

Shoes for senior citizens

The increasing number of people over 50 years of age in western countries is the result of a falling birth rate and the fact that people are living longer. In France, the proportion of people aged 60 or more increased from 18% in 1970 to almost 24% by 2012, totalling more 15 million. It is estimated that by 2050 no less than one in three will be over 60. This steady increase in the number of senior citizens offers the potential of a new market for footwear, one which a group of French manufacturers has already recognised. The problem however is just what the ideal criteria are for suitable products.

Three years ago, they joined with CTC, the French technical centre for the footwear industry, and with support from the French government, to determine the needs of older people, collate the results and develop new footwear products to meet them. Referred to as ADOCS (improved footwear for seniors), the project set out to pursue four lines of enquiry: anthropometric measurements, ergonomic analyses, analysis of locomotion, and style and trends.

Although much work has been done in the past on children's shoes, there has been little if any regarding people at the other end of life. Little information has been available let alone any suggestion of a general data base. ADOCS looks set to change all this and the work CTC has carried out so far has already shown just how much feet change as we grow older. It has also dramatically demonstrated how this also changes the way we walk (locomotion) and suggests older people really would benefit from specifically designed footwear in the same way that children do already.

To fully understand these changes in locomotion, it is necessary to also examine the general physiological changes that occur over time. Our general physiological capacities obviously decrease with age but, exactly why for example, do we become out of breath more quickly during physical activities such as walking or climbing the stairs? A large part of the answer is due to overall changes that take place in the body during the ageing process.

PHYSIOLOGICAL CHANGES

Many physiological changes appear with advancing years. For instance, muscle strength is reduced by 1% to 1.5% every year from the age of 40 and muscle mass decreases (sarcopenia) by the same degree to be replaced by fat mass. Speed of movement also deteriorates, caused by a decrease in muscle power which accelerates over the final years. A reduction of 1% per year between 50 and 60 years of age increases to 2.4% between 70 and 80.

Cardiac function changes and output slows down due to a linear decrease in heart rate while the speed of blood flow also becomes lower. Even during less intensely physical activities, such as walking, the blood flows more slowly to the active muscles and is therefore less effective. This cardiac degradation happens whatever the level of physical

activity people undertake.

The muscular changes also cause a reduction in VO₂ (maximal oxygen uptake by the lungs) so that the body is not able to absorb as much oxygen as before when exercising. This is why no one of 60 years of age will ever achieve a world record time for a marathon even though a surprising number now regularly take part in them.

Finally, there are changes to the nervous system whereby the alpha motor neurones that transmit instructions from the spinal cord to the muscles (the way out of the central nervous system) diminish after 60. In people in their nineties, one can even see decreases in the order of 30%.



CREDIT: SHUTTERSTOCK / T-DESIGN

Although these changes vary from person to person depending on sex, age, physical activity, lifestyle, etc., they can nevertheless be found in a majority of cases. Analysing the way an older person walks therefore entails a consideration of all the general changes that occur within the body but, at the same time, it must be principally focussed on those taking place in the foot itself.

CHANGES TO THE FOOT

The skin of the foot weakens with age, increasing the risk of blisters or wounds. Its three layers (epidermis, dermis and hypodermis) all become thinner so that it takes longer to heal. It also loses its elasticity due to the destruction of collagen and becomes drier. After 70 years, there can be up to 70% less active sweat and sebum (an oily wax) producing glands that help preserve hydration of the skin as, little by little, they begin to disappear. Nails also become thick and dull, and are the cause of 55% of chiropody consultations.

One of the major problems of the older foot is atrophy of the plantar capito. These comprise fatty lobules at the heel and under the metatarsal heads that act as natural buffers. The two areas thus become more painful and the skin becomes fine and rough, conducive to the development of corns, calluses, etc. Thinning of the plantar capito can in fact be found in more than 25% of the over 50s.

