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# Ergonomics Design Metal Chair for the Elderly

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***Abstract* - Ergonomics have an importance of growing day by day in safety design. The accepted criteria of good seating behaviour have changed substantially in recent decades. Application of ergonomics in the design of metal chair, by taking into consideration, how the metal chair can be designed to fit the elderly that are using them. Problem faced by the elderly in home that they needs sitting long time on chair. Metal chair are suitable for elderly because it has especial characteristics as hardness, light weight, easy clear, easy adjustable ….and so on. So the research aims to determine the demands of comfortable design of metal chair for elderly in interior architecture. The research showed the value of application of ergonomics, anthropometrics and physiology to a complete design cycle. It provides a case study for the activities required to reach a safe, comfort and marketable metal chair.**

**Keywords: Ergonomics -Comfortable - Metal chair- Elderly - Interior architecture.**

## 1 INTRODUCTION:

Elderly usually prefer remain seated in the interior architectural area for a considerable amount of time. Elderly often acquire, puts an extreme physiological strain on the muscles, the ligaments and in particular on the discs. Correct standing and sitting posture is an important factor for the prevention of musculoskeletal symptoms.

The elderly have chronic diseases or health problems, the risk increases dramatically. They have decreased mobility, decreased flexibility, decreased muscle strength, and slowed reaction time, gait changes, difficulty lifting the feet, altered sense of balance and postural change. Old people, of both genders, are usually less tall than younger people (Câmara J. J. D. et al., 2010.) Design metal chair with ergonomic and anthropometric considerations will give metal chair sustainable, safety and comfort. Also it helps in healthcare for elderly. (Norris B. et al. 2014)

Short term comfort is easy, but long-term comfort comes from effectively applied ergonomics. A human body needs certain things. A tilt that moves synchronously, as the human body does, is important for comfort. Pressure distribution is good. Often develop musculoskeletal problems, which are related to sub-optimal surrounding, environment ergonomics that might be responsible for improper sitting postures and movements causing unnecessary musculoskeletal loading, discomfort, and fatigue. (Chopra A., 2014)

The designer needs to consider the correlations between body dimensions. When looking for the most important body related component of seating comfort, It was found that back and buttock comfort is most important. While thigh and leg comfort is least important to arrive at comfort ratings.

Bad design of metal chair for elderly may affect-muscles, ligaments, tendons, nerves, joints, and supporting structures (inter vertebral discs). A number of disorders are included under this category: upper and lower back pain, herniated disc, neck pain with or without cervical root problems, carpal tunnel syndrome and repetitive strain injuries. (Leggat P.A. et al., 2007)
(Rungtai L. et al. 2007)

Also may result in injuries later on and commonly results in irregular posture “seat height, seat depth and seat width”. Existing designs have basically been unaltered for years. Non-ergonomic dimensioned chair, unsuited to body dimensions, increases physical strain. (Domljan D. et al. 2008)

Mismatch between chair and anthropometric measurement of user is a causative. Certain types of sitting contribute to postural discomfort and factor for low back pain and musculoskeletal discomfort in users. Design of metals chair different sitting postures may contribute to discomfort. It may be the case that sitting is not a risk factor. (Fredericks T.K. & Butt S.E. 2005)

Psychological stress and imposes ill effects on elderly performance. It should be performed to determine the effect of metal chair on user’s health, and the need to adopt the use of adjustable metal chair in interior architectural health hazards. (Asif S. et al. 2012)
When study ergonomic and anthropometry of metal chair for elderly, it is clear:
There are three cases for sitting as during relax, during sitting and during food.


Figure (1) multifunctional of chair

It is very essential to consider the anthropometry of elderly while designing metal chair to assure the suitability and improve the efficiency of using. It is difficult to design the seating metal chair that suits every elderly. Anthropometry considerations can increase the suitability of metal chair with majority.

