Press information

Optimised clothing for wheelchair athletes

Greater functionality and comfort for wheelchair basketball players and hand bikers

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BÖNNIGHEIM (ri) About 750 athletes from 45 countries competed for medals at this year's Paralympics in Sochi, impressively demonstrating the high standard of international sport for the disabled. 21-year-old Anna Schaffelhuber won four gold medals all by herself. The skiing star is one of about 600,000 people in Germany who are permanently confined to a wheelchair.

The sports equipment used by wheelchair users, such as monoskis and hand bikes, are one-off products that are individually customised to meet the special needs of the athletes and their particular physical disabilities. By contrast, when it comes to clothing, wheelchair users often have to resort to mass-produced garments off the rail for able-bodied athletes. In recent years, as part of research project AiF No. 17377 N, scientists at the Hohenstein Institute (Bönnigheim) have generated huge amounts of data from which they have been able to derive practical ways of optimising sportswear for wheelchair users. The results of their research include studies of body measurements and proportions, movement processes and the posture of wheelchair users engaging in specific sports. Now clothing manufacturers will be able to make use of these studies when developing their products.

Building on the data, and comparative data from people who are able to walk, the team led by project manager Anke Klepser has produced guidelines for designing and processing long- and short-sleeved shirts, winter jackets and trousers. To help with choosing suitable textiles, the researchers also defined some useful material parameters. These particularly take account of the special thermo-physiological needs of sportsmen and women with a physical disability when it comes to transporting heat and sweat.

As long ago as the 1980s, experts at the Hohenstein Institute recorded the body measurements of wheelchair users in connection with another research project (BMBF 01 VK 050–ZK/NT/MT03). The aim then was to improve the fit of everyday clothing. However, with the help of the 3D scanner technology that is available today, for this project it was possible for the first time to measure the complete body and create a virtual twin (avatar). With its help, even after the end of the project certain posture-specific body measurements, such as of the back, legs or arms, can still be calculated.

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For the project, male hand bikers and wheelchair basketball players were measured, once in a normal wheelchair using a stationary 3D body scanner and then again in their sports wheelchair using a portable scanner.

For Anke Klepser, the practical benefits of the project for wheelchair athletes were particularly important: "By choosing these two sports we are covering both indoor and outdoor activities which means that our research results can also be adapted for other sports disciplines. Another advantage is that we have looked at two different body postures, with the hand biker who is almost lying down, and the wheelchair basketball player who sits in a more upright position, and this also makes the results more transferable to other sports." Anke Klepser says that women will also benefit from the results of the research: "The requirements for suitable textile materials in terms of sweat absorption and thermal insulation are universal. Other important aspects of the design, such as the position of seams, also apply regardless of the gender of the wearer. All that matter here are the specific thermo-physiological requirements and movement processes for wheelchair sport."

The sitting position of wheelchair basketball players, in particular, creates specific requirements for the cut of clothing: trousers tend to be too short at the back round the waist and too high over the stomach. More work is required to adapt trousers, compared with upper body garments.

By contrast, the virtually lying-down position of hand bikers generally requires both the back and front of the trousers to be higher. On the other hand, the seat area does not need to be specially modified to fit.

In the majority of wheelchair athletes, the upper body and arms are very muscular and this must be taken into consideration in the design of shirts and jackets. To ensure a good fit offering a great deal of freedom of movement, the garments therefore have to have specially adapted seam lines. Stretchy materials with good elasticity further improve both the fit and the wearing comfort.

In addition to the anatomical specifics, as part of their project the researchers also considered those special requirements which arise from the athletes' commitment to their sport.

That is why, in addition to the 3D scanner measurements, Anke Klepser also conducted a survey to identify what the volunteers would like to see improved. For instance, the hand bikers said that they would like to see a narrow lower leg trouser width which would offer them better head wind protection.

The scientists also had to consider the specific requirements of disabled athletes in relation to the wicking of body sweat, also known as the moisture management of the clothing: Because, due to their position, their back or the back of the thigh is in close contact with the hand bike or wheel chair, sweat can build up very quickly here. It was a question of trying various different suitable materials and functional designs (comfort mapping) in those areas to avoid this.

