Mobility is an essential aspect of everyday activities of human life and it requires postural stability for its safe execution. However, the mechanism underlying the maintenance of good postural control can be affected by ageing. These age related changes may predispose old people to postural disequilibrium and to falls. In this article, Dr Macherla Radhamanohar discusses the affect of ageing on mobility.

The human body has a small base of support compared to its vertical height and the constant destabilising gravitational force on it makes it an essentially unstable structure. The body constantly has to take corrective actions therefore to maintain postural stability.

The corrective actions needed are involuntary and automatic, but can produce body sway. Limits of such spontaneous sways are known as ‘limits of stability’ and in a normal adult (in upright posture with feet comfortably apart) these limits form an ellipse. However, when the centre of mass is displaced beyond the limits of stability a fall occurs unless a quick corrective action is taken (e.g. moving one’s foot).

Neuromuscular mechanism of postural equilibrium
Keeping the centre of mass within the base of support so as to maintain upright posture requires a complex neuromuscular mechanism. The key components of this neuromuscular mechanism are the sensory organs, vestibule, brain, muscles and also the lower limb joints. Therefore, input from various sensory systems like vision, proprioception from lower limb joints and facet joints of the cervical spine, pressure receptors of soles and the vestibular apparatus all play an important role.

During upright posture on a firm fixed surface somatosensory inputs play the dominant role in maintaining balance. The signals from the pressure sensors in legs are important for this and these are supported by visual inputs. Vision though plays the key role in maintaining postural stability when the support surface is soft or unstable. Compared to somatosensory and visual systems, the vestibular system primarily detects the head motion and is less perceptive to the body sway.

The information received from these sensory modalities is integrated in the higher centres of brain and then is used to produce a corrective and co-ordinated motor response at the joints to keep the centre of mass within the base of support during stance and motion (Figure 1).

Postural disequilibrium
Most of our daily activities require control of balance. Normally when the body is challenged by minor perturbations like a slip or a trip, postural equilibrium is restored by a quick compensatory motor response. But if there is impairment in the components of neuromuscular mechanism it may predispose a person to falls when faced with such destabilising forces. At first, the central nervous system to some extent tries to adapt and compensate for this – for example, if there is
impaired proprioception it can be compensated for by vision.

When the compensatory mechanism is inadequate or the destabilising forces are beyond the normal capacity of neuromuscular mechanism postural disequilibrium sets in and a fall can result.

**Ageing and affect on postural equilibrium**
The development of this mechanism of postural equilibrium results from the body's interaction with the environment through the early developmental years. Postural equilibrium is at its optimum between the age of 30 and 60 years. However, various anatomical and physiological changes occur with ageing and this includes changes in all sensory and motor modalities subserving postural equilibrium.

Advancing age brings changes in vestibulo-ocular reflex (this a reflex eye movement that stabilises images on the retina during head movement) and also a progressive loss of labyrinthine hair cells and vestibular ganglion cells. In addition, Lord et al noted that older people who experience falls are more likely to have low contrast sensitivity, decreased proprioception and decreased cutaneous sensation. Visual changes such as reduced visual acuity, contrast sensitivity, darkness adaptation and depth perception have also been noted in the aged population.

Contributing to this greater risk of falls is increased muscle stiffness in elderly people, which may interfere with balance. A diminution of neuronal cell density of the cerebral cortex and a decrease in the number of purkinje’s cells in the cerebellum have also been shown to be associated with ageing and disequilibrium – this is because both the cerebral cortex and cerebellum are involved in processing the information received from sensory sources and sending information to the motor system to take corrective actions.

Degenerative changes in the sensory and motor systems in the tendon receptors of the lower limb and impairment of proprioception have also been shown to be associated with old age. The collective effect of degenerative changes in the sensory, musculoskeletal and vestibular systems causes the increased body sway seen in old people over the age of 60 years.

**Impact of disequilibrium on the elderly**
Young adults with fully intact neuromuscular apparatus are able to cope with trivial challenges like trips or slips, but these challenges may overwhelm the postural control in older people with age related changes and may lead to falls. Falls are common in elderly people and about 35 per cent of community dwelling elderly people experience a fall each year.

Multiple pathologies (e.g. diabetic neuropathy, stroke, postural hypotension, cataracts, macular degeneration etc.) and polypharmacy are common in old age and affect postural stability, and in turn may cause falls on their own or combined with background age related deficits in balance. Added to these are the environmental factors such as poor lighting, uneven pavements and inappropriate furniture, which pose a real challenge to elderly people with balance problems.

Injuries resulting from falls in older people, particularly bone injuries like hip fractures are of major concern. In addition, fear of falling in elderly people may lead to restriction of activities of daily living, deconditionning, depression and curtailment of social functions.
Figure 1. Neuromuscular mechanism of postural equilibrium

Management of disequilibrium in elderly people
Medical assessment should be carried out to identify any contributing pathologies (e.g. medications, anaemia, stroke disease etc.) and these should be treated. A review of medications that may be contributing to disequilibrium may also help in managing balance problems in elderly people (e.g. sedatives, phenothiazines, antiepileptics etc.), and physicians should consider stopping them where possible or reducing the dose. Multi factorial intervention including muscle strengthening and balance retraining exercise programmes (e.g. Tai Chi\textsuperscript{13}) can also help in reducing falls. Physiotherapists and occupational therapists may also be able to help with home-based exercise programmes and give advice on appropriate mobility aids, appropriate furniture and domestic appliances. Physiotherapists will also be able to assess balance using various scales, e.g. Berg Balance Scale.

When vestibular dysfunction is suspected, patients should be referred to an ear, nose and throat specialist for further evaluation of vestibular function and vestibular rehabilitation.

It should be remembered however that although falls may be contributed by the age related changes, they are not an inevitable feature of old age. A detailed account of the management of disequilibrium in older people is out of remit of this article.
Postural stability is vital for safe mobility and in carrying out most of our everyday activities. A complex neuromuscular mechanism underlies the postural equilibrium and changes occur in various components of this neuromuscular mechanism with ageing that may contribute to falls in older people

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Key points

- Postural control is essential for most of the daily activities of living.
- Postural equilibrium is maintained by an effective neuromuscular mechanism.
- Ageing is associated with changes in all motor and sensory modalities subserving neuromuscular mechanism essential for postural stability.
- The age related changes may predispose old people to postural disequilibrium and to falls.
- Physiotherapists will also be able to assess balance using various scales e.g. Berg Balance Scale.