## 2 FACTORS CONTRIBUTING TO POSTURAL DISCOMFORT

Some studies examine chair dimensions and anthropometry of elderly, it was found that a substantial frequency of mismatch especially for chair height, seat height and seat depth, contributing factor to increase accident rates, health problems and leads to elderly discomfort.. Also deviations from the defined accepted limits varied among groups and between genders signifying their special requirements and their different potential problems. Incorrect sitting posture and may be a predictor of back pain and future disorders. May have permanent consequences to the human body and subsequently lead to significant problems during sitting and this should be reflected in the critical dimensions of seating. The accompanying guidelines are based on data from various sources so as to reflect the wider range of sizes.
(Miriam E.F.R.et al. 2009)

The discomforts of muscle contracture of neck and back problems are due to sitting for a long time at inappropriate posture. Bad habits or bad using chair is not consistent with anthropometric characteristics. (Zhang L. et al. 1996)

The elderly with lumbar disc disorders are much more sensitive to discomfort than healthy others. They get more "powerful and painful feedback" when the spinal pressure increases. The chair's backrest is comfortable. This creates a problem in the hip joint. So they compensate by opening the angle of the chair back. But this creates problems in the neck. Musculoskeletal stress is resulting from efforts to maintain stability and comfort. Preventing these ill-effects of improper chair should be a health concern. (Nag P. K et al. 2008)

Risk of trapping the fingers and the form contractual chair shall be of such design as to guard against personal injury and snagging or tearing of clothing as figure (2). Therefore it is rounded or shaped and positioned to avoid personal injury and damage to clothing the person's upper body.

Figure (2) Show Ease of movement and light load.

Design sitting requires control to maintain stability. For example when the feet don't reach the floor, consider using a footrest. Chairs should be of an appropriate height to allow the individual's feet to rest flat on the floor with no pressure behind the knees. Elaborated later on, was the use of accessories like cushions on their chairs. The seat back plays a critical role in supporting the spine and must adjust to accommodate these differences among people. (Grimes P. & Legg S. 2004)

## 3 MECHANICAL SITTING AND BACK PAIN

The act of sitting can place many stresses on elderly body. The act of sitting begins with a slightly forward lean (to keep the body balanced) and a bending of hips and knees. When a person sits will tends to slump down and forward, causing an outward - curving shape in the lower back, stretching ligaments and further increasing compression of the discs. Simultaneously, the head comes forward, forcing the muscles at the back of the neck to work to keep the head in its original position.

The mechanical act of sitting is controlled by a complex interaction between the skeletal system and the soft-tissue structures. Sitting position that need to motion, so sitting is a mechanical depend on understanding interaction between five body elements: (vertebrae - pelvis, - discs between the vertebrae - muscles, Skin. The primary skeletal structures influencing the mechanics of posture are the spinal column and the pelvis. For example vertebrae spinal column is one of the most important structures in the body when it comes to seating. Each vertebra supports the next one at three points: the broad center plate and two lateral buttresses, called joints or facets. The joint surfaces are coated with a slick cartilage to promote repetitive ease of motion and durability. (Pynt J. et al. 2001)

The discomfort results from lack of movement but this is probably not due to any increase in spinal load, rather to the load on the musculature of the body and stress on other body systems. Inter-vertebral and discs made up of fibrous cartilage, serve to separate the vertebrae and give them flexibility and cushioning. Through continued postural and activity stressors, the disc cores lose their strength and flatten. This brings the vertebrae closer together causing wears and tears on the facets and possible pain if impingement on a neighboring nerve occurs. The front edges of the vertebrae squeeze closer together while the back edges spread apart, putting great pressure on the front portions of the inter vertebral discs.