In contrast to this, depending on the type and degree of the spinal cord injury, for many wheelchair athletes paralysis of the extremities is associated with restricted functionality of the body's own temperature control system. For example, quadriplegics, whose legs and arms are all affected to a greater or lesser extent by paralysis, do not sweat or only sweat to a limited extent and run the risk, especially in the case of very high external temperatures and/or intensive physical exertion, of suffering a circulatory collapse due to the body overheating. Water applied externally to the clothing can help in such cases by ensuring the necessary cooling through evaporation. Anke Klepser and her team also had to consider this kind of specific aspect in their research work: "The clothing requirements for wheelchair athletes are extremely varied and complex. We are confident that our data and information will form the basis for many optimised products which will make life easier for the athletes and will support them appropriately in their outstanding achievements. The results of the project are already available to any interested manufacturers."

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▸ MOVEMENT PROCESS Cranking movements with the arms
▸ POSITION IN WHEELCHAIR Virtually lying down

SPECIAL FEATURES	SOLUTION
SHIRT	
• The mechanical motion causes friction, especially between the arms and the body. During intensive training sessions, this can lead to irritation, especially at the seam between the front and the back of the garment. • Sweat on the body and clothing soaked in sweat cause the body to cool down rapidly when physical activity ceases, the so-called „post-exercise chill".	• By positioning the dividing seams on the front and back, and having the armholes very high on the body, rubbing on the seams is avoided • A close fit and stretchy materials ensure that sweat is instantly absorbed. Functional materials ensure that sweat is quickly carried away from the body and that drying times are short.
TROUSERS	
• The cut of trousers is generally designed for people in a standing position. • Athletes switch regularly from their everyday wheelchair to their sports wheelchair, which can cause significant mechanical strain, especially on the trousers. • The blood circulation in the legs of wheelchair users tends to be poor, so they get cold particularly quickly. • Seams, especially in the seat area, can cause pressure points and, if they rub, skin irritation • Wide trouser legs do not offer adequate protection from a head wind when in a virtually lying position, so the legs can become cold.	• The virtually lying position normally requires trousers to be higher at the front and back. On the other hand, the seat area does not need to be specially modified to fit. • Double-faced material, a two-layer combination of materials, can give the outside of trousers a good grip. Inside they are soft, making them comfortable to wear, and really smooth, so that they are easier to take on and off. • Softshell-Material bietet eine besonders gute Wärmeisolation und schützt zudem auch noch vor Wind- und Regen. • All seams are flat. • Narrow legs protect the wearer from the head wind and from becoming cold.

▸ MOVEMENT PROCESS frequent stretching of the arms above the head
▸ POSITION IN WHEELCHAIR Seated

SPECIAL FEATURES	SOLUTION
GENERAL	
• Basketball clothing is worn casually loose. Wheelchair users also like to follow this trend.	• The cut is loose but functional.
SHIRT	
• The upper arms and upper body of wheelchair users tend to be very muscular. • The cut of shirts is generally designed for people in a standing position. • Athletes secure themselves in the wheelchairs with straps. These fasten with Velcro tape which can pull threads on delicate fabrics or roughen the surface.	• Modifications to the width on the arms, chest and shoulders. • To avoid creasing, the length is generally shortened, though the back is somewhat longer than the front. Seam-free construction under the arms. • Robust materials are used which do not have a delicate surface.
TROUSERS	
• The cut of trousers is generally designed for people in a standing position. • The musculature of the legs is underdeveloped. • Seams, especially in the seat area, can cause pressure points and, if they rub, skin irritation.	• The seated position generally means that trousers need to be higher round the waist at the back but considerably lower at the front. The seat area is specially designed. • Leg widths are adapted to the reduced proportions. • All seams are flat. Alle Nähte sind flach gestaltet.

The fundamentally different body position of hand bikers requires a specially adapted cut and presents specific challenges for materials and processing. ©Armin Kