniture (in conjunction with basic anthropometric requirements). Karvonen et al. (1962) supported a related view, recommending that school furniture design should permit changes in sitting posture. If, however, comfortable and correctly designed furniture was provided, there would be less incentive for children to make postural changes. As children's muscles tire more rapidly than adults’ during static muscle work, introducing regular postural change is important. To this end, it is encouraging that some of the advanced and ‘ergonomically aware’ furniture companies are developing both adult and pupil seating systems that promote the adoption of dynamic seating postures (Legg et al. 2002).

A good sitting posture includes using the minimum amount of static spinal muscle work (Bruynel and McEwan Stotter 1985). This is difficult to maintain without the assistance of correctly designed classroom furniture. Providing such furniture, in conjunction with postural education, should be important in preventing, or at least reducing, spinal problems in the future (Molenbroek et al. 2003). Minimal static muscle activity should enhance spinal care.

Physical Growth Rates and Gender Differences

Children’s growth during adolescence is often typified by growth spurts and appears to vary according to their age. Significant physical growth takes place during the school years; girls reach 65% of their stature at age 4, whereas boys reach 60% of their stature at age 4 (Oxford 1969). The growth spurt occurs at an earlier age in girls than in boys, with girls reaching 95% of their stature at age 13, but boys not reaching the same percentage until age 15 (Oxford 1969). According to Floyd and Ward (1969), the mean stature for secondary school boys is 174.5 cm, whereas for girls it is 163.1 cm. The implication of this is that a range of furniture sizes should be available to achieve a reasonable fit, with a recommendation that beyond age 14 one category of furniture size was determined to accommodate the five secondary school years (Evans et al. 1988).

Numerous authors recognised the importance of postural education during children’s growth phase, along with appropriately dimensioned and designed furniture. Theoretically, this should benefit them in later life (Harris and Straker 2001, Blöte and van der Heijden 1988, Karvonen et al. 1962, Bruynel and McEwan Stotter 1985, Trevelyan and Legg 2003).

Girls are reported to have different thoracic spine measurements than boys at age 13, and they have less kyphosis in the thoracic spine (Mellin and Poussa 1991). Although these authors did not make a direct link to posture, their work was significant in that they analysed thoracic and lumbar spine mobility during a notable period of students’ skeletal growth.

To discuss gender differences and their interrelationships with school furniture design, anthropometric measurements have also been taken (Jeong and Park 1990, Mououdi and Choobineh 1997, Parcells et
Statistically significant differences between boys and girls were found in 14 of the 17 measurements taken by Mououdi and Choobineh in their study of 6–11 year olds in a province in Iran. These authors did not, however, find any difference in sitting trunk height or stature between boys and girls. By contrast, Jeong and Park study of 1,248 Koreans aged 6–17 years found that popliteal height was an important design factor for seat height, concluding that boys above 126 cm in stature required higher desks and chairs than girls of the same stature. Girls above 120 cm in stature required a greater depth and breadth of chair than boys of the same stature, showing that stature has a high relationship to body dimensions for school furniture design. Although Jeong and Park used similar anthropometric measurements to Mououdi and Choobineh the writer questions whether the differences found could be explained by ethnic differences. Boys and girls have different requirements for the design of their workspace in the classroom (Jeong and Park 1990). Significant gender differences are therefore apparent in relationships between stature and body dimensions, and thus relate to furniture design. These differences, and differing physical growth rates, are likely to have a direct impact on students’ postural patterns.

**Anthropometrics**


Parcells et al. (1999) study of 74 Michigan district school students (ages 10–14 years) found that fewer than 20% of the students could find an acceptable chair/desk combination. Most of the students were sitting in chairs with seats that were either too high or too deep. Bruynel and McEwan Stotter (1985) gathered anthropometric data on a similar age group (13–14 year olds), to assess the suitability of New Zealand school furniture. Of note, this was the only paper reviewed that referred to New Zealand anthropometric measurements. Although it could be assumed the same data documented by overseas authors will apply to the New Zealand situation, this is unknown. Bruynel and McEwan Stotter’s comparison with the measurements taken in a 1969 Department of Health study showed a mean standing height of 161.2 cm, and an average desk height of only 70.5 cm. With this, they recommended desk height should be approximately 80.5 cm, i.e. for the average height of pupils in their survey. They also discussed the need to consider growth differences between genders in the 13–15 age group. Mououdi and Choobineh (1997), however, studied a younger group (6–11 years), finding statistically significant differences between boys and girls in 14 of the 17 measurements taken. They, along with Jeong and Park (1990), did not find any difference in sitting trunk height or statures between boys and girls though.

Popliteal height was reported as an important design factor for seat height (Jeong and Park 1990, Oxford 1969, Bruynel and McEwan Stotter 1985, Molenbroek et al. 2003, Legg et al. 2003). Oxford, and Bruynel and McEwan Stotter, noted significant chair seat variation, with the difference between shortest and longest lower leg measurement at age 15 years being 40% of the shortest measured, and at 18 years being 44%. These differences were not reflected in the classroom furniture used. According to Oxford, a classroom chair that satisfies recognised postural requirements should be one where the height of the seat is equal to the lower leg measurement, where the backrest can be utilised, and where gender differences are allowed for. Mandal (1984) would dispute the seat height/lower leg measurement principle of the aforementioned authors. Furthermore, despite the average height of school children increasing in recent years (4–5 cm), the height of school furniture has actually become lower (Mandal 1981).

Anthropometry was just one component of Ray et al.’s (1995) study of 198 kindergarten children in India (ages 3–5 years). The aim was to facilitate the design of functional fittings, in order to minimise biomechanical, circulatory and visual problems. Unfortunately, Ray et al.’s data could not be compared with other authors’ in this literature review as the age of their study group was less than 5 years, and gender differences were not accounted for.

The evidence seems to show that students’ anthropometric measurements are often incompatible with their classroom furniture. The authors question whether ethnic anthropometric differences may be relevant here too.

**Furniture**

School furniture, particularly chairs, has received widespread attention. Seating and proper positioning during certain work tasks is a major focus in the adult workplace, but is typically ignored in school classrooms (Yeats 1997). A unique opportunity exists to protect school children from injury, as they are not only the youngest workers of today but also the adult workers of tomorrow or, as Floyd and Ward (1969) referred to their 1964 study, “the school children of today are the next generation of industrial employ-
ees”. There appeared to be a consensus that school children are repetitively exposed to the hazards of abnormal or awkward postures, due to classroom furniture that is often too big or too small. This may also affect their academic performance (Oxford 1969).

A number of authors discussed “alternative” chairs (Knight and Noyes 1999, Mandal 1982, and Knusel and Jelk 1994, Legg et al. 2002). Knight and Noyes compared the effects on children’s behaviour and sitting positions on traditional classroom furniture with a new design of chair, known as ‘Chair 2000’, and associated tables. ‘Chair 2000’ had two principle features of importance: it provided a seat that sloped slightly back but with a deeper and more shallow curving front edge than conventional seating, and it had a protruding back support approximately half way up the back of the chair. These design features were different from Mandal’s though. Mandal (1982) argued that efforts to improve seated posture have been based on four misleading design principles. These have been (1) the need for lumbar support; (2) a backward sloping seat base; (3) a low chair; and (4) a low table. The traditional sitting position with straight backs and 90° angles at the hips, knees and ankles is believed to be based on attitudes that have evolved through many generations. Mandal, quoting from the International Standard Organisation 1977 on the dimensions for education furniture, strongly commented that no normal children could sit on the recommended furniture for more than 1–2 minutes.

Mandal (1984) recommended against flattening the lumbar lordosis, and promoted higher chairs and tables, specifically recommending that the chair should be at least one third of pupil height, and that the table should be at least half the height of the pupil height. Chairs should have forward tilting seat bases and desktops should be sloping (as per the older-style school desk that had a 10° slope). Mandal wrote that Victorian standing desks had a slope of 30° thus encouraging a “perfect posture for writing and reading”. More recently, the effect of a 10° desk inclination (on university students’ sitting posture while reading and writing) was studied by de Wall et al. (1991). Their recordings of students’ head and neck positions showed that a 10–15° backward chair inclination significantly reduced static neck and shoulder muscle activity. The degree of forward head and neck flexion, combined with the static nature of desk tasks, appears to be related to the incidence of neck and/or shoulder complaints. A vicious circle, i.e. one where pain can in turn lead to reflex muscle spasm may develop (Nowotny et al. 1987).

Traditional seating was replaced with air-filled balls (Pezzi balls) in the study by Knusel and Jelk (1994). As with Linton et al. (1994), Knusel and Jelk compared school children in classrooms fitted with ergonomic school furniture to those in a conventional setting. At the beginning of the study 15% of the children reported having already experienced one or more episodes of back pain, and between 15% and 37% demonstrated functional or morphologic changes. The air-filled balls provided a “well-received” alternative to conventional seating.

Although comfort is a “soft” variable, it may nevertheless be important for compliance with advice on posture. Linton et al. (1994) aimed to determine whether ergonomically designed furniture (compared with traditional furniture) would result in altered sitting patterns and reduce potential musculoskeletal symptoms. The experimental groups reported their furniture as being significantly more comfortable, but no clear improvement in actual sitting behaviour was observed. The finding that postural improvements did not seem to occur simply by using ergonomic furniture was, in part, also shared by Knight and Noyes (1999). They concluded that children showed a modest, but significant, improvement in on-task behaviour and a marked change in sitting positions following the introduction of the newly designed furniture. They hypothesised that children would concentrate better and adopt fewer “non-standard” sitting postures with the new furniture. Greater awareness of the importance of school furniture design could be achieved through training, and teachers need to actively promote a basic understanding of correct sitting positions.

The multifactorial impact of furniture was demonstrated by Oxford (1969), Hira (1980) and Yeats (1997). Oxford stated “when pupils sit on chairs that are too low, there is a marked tendency for them to slouch, to push their feet forward and become a nuisance to others, and, generally, to adopt bad postural habits”. In addition “when chairs are too high, pupils are forced to perch on the front of the seat, to sacrifice the comfort of the back rest, to lean on the table, to fidget, and if the table is too high, to sit with arms and elbows in a state of tension”. The application of ergonomics to fixed seating, e.g. as in university lecture theatres, is also limited (Hira 1980). If improvements were made in furniture design, this could benefit students by introducing dynamic positioning. In turn, these could improve circulation and spinal alignment, increase levels of arousal and concentration, as well as decrease pressure on the diaphragm and abdominal cavity.

To determine the effects of school furniture design on the postural health of children, Yeats (1997) conducted an extensive review of the literature, specifically looking at the following: a) the variation in anthropometric measures of children, b) the perform-
ance of activities exposing children to various postures, c) the physical design features of school furniture.

Not only is adjustable school furniture an important design feature, it is important if children are to have equal educational opportunities, increased comfort, and decreased incidents of musculoskeletal symptoms. Additionally, a range of sizes of furniture should be available, with children being offered choice as to furniture that suits them best.

Postural Education and Prevention

The importance of training children and young adults in a sound sitting posture has long been considered as a method of preventing neck and low back pain in later life, and in promoting work efficiency. Improving faulty posture during childhood could assist in preventing the development of degenerative spinal conditions and related back pain in adults (Mandal 1981, Bruynel and McEwan Stotter 1985).

Educating teaching staff on the importance of prevention of back pain due to poor posture would have a greater effect than merely providing ergonomic furniture (Knusel and Jelk 1994). Postural hygiene education programmes (including anatomy, muscles, exercises and activities of daily living) have been introduced in some school groups, but these have only shown a marginally significant decrease in the number of children requiring medical treatment for low back pain (Mendez and Gómez-Conesa 2001). Repeating this education, repeating it in different settings, and providing practical instruction (rather than providing verbal information only) might be required to produce durable changes (Robertson and Lee 1990, Legg et al. 2002).

McMillan (1996) and Wilson (1996) commented on the importance of postural awareness factors in school children. Knowledge of postural stability in children should also be considered. The evaluation of current theories and assessment tools for postural stability in children is linked to sensory, motor and biomechanical systems (Wescott et al. 1997). Relatively few tools are available for reliable measurement or documentation of postural stability. In a similar vein, Nowotny et al. (1987) examined deep sensibility (proprioceptors) and their role as a source of disturbing the steering system function as well as for moulding the habit of defective body posture. The authors investigated the “sense of body arrangement”, i.e. body posture, concluding that “the sense of corrected body posture” was disturbed in children with existing postural defects. These defects are likely to influence children to form a habit of incorrect body posture. Correctional procedures and body postural exercises were thought to be beneficial (Linton et al. 1994, Robertson and Lee 1990, Nowotny et al. 1987). Although the importance of postural education and prevention is commonly understood, its tangible benefits have yet been clearly demonstrated; they are probably seen as a “soft” option.

Multifactorial Characteristics

No one single factor contributes to pupil posture (Storr-Paulsen and Aagard-Hensen 1994, Ray et al. 1995, Linton et al. 1994). Its multifactorial nature was well demonstrated by Knight and Noyes (1999). They considered each of the following: a) attending to the teacher, b) writing or drawing on desk tops, c) postural factors, d) anatomical and physiological considerations, e) anthropometry, f) school organisational factors e.g. time scheduling.

Each of the above factors is encompassed in the term of ergonomics. In a briefing paper to the New Zealand Ergonomics Society on Ergonomics in Schools Action Group (ESAG), McMillan (1996) raised concerns as to the appropriateness of school furniture as part of a paper aimed at increasing the awareness and understanding and application of ergonomic principles in schools. Furniture design has often been thought of as the primary factor, but it is only one (Linton et al. 1994).

The variation in anthropometric measurements of children, the performance of activities exposing them to various postures, and the physical design features of school furniture were all features examined by Yeats (1997). Analysing just one factor in isolation e.g. classroom furniture, is unlikely to reduce the potential for children developing spinal musculoskeletal symptoms in adulthood.

Computer use

Much of the earlier literature relates to traditional paper-based tasks postures and furniture, whereas some of the more recent studies have introduced computer use. This is a reflection of the increasing use of computers in schools, universities and recreationally. With this, there has been a reported increase in the number of students requiring treatment for musculoskeletal injuries and discomfort associated with their use (Harris and Straker 2000). This is of particular concern as it occurs during critical periods of skeletal growth. The early indications are that computer use creates different physical stresses than paper-based tasks in children. Whether they are worse remains unclear, but studies support the view that children are at least as much at risk as adults (Straker 2001).

Features relating to pupils’ posture during computer use show similarities to non-computer ones. These include the following: a) sustained sitting e.g.
at a laptop. This may represent a risk of developing shoulder and neck discomfort. In one study, laptop duration ranged from 11 minutes to 10 hours, with an average of 102 minutes, and a mean daily use of 3.2 hours (Straker 2001). Laptop use is mandatory in some schools. Introducing regular postural changes needs particular attention, to offset reports of eye, neck and mid-back discomfort, b) there is negligible opportunity for postural change e.g. during laptop use. Typically, the screen is fixed to the keyboard. The resulting posture adopted is awkward, and with neck flexion often being greater than is generally accepted. Harris and Straker (2000) reported that neck flexion was 30° more than that recommended by the Australian Bureau of Standards. Neck flexion greater than 15° can result in soft tissue fatigue, c) student postures vary according to the computer's location e.g. in boarding houses, laptops are often used lying on the bed or floor, or sitting on the floor or on a stool with the laptop on the knee, d) the type of computer can significantly affect spinal postural changes, e) appropriate computer workstation equipment, or a complete absence of it, can impact on task performance e.g. typing performance and mouse accuracy (Maxwell and Laeser 2001), f) students' anthropometric requirements are often overlooked.

Students' regular exposure to computers is likely to continue to be a moderately significant feature of their education. Correspondingly, there should be an increase in attention to the range of preventative factors linked with student sitting posture.

Pain reporting

The epidemiology of pain in children and adolescents is not well documented, but it has been shown that a reasonably high proportion of school pupils report low back pain (Legg et al. 2003). Whether their pain is associated with their sitting posture or with other school features is not known (Trevelyan and Legg 2003). Watson et al. (2002) recorded a prevalence rate of 95%, with the most common reports being the difficulty of carrying school bags. Few sought medical attention though. According to Burton et al. (1996) though adolescent low back pain may be considered a normal life experience though, and is unlikely to be responsible for disabling trouble in later life.