Beginning at the top of the spinal column, the cervical region (neck) consists of seven vertebrae that produce a forward spinal curvature known as a lordosis. Next, the thoracic region (mid back) consists of 12 vertebrae that provide a rearward spinal curvature. At the bottom of the spinal column, the lumbar region (low back) consisting of five vertebrae promotes another forward spinal curvature. The long thigh bones rotate in their pelvic sockets, while the strong ligaments attaching the femurs to the pelvis pull on the rear of the pelvis, tipping it back. About 65 percent of the total change of angle takes place in the hip joint; the rest happens mainly through pelvis rotation. (Helander MG. et al. 1987)

Spinal shrinkage (fig. 3) is affected by unloaded movements and therefore to what extent the freely moving. Synchronized mechanism on modern metal chairs affects shrinkage and by inference also disc degeneration. Found mechanism which drives elderly to change position or is postural activity determined primarily tasks? A suitable range of movements has the border between dangerous and beneficial movement types or the optimum frequency of change.

The forward slope of the seat should open the angle between the thighs and the body and thus, by reducing the pull of the thigh muscles on the pelvis, allow a more upright position of the pelvis using a chair with a horizontal or slightly backwards sloping seat (the traditional chair) is associated with a backwards-tilting pelvis. The thigh-torso angle is mostly less than 90° and the lumbar curve is kyphotic (flattened). (Acharya RS. et al. 2010)

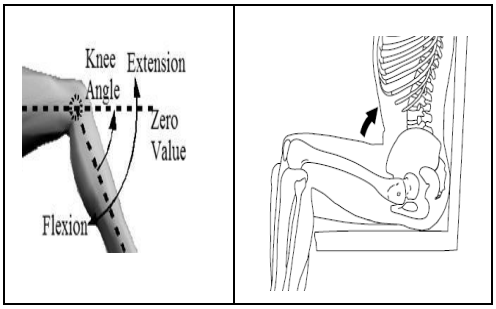
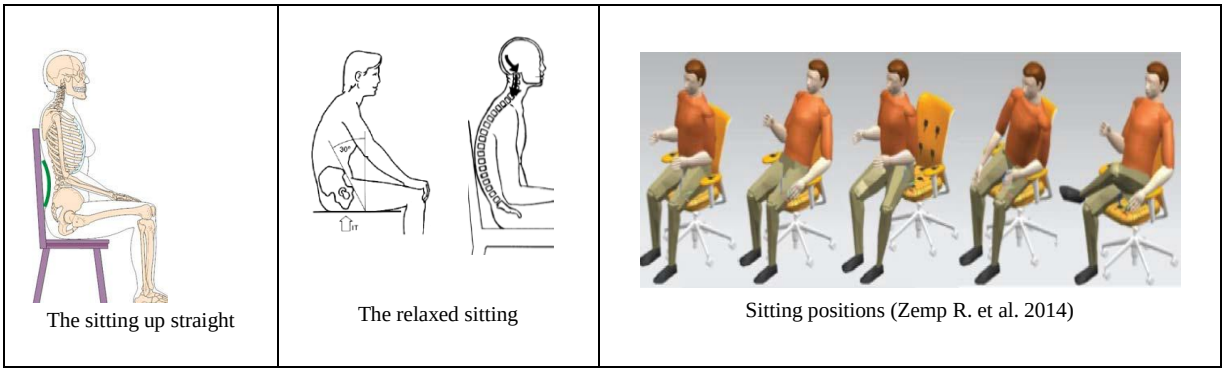



Figure (3) Posterior Rotation

Also the skin and other tissues (muscle, fat, blood vessels, and nerves) of the buttocks, thighs, and back need a constant flow of blood to stay healthy. Too much external pressure for long periods can reduce the blood flow and cause other kinds of damage, ranging from wringing fluids out of cells to impeding the transmission of nerve signals. (Weisman G. et al. et al. 1980)



The sitting up straight

The relaxed sitting

Sitting positions (Zemp R. et al. 2014)

Figure (4) Sitting positions (from left to right): Upright, tilted, forward inclined, laterally tilted (right/left) and crossed legs (right/left).

A shallow seat (fig. 4) may make the chair unstable, especially when the chair angle of the forward slope was relatively large. The balance chairs have a seat angle of approximately 15°. Resulting forward thrust of the body makes some additional support necessary. From a biomechanical viewpoint, the immobility of the flexed knees is not recommended. It is also not in an optimal posture to support a load. To be able to alternate between periods of leaning backwards and sitting upright may have more positive effects. for example, that a fixed backrest angle of 120° increases disc hydration compared to sitting upright. (Zemp R. et al. 2014)

It is necessary for the body to lean on the chair and be stabilized against gravity. When the body will fall forward and become unstable, causing the person to feel "pain". The elderly to feel pain (this painful feeling is considered as an unstable element. (Jun M. 2014)

Back pain will result from seated due to inter vertebral disc degeneration. This degeneration results from the continuous load imposed by long-term sitting and produces increased pressure on surrounding nerve roots and other paraspinal tissues. In an in vivo experiment, the influence of movement on spinal load was investigated by varying the settings of chairs (fixed or freely moving seats) and comparing this with short periods of standing. It was concluded from the study that chairs with a freely moveable seat angle facility, so-called synchronized mechanism chairs, produce no substantial difference to the total compression on inter vertebral discs. (Jensen C. V. & Bendix T. 1992)

Compared comfort and the amount of movement on metal chairs compared to fixed chairs with 5° forward and 5° backward sloping seats. Scientists found no differences between the groups in terms of either comfort or the amount of movement.
Movement of the lower spine is thought to change pressure in inter vertebral discs and seems to be beneficial for the vertebral disc nutrition process. Movements may be dictated either by the task requirements or by a physiologically driven need for position change. They can therefore be a measure of discomfort rather than mobility. Then in an ideally comfortable chair at an ideally designed, no postural changes should take place and this is physiologically undesirable. It is important to evaluate the comfort ratings, adjustability and safety. (Khalid S. et al 2013)

The lumbar supports can reduce load on the spine. By tilting vertebra, it also increases pressures at the front of the discs. The lumbar supports have little effect on the contours of the lumbar spine. Rather, they found that the lumbar curvature is primarily affected by the pelvic angle. The elevation was inclined by 5 degrees at back for the buttock to receive proper support in the sitting posture and permit easy movement during the change in posture to minimize strain under the knee and to permit free movement of leg. (Lueder R. 2010)

So a primary goal of design metal chairs is promote the spine's natural curvature. Metal chairs have an impact on back comfort and health to the extent that they affect the major ergonomic risk factors of sitting. (Webster BS. & Snook SH. 1990)

## 4- RESULTS & DISCUSSIONS

The approach followed in this work will be familiar to ergonomic, anthropometric and design. Study was to demonstrate the value and effectiveness of a metal chair and comfortable approach to analysing design requirements and developing safety solutions with elderly. So the present research studied comfort application of chair design requirement with understanding of human performance elderly. In order to accommodate the variation in anthropometric measures of different cultures and ages are becoming increasingly important. From this research, it is clear that With the increase of age, development of skeletal system, muscular system, fixed design of metal chair may not fit the body dimension of all age elderly where:-

- Metal chairs and seating should be designed primarily in the home to provide adequate support for the elderly, without placing unnecessary stress on any part of the body. That encourage on posture which allows for comfort, efficiency and minimal muscle fatigue.

- The chairs that do not provide effective support and adjustability can significantly increase the spinal stresses resulting in discomfort and increased injury risk.

- Found that "poor sitting habits" were statistically associated with low back pain according to seating is a contributory cause of back injuries. Providing adjustable metals chairs, which suitable solution.

- The design of chair must reflect variations in anthropometric measurements across elderly of different sizes and cultures.

- Metal chair should be adjustable so that elderly can get optimum lumbar support.

- Avoided the case can inactivity be hard on the body's muscles. Static activity, which includes holding any posture for a period of time, "is characterized by the constant contraction of muscle fibers, which causes congestion, traps waste products, and prevents the flow of oxygen and nutrients into the tissue," The result is fatigue and pain.

- It is important to keep in mind that posture change is essential to healthful sitting.

- Found that a mismatch between thigh length and seat depth is significantly related to general seat discomfort.

- Adjustability should be provided to for the wide variability of certain critical dimensions among the user. The adjustment ranges must then be carefully chosen.

- The comfort at seated is dependent on the amount of movement that is possible. This is largely determined by task factors, contribute can significantly to reducing the risk of lower back pain or injury.

- The Design for the elderly important for domestic care. A chair that is well designed and appropriately adjusted is an essential element of a safe and interior architecture.

Several aspects of chair design influence postural behaviour as important criteria for back and body comfort. Requirement achieving needs adjustability in metal chair. There are many sides which affect on design of metal chair as the following:-

*a- Physiology:*

It is an important to build metal chair flexibility to allow elderly to shift positions easily." Movement provides nourishment for the spine, keeps the joints lubricated and flexible, improves circulation and removes waste products from the muscles. Aimed at reducing the occurrence of low back pain:

- It should be important the design and using good metals chairs can be changed to reduce back-pain risk factors. The general principles are similar to those for seating design and design to reduce musculoskeletal disorders of the upper extremities
- Pressure should be evenly distributed on the seat as well as on the backrest, reduce contact pressure on the skin and other tissues.
- Compression of the tissues (most particularly the blood vessels and nerves) at the back of the thigh and behind the knee.

- Good design of metal chair has an important rule contributed to reduce the high incidence of musculoskeletal.
- Backrest-angle adjustability allows the sitter to increase the angle between torso and thighs, reducing pressure on discs by restoring the natural inward curve of the lower back.

-Reduce muscle activity required while sitting from through reduce the weight carried by the lower spine to maintain comfortable postures.

- The front edge of the chair must not hinder the blood circulation to the lower legs.

*b- Ergonomic:*

- Application of ergonomic dimensions depend on using anthropometric data in design involves on creative. As well as science and use of such data for designing chair requirement determines. Anthropometric design principle should be applied.

*c-Anthropometric:*

- The anthropometric database is used as a design reference for metal chair comfortable has an important role in the maintenance of good sitting posture.
- It was found that a mismatch between thigh length and seat depth is significantly related to general seat discomfort and that a mismatch in the seated elbow height and the table height was significantly related to pain in the shoulders and neck.
- length of lower leg (popliteal area to floor) which leads the "chair height" at the front edge, generally from 14 to 18 inches (35.6 to 45.7 cm). Length of the upper leg (often measured from the plane of the back to the popliteal area or back of the knee), that leads the "depth of the seat incorporates several inches of adjustable seat pan depth. A minimum of 2 inches of adjustability is recommended while 3 inches is preferred.

*d- Safety*:

- The structural design of metal chair shall be sustained and impact weight which uniformly distributed on all supporting parts.
- Comfortably metal chair requires that controls be safety reached. They do not require excessive force to move and that there are no sharp edges or nip points which could damage a hand.
- Minimize their risk of suffering musculoskeletal disorders
- The edges of the seat pan should be smoothly finished to prevent any accident from any sharp edges
- Easy clean.