Sensory perception of touch, vibration and overall sensitivity decreases with age, while achilles reflex (reflex action to pulling the toes up) also becomes less efficient. How to explain these changes? During ageing, the number of receptors decreases as the skin becomes thinner. Messages sent via the nerves are less numerous and the reactions they generate become slower and less accurate. Achilles reflex is absent in 30% of people of 70 or more. This loss of sensitivity alters the interface between the foot and the ground surface as well as our sense of balance. This is why older people's reaction to uneven surfaces is slower and less precise than that of a younger person.

Beyond the age of 80, the foot becomes more flexible and the arch much weaker. Joint mobility is impaired and osteoarthritis, which can



With age, the skin becomes drier and more fragile. CREDIT: SHUTTERSTOCK / ALICE DAY

develop from the age of 40, is also commonplace in elderly subjects. Cartilage becomes thinner and may even disappear, leaving space for the formation of osteophytes (bone spurs) around the joints. Joint angles are also reduced and the joints themselves become painful.

In addition, tendons lose their elasticity. Indeed, from as early as 50, we produce one-third less collagen than at age 20. The number of tenocytes (cells that form tendons) falls making tendons more rigid, causing an increase in musculo-tendinous

stiffness and reduced tendon strength. For example, while the rupture level of a tendon in a person of 20 to 30 is about 8 kg/mm², for one of 70 it is around 4.8 kg/mm². This change explains why sports less prone to joint traumas such as swimming and cycling are recommended for older people rather than ones such as running, where joints take the full body weight.

PATHOLOGICAL PROBLEMS

In addition to these 'normal' developments, there are also various ailments that can amplify them such as hallux valgus, a distortion and swelling at the base of the big toe (bunions). This is the most common foot deformity and is present to some extent in half of all people over 50 in a proportion of seven to one in favour of women. Major causes are shoes that are too tight and a higher than normal instep. The consequences are numerous and damaging. Indeed, a pronounced bunion increases instability when walking and therefore the risk of a fall. Pain is also more frequent and more intense. The prevalence of this condition is therefore a major factor when producing shoes for older people.

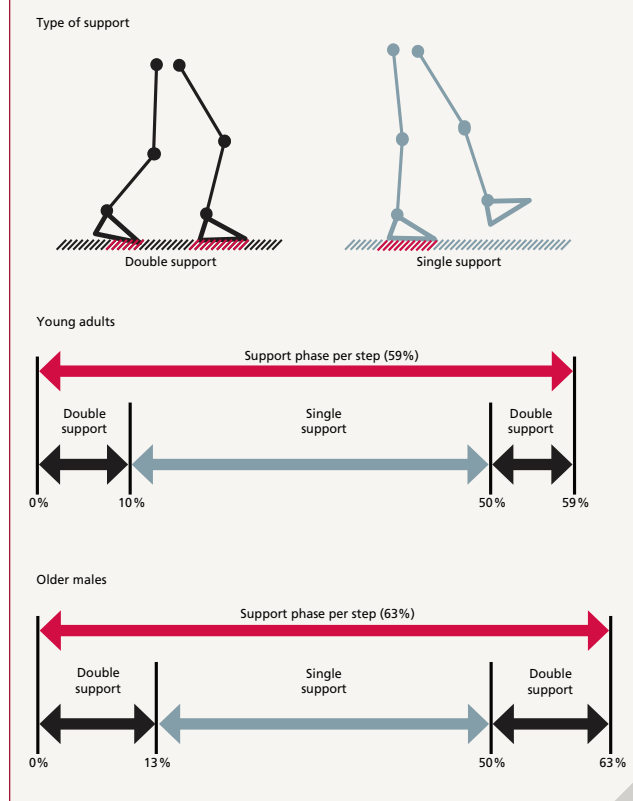
Claw toe is a contraction or bending of one or two (fairly rare) joints of the second, third, fourth or fifth toe. This abnormal flexion can create pressure on the foot when wearing shoes and also make foot entry more difficult. Symptoms include pain or irritation when wearing shoes and corns or



Hallux valgus is a common problem in older people.

