

Better furniture types for work and studies reduces bending and pain

Conventional work-furniture is causing damaging postures, while tall chairs and tables which can slope can cause highly significant improvements in flexion, pains and comfort.

By: Torsten Mandal, M.Sc., independent consultant, PhD student

Abstract

The paper explains posture problems with conventional furniture, and solutions using appropriate science-based ergonomic design. Most chairs do not allow good postures, but induce bending, discomfort and pain, at least when having to see well what is on a table or key board. However, anybody keep a straight back sitting on a horse or tall table edge, or standing and reading on a notice board. It is possible to obtain an upright, balanced, comfortable, healthy and effective posture for work with some recent types of furniture. It requires much higher furniture than usual, with seats and tables (or keyboard) sloping toward each other. In this article, evidence is reviewed and implications for furniture design discussed.

Introduction

Standard furniture for schools and offices is a major health hazard. Back and neck pain is one of the most frequent maladies affecting people working in offices. Neck- and eye-strain from work often causes headache. Forward bending can while working reduce the lung volume capacity in often poorly ventilated rooms. Fluid circulation in legs can be restricted by sharp front edges of seats causing swollen legs [1]. Furniture not allowing movements and comfort while working is likely to contribute to problems with attention, health and school drop-outs. By the age of 15 or 16 years, about 60 to 70% of school children experience back pain [2, 3, 4].

Why conventional work furniture is harmful

No scientific or practical explanation has been offered for conventional design of working and study furniture, or their guidelines. Despite that users got much taller, chairs and tables got much lower and simpler. The designs were inspired by pseudo-functionalistic and over-simplified fashions. These were backed by health authorities and industry; despite they were in contradiction with the relevant scientific evidence,

and the experience from actual desk work. E.g., a drawing of a spinal column in a conventional 90° sitting posture instruction was even cut and pasted from an x-ray photo of a standing person [see e.g. 5]. Sitting erect on conventional work-furniture requires bending in the hip joint more than it is possible with a healthy curve (*lordosis*) in the lower back. This was shown with respected X-rays studies when lying on the side [6] and sitting [7], cited by [5, 8, 9]. Necks cannot bend as much as required to relief back on standard furniture while seeing letters on tables.

Moving upward and forward

After trying his children's habit of tilting forward on chairs, and that it immediately reduces his persistent back pain, A C Mandal (MD, chief surgeon, Finsen Institute) constructed the first modern office chairs with forward tilting seat, which can be tall and give an upright, balanced posture [1, 10] and school chairs with similar tilting or upward curved seats.



Figure 1. Standard furniture causes poor postures, unlike horse-riding and tall furniture (former laboratory in Uganda) allowing similar postures.

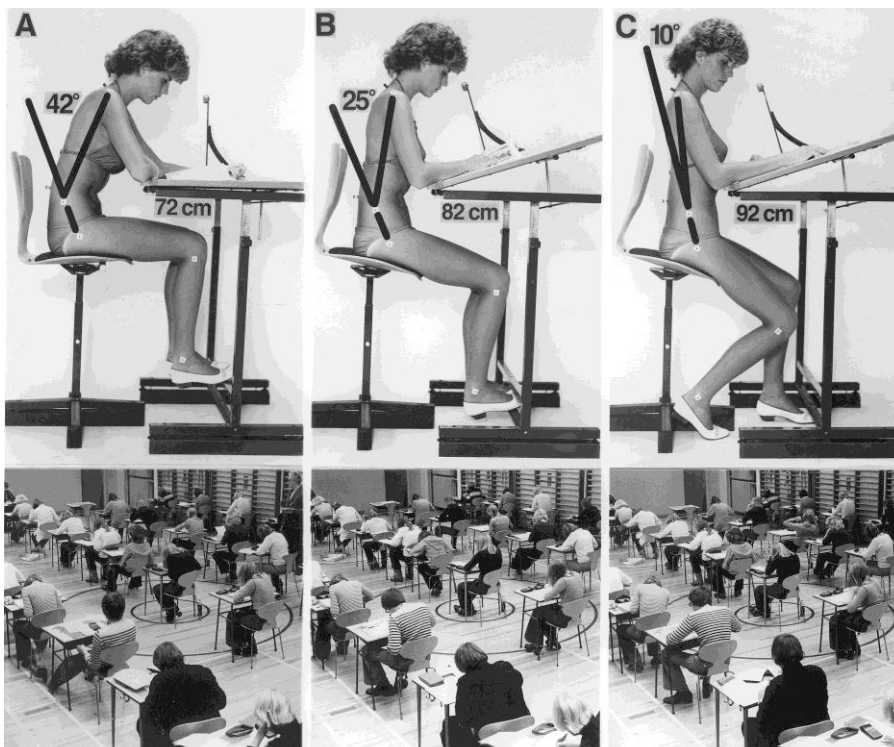


Figure 2. Automatic camera studies. Row 1: highly significant improvements of posture with increasing heights of chairs and tables above feet level when seat and desk can slope. Row 2: Examination of students trained much in conventionally postures on conventional furniture.

Methods and results

Automatic cameras have documented strong improvements possible.

At least after a few minutes, people bent backs and necks much on conventional furniture when reading or handwriting. However, high furniture with proper slopes allowed a comfortable posture, resembling that of a horse-rider (*Figure 1*). This was shown several times in Denmark using automatic cameras for:

- A schoolgirl recorded daily for ten days published by [9], *Figure 2, row 1*.
- School students trained 60 times in conventional postures believed to be correct then by physiotherapists [11, 9], *Figure 2, row 2*.
- Physiotherapist students at their final examination sitting at least as bad [11].
- Data entry personnel and secretaries [8, p. 74 to 81].

Where changes in angles of hips- and neck-bending or pain/comfort scores were measured with replicates, they were very big and statistically very highly significantly better ($P < 0.001$) for improved furniture developed and studied by AC Mandal with assistance by T Mandal [8, 11] at least while reading or handwriting or doing data entry. Tall furniture giving healthy flexion resulted in more than doubling of the test person's own comfort scores [8].

Other studies

Likewise, for secretaries reading and handwriting on conventional furniture, pressure on the front third of the seat was high, and almost twice as high compared to forward tilting seats. This is important for fluid circulation and pains [1].

Improved furniture and heights clearly improved postures and were preferred by all interviewed.

Pressure measured in the stomach was also increased by conventional furniture compared to standing or improved types (unpublished, Finsen Institute, Copenhagen).

Accordingly, 80 young and mature (max. 50 years) people studied on furniture we pumped up and down some times so they could find their own preference while reading. All preferred 15 to 25 cm higher chairs and tables than the *international* ISO standard, and they preferred seats and tables sloping towards each other and their flexions reduced much. These standards were "Chairs and Tables for Educational Institutions – Functional Sizes" (ISO Central Secretariat, ISO/TC 136, Geneva). The fixed *European* CEN standard heights for *office* furniture was almost high enough only for small *children* at 130 cm if proper angles were allowed (pr EN 91, Meubles du Bureau, CEN, Paris, 1981). It was nearly 20 cm below what 180 cm tall people preferred if table and chairs could tilt [8, 11, 12]. Likewise, the standard for school furniture was much too low (CEN, European Committee for Standardisation, 1994, Chairs and Tables for Educational Institutions prEN 1729, Brussels).

However, the recent CEN standards for *educational* furniture offer options for high sloping furniture, conventional and intermediary forms and an improved, and upward curved or flat slightly sloping seats [13]. They are now approved as: 'EN 1729-1 Edition: 2007-02-01, Furniture — Chairs and tables for educational institutions, CEN' (publisher: www.astandis.at).

Results by Mandal were confirmed by relevant independent studies (see discussion).

Improved furniture design

Tall, tilting and/or rounded seats needed.

Tall seats are needed for sitting with an open angle in the hips to avoid constant bending of knees and feet, restricting blood circulation. When leaning backwards, a footrest at the table or chair-height-adjustment can be used. Knee-support chairs are based on the same principles, but are often causing a fixed sharp angle of the knee. Saddle chairs and tall flat *stools* can be good for backs but are often uncomfortable to sit on long time. Big inflatable balls can help too, but can be impractical if tall enough and children may play with them. Possibilities for movement and flexibility are increasingly emphasised.

Backrest is not really useful for actual work over a desk with proper furniture

When the balanced posture is achieved on improved furniture, one can sit upright like horse-riding with a healthy lumbar curve without constant tension, so back rest is not needed in this posture. Trying to use it will reduce the important freedom of movement, induce sliding and/or require bending backwards in a worse posture. When actually leaning backwards and relaxing, thighs will easily slide forward on many seats, and harmfully bending the lower back the wrong way (kyphotic). Working from a permanently back-leaned posture can require more straining angles of necks and eyes to see papers or keyboards well, and can require holding arms further away from the body. This can cause pains in head, neck and eyes, lack of movements and sleepiness, if possible at all as e.g. confirmed by personal observation. Still, it can be comfortable to have a backrest sometimes for resting *if* it is made well so one actually can e.g. lean back and relax without feeling hard edges against the upper back, only lumbar support or no lumbar support at all.

To push the lower back forward on conventional furniture without constant unhealthy muscle tension, unfortunately requires a locked position, much force and a seat with much friction (unpublished measurements by T Mandal). It is often not even possible because people sit much on the front of the seat even conventional seats when reading or handwriting [1].

Tall sloping tables or key boards are needed

The slope and heights of tables, keyboards and monitors are particularly important for the upper back, neck, viewing distance, and viewing angle. If sitting according to conventional guidelines, letters on the standard desks are seen as having a small fraction of the height they could be seen with using improved furniture. Furthermore, children tend to be short-sighted. Particularly flats-screen monitors need to have a proper angle and tall height, otherwise people bent without noticing it. A big ruler with guidelines is fixed at the low edge of SIS BackUp tables to prevent things falling when tables are in the sloping position. Easily height adjustable tables allowing even standing work are becoming widespread in e.g. offices in Denmark.

Present situation

Today, new furniture for work and studies often have more or less rounded front edges or tilt forward, but the rounding is usually too small, heights are too low. Instructions are often missing, wrong or unclear mixtures of conflicting principles. Some school chairs slope or tilt slightly forward, but not enough. Other means may also help to some extent, but most students and office staff still need to sit the majority of the working hours. In Denmark, tall stools and saddle chairs are widely used by e.g. surgeons, hairdressers, dentists and in institutions for small children. More or less ergonomic student furniture now exists. However, only some improved furniture allows thighs comfortably sloping up to 15 or 20° forward without sliding, without bending knees much if heights and positions of legs and arms are suitable. Some need to get used to it.

E.g. SIS BackUp student furniture is effective, at least when student are informed how to use them and heights are correct, and widely used for years in schools in Denmark and some other countries, www.SIS-AS.DK (Figure 3).

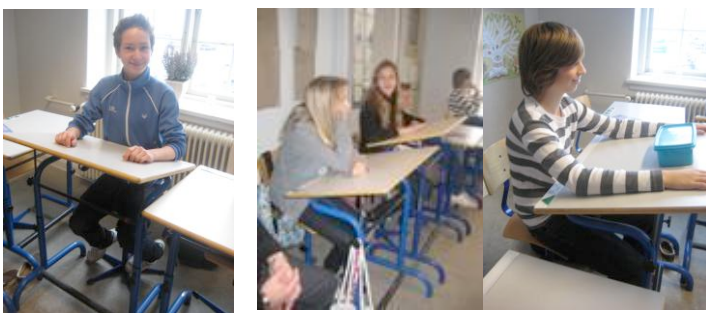


Figure 3. Danish school students at BackUp (SIS) furniture after two minutes instruction.

Such furniture types makes it possible for the hips to balance, instead of either sloping backward or needing a constant, strong, unhealthy muscle tension (Figure 4).



Figure 4. Swedish school class taught in a studio after a few minutes good posture training for improved furniture.

To prevent sliding, the seat is curved much upward. It only slopes forward on the front part which should be used for reading and writing. On wood-seat versions of SIS-BackUp, friction-varnish is applied on the front and should be maintained after some years. An optional thin replaceable cushion with cloth giving friction can also be mounted improving comfort and friction, or special plastic material chosen.

Sometimes, bad furniture is promoted as ergonomic, while no or wrong use of good furniture is shown and promoted. Fully convincing 'experts' trained in other ideas, or getting enough awareness, can require insight, but some guidelines are visible online [13], *Figure 5*.