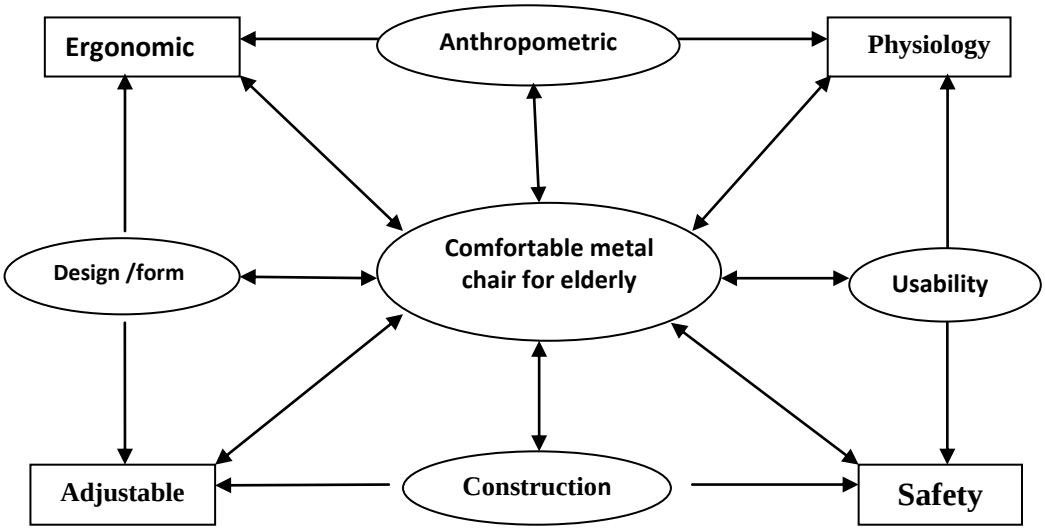



Figure (5) Comfortable Metal Chair for Elderly

It can be determined the criteria used to optimize seating comfort and to minimize risk metal chair fixed in the environment interior architecture. To reduce fatigue facilitate proper posture include the following:

- The comfortable sitting helps to relieve fatigue and sitting gives us greater postural stability, meet some basic ergonomic requirements for avoiding discomfort.
- Reduce the weight carried by the spine, and avoid non neutral back postures.
- No single sitting position will be comfortable over an extended time.
- The front edge of the seat should not interfere with the circulation to the lower legs.
- The sitting helps to reduce the strain on the back muscles and on the inter-vertebral discs of the lumbar spine.
- Chair provides necessary support to the back, legs, buttocks, and arms, contact stress, forceful exertions, the weakened elderly for caregiver access to the thorax.
- It can allow elderly to place feet flat to keep knee joint angle at approximately 90º.

Table (1) overall chair evaluation How would the user rate of use of the chair, its overall appearance and its overall comfort

| Comparative elements | Fixed metal chair | Adjustable metal chair |
|---|---|---|
| Anthropometric *dimensions* | Fixed dimensions | Adjustable dimensions.<br>Fit different body sizes. |
| Height of armrest seat | 23 cm | From 15 to 23 cm adjustable up and down, as well as in and out, easy to change the tilt position.<br>removable arms for easier side transference |
| back support and lumbar support | Don't support the body on all situations. | Can support different degrees of tilt backrest angle and adjustable footboard height. |
| Seat - Width & depth | Effective seat depth from 380 mm to 480 mm.<br>seat width at least 450 mm<br>slightly backward sloping seats | The seat angle to be changed, were consistently rated as more comfortable than fixed seats. Allow to maintain their mobility by being able to move from sitting to standing posture by them. |
| seat height | chair height" at the front edge, generally (fixed) | from 14 to 18 inches (35.6 to 45.7 cm)<br>Can the seat height adjustment be made easily and quickly while seated, moves the entire chair up and down. |
| Seat Angle | The seat angle may not be a determining factor in seated movement behaviour. | Tilt the seat angle slightly forward 5 to 15 degrees to increase the low back curve.<br>Permit easy movement during the change in posture to minimize strain under the knee and to permit free movement of leg. |
| backrest to seat | fixed seat length limit the users difficult to change the tilt position | the chair's tilt can be adjusted<br>It can be easily adjusted by slightly pushing outward. |
| footrest | Not found | Angle adjustment of the leg rest 12 º - 90 º<br>Adjustable footrest for better circulation |
| adapts | difficult adapts | The allow a chair to adjust to a given posture and removable Postural variation. |
| Movement | Difficult move | Multi-directional the ability to move the chair from room-to-room.<br>low weight. |

From the above table, it is clear that the fit metal chair for elderly is adjustable metal chair. It can be more comfortable and safety for them. Sitting requires on the chair use synchronized mechanism and the backrest and seat are linked together, that were designed with a view to encouraging movement, which being beneficial to the spine, and therefore improving comfort. Relax mechanism that involving in chair was developed for the health care for elderly and movement has a positive health effects on various other body systems, particularly the spinal muscles.

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