CREDIT: SHUTTERSTOCK / ALEXANDER BARK

Figure 1 – Changes in foot contact with the ground. CREDIT: CTC



callouses on the affected toes or under the foot caused by constant rubbing against the shoe. This condition is again common in the elderly with more than 30% of over 70s affected. It can be the result of muscle or tendon imbalance, badly fitting shoes or, in some instances, simply be inherited.

Arch collapse can be found in a quarter of all elderly people. The fascia or plantar fascia, the fibrous membrane forming the arch is degraded due to the decrease in collagen. The older foot tends to flatten out, one of the causes of the increase in foot width in old age. In cases where the sole of the foot touches the ground completely, the person concerned is referred to as being 'flat footed'.

In 2005, approximately three million French people suffered from diabetes. By 2025 that figure is expected to double and one in six diabetics can expect to have at least one foot ulcer during their lives. These infections, if not treated properly, can lead to a partial or full foot amputation. The glycemia (blood sugar) level associated with this disease degrades the body's immune system so that wounds to the foot that older people are more prone to experience take longer to heal and the risk of infection becomes more serious.

Rheumatoid arthritis affects more than 300,000 people in France with women between 40 and 60 most at risk (two to three times more than men). This disease causes an inflammation of several joints at a time, including those of the foot. It thus leads to a weakening of the support structures of the foot (joint capsule, ligaments, tendons and muscles), especially in the metatarsal region. Over time it can destroy ligaments and tendons to such an extent that articulation of the foot is lost. It also increases the risk of hallux valgus, flat foot, instability when walking and a risk

of falling in the elderly. All these physiological and pathological conditions that arise in old age inevitably also lead to a gradual decrease in a person's independence.

NON-LOCOMOTORY CHANGES

As we age, we become less inclined to take risks and so the way we walk tends to become more cautious. The foot spends more time in contact with the ground than when younger so that less and less time is spent resting on a single leg which helps older people to cope better with uneven surfaces, etc. The downside is a reduction in walking speed as they now take shorter steps (Figure 1). This is more pronounced in women than in men. The width of the step is also increased and the foot itself is not raised so far when it is lifted off the ground. As a result, it tends to be carried forward closer to the ground surface, so increasing the risk of tripping.

Finally, other aspects of general physical deterioration can accentuate these changes. Decreased vision, degradation of the cognitive apparatus and the inner ear all serve to adversely affect balance in older people, increasing the likelihood of a fall. 30-50% of people over 65 experience at least one fall per year and over 50% for those over 85. It is also known that in 40% of cases, the future autonomy of the person concerned is compromised. One of the main objectives of the ADOCS project is to limit the risks imposed by all these various conditions and ailments by creating a set of parameters for footwear aimed specifically at older people.

CHALLENGES TO BE MET

What we can see from all this information that CTC has gathered so far, is just how much feet can change with age and how complex that change can become. Of course, not everyone is affected in the same way and, in some, the ageing process will be slower and the negative impacts either less apparent or delayed. Regular physical activity can be a major influence in this regard. Nevertheless, it is abundantly clear that if manufacturers want to tap into this potentially lucrative and expanding market, there are many physical factors they must take into account.

One key area is likely to be last design where it might prove necessary to make each shoe style available on more than one last so as to cope with the various conditions and age groups. Alternatively, more shoes may need to be marketed with a variety of optional footbeds offering varying degrees of support and cushioning. Correct styling will also count as people's perceptions and preferences also change the older they become. Overall comfort will be important in terms of soft and low friction lining materials while safety will call for non-slip impact absorbing soles. Finally, shoes should be correctly fitted by retail staff with sufficient knowledge of the pathological conditions that affect older people.

So far, CTC has been able to establish a short list of the types of footwear to avoid for older people. Not all parameters have yet been tested, however, so the results remain uncertain. The project is very much an ongoing exercise and still has some way to go. However, CTC hopes that it will soon be able to design a prototype based on the data being collected that will enable manufacturers to either modify their existing products or create new ones reflecting the real needs of the older generation. 📌