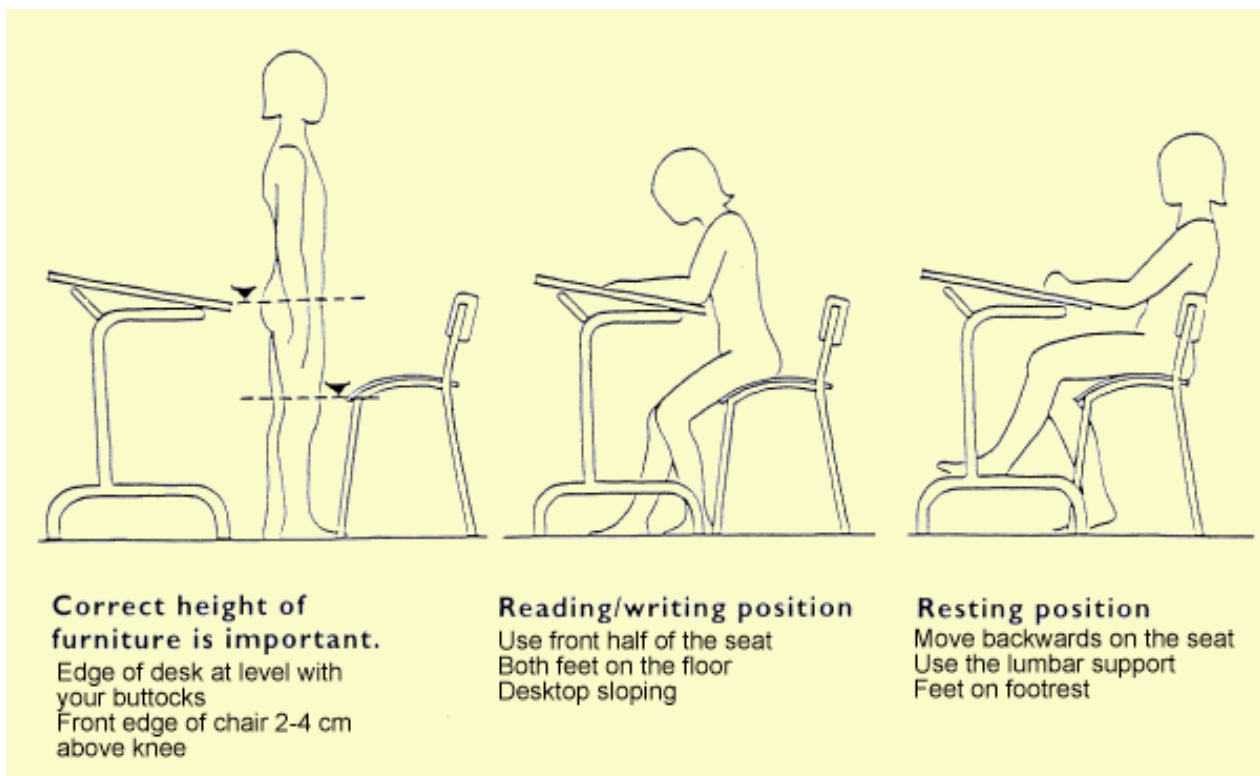


Figure 5. Good guidelines for heights of truly ergonomic student furniture and for working and resting postures.



Figure 5. None of these ladies had heard about conventional or improved guidelines for sitting but have good postures at least for their backs. Left: One of the most common working chairs in Uganda and its typical use -- good for the back but tiresome on the knees after a while. Right: A good Swedish chair in an office in Tanzania with too low, level table resulting in bent neck.

It is natural to sit well on *proper* furniture (*Figure 5*), compare with *Figure 2*, row 2, but people who have been told to move back at the seat and use back rest often bend their backs even more when pains make them aware of their posture.

Discussion of literature and conclusion

Other *relevant* studies have confirmed these findings of the improved furniture types suggested by Mandal reduced harmful flexions and pains significantly, improved healthy lordosis-curves, and generally were preferred (e.g. studies in schools [4, 14]).

Some studies have reported less clear advantages due to test-persons have been told to follow wrong conventional guidelines and heights on chairs designed by A C Mandal [8], or due to using no guidelines, low furniture heights and flat tables, smooth straight seats, or using irrelevant measurements methods giving best scores

for the most bent postures (lumbar pressure or muscle activity). Results and discussions in some articles are conflicting with their conclusion. Unlike flexion, back *pain* cannot be expected to be measurable in the first years in primary school, but soft spines may get deformed. At least studies without improved furniture confirmed the dangers of sitting much compared to moderately. Other superficial, non-experimental statistical population-studies may not give clear result on any of the causes or treatments of back pain, because the many causes and effects cannot be distinguished, "ergonomic furniture" is poorly defined, and sitting on most current furniture a few hours a day may not be as harder as doing heavy manual work the whole day, or sliding down in bad resting chairs for many hours a day.

However, the results are clear when suitable research methods are used (e.g. [1, 4, 9, 10, 11,14]): Conventional work-furniture is causing damaging postures, while tall chairs and tables which can slope can cause highly significant improvements in flexion, pains and comfort.

Torsten Mandal, M.Sc., independent consultant, PhD student

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[Torsten Mandal is the Danish, and Veronika Kotradovyá the Slovak, contact person of Association for Body Conscious Design, see contacts].

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Permanent address of author:

Peter Bangs Vej 39, 2; 2000 Frederiksberg,

Copenhagen, Denmark. Email: TorstenMandal at Gmail .com.