The frequency of pain reported varies. Approximately 30% of the students in Bruynel and McEwan Stotter's study (1985) reported they had suffered neck or back pain, whereas Knight and Noyes (1999) noted that 62% of children said they experienced back pain “sometimes” or “more often”, and that 9.5% experienced it “very often”. These authors also identified a high level of reporting of back pain that was significantly related to the frequency of “non-standard” sitting at school desks. Whether school furniture is responsible for student sitting discomfort, and whether discomfort it can be related to a mismatch between individual anthropometry and school chair and desk dimensions has not been shown (Evans et al. 1992). Despite this, the following has been found: a) a mismatch between thigh length and seat depth has been significantly related to general sitting discomfort, b) a mismatch in seated elbow height and desk height has been significantly related to reported neck and shoulder pain.

Muscular tension (particularly in the neck and shoulders) in adolescence was a significant factor for later excess morbidity from neck pain. No consistent risk factor for low back pain was found (Hertzberg 1985).

Anthropometric measurements have also been taken as a predictor of low back pain, although their role seems modest (Nissinen et al. 1994). Standing and sitting differences have been positively associated with low back pain in boys, but not in girls. Sitting height and trunk asymmetry may be a contributing factor to low back pain in puberty.

Discomfort has been associated with computer use. Pain, headaches and muscle fatigue can develop in the neck and upper back region after just 20 minutes of computer use. And, the longer the duration on one task, more discomfort may result. 60% of students have reported discomfort with laptop use, and 61% have reported discomfort with carrying their laptop (Harris and Straker 2001).

Despite unclear consensus in the literature as to the causal factor(s) of low back and neck pain in children, its prevalence appears high. Anthropometric variations, the possible adverse developmental effects of prolonged exposure to postural stresses, and computer furniture are among the important factors to address to ensure there is a reduction in the prevalence of pain.

Vision

Sitting postures can influence student's visual perception, and vice versa. If children sit with their hips, knees and ankles at 90°, their ability to read or write is compromised as their axis of vision is horizontal (Mandal 1981). To read or write, they try to bend over the desk in order to position their eyes at a reasonable distance from the book i.e. 20–30 cm (compared with 50–60 cm in the very upright position). This is due to the following: a) their short focal distance (approximately 30 cm), compared to an adult's focal distance of 50–70 cm (due to presbyopia), b) their flexible backs, c) the demands of the classroom to often requiring them to keep uniformly focussed
on the same task. Their daily sitting duration is 4–5 hours (linked to their task). Letter size is also important.

When reading small letters at a great distance, the eye sees letters through a very small angle, thus encouraging children to lean forwards to improve their visual comfort. Larger letters, therefore, make it possible for children to sit more upright. Eye discomfort has recently been reported during computer use, primarily at desktop computers, but not at laptops (Straker 2001).

Conclusions

The seated posture, anthropometrics and furniture, as well as computer use, reports of pain and vision factors can all influence school pupil posture. The main merit of the papers reviewed has been to highlight these multiple factors and, therefore, indicate that a multi-dimensional approach is needed if sustainable improvements are to be made (Trevelyan and Legg 2003). If implemented, this supports the view that the potential for students to develop neck and/or back pain in their adult working life may be reduced.

The factors requiring specific attention include providing a range of furniture sizes, incorporating anthropometric characteristics (including gender and age differences), providing postural (behavioural) education, promoting task variation in classrooms, and modifying teaching/organisational schedules. Each of these needs to be implemented during critical periods of pupils’ skeletal growth. It is suggested that they will be become more important as the use of computer technology becomes an increasingly significant feature of educational and recreational life. This is particularly so as it is a widely held belief that computers enhance children’s learning ability.

A reasonable consensus was found that a classroom chair that satisfies recognised postural requirements would be one when the height of the seat is equal to the lower leg measurement, and one where the backrest can be utilised. Mandal was the only author whose ideas differed, recommending that a 60° hip flexion angle and a sloping desk were important for a sound sitting posture.

The prevalence of neck and/or back pain reports among the student population was significant. It is suggested this may become of greater concern in future (adult) years. This factor is important as today’s school pupils are tomorrow’s adult workers.

Despite the findings of this literature review, none of the papers cited clearly and objectively showed that adolescent MSD progressed or was related to MSD in adults. It is therefore concluded that no objective evidence could be found to support the view that there is a relationship between poor school posture and the development of neck and/or low back pain in adult working life. There is however, sufficient evidence in the literature to indicate that this issue warrants further exploration. An enthusiastic longitudinal co-operative and co-ordinated approach will be required to achieve this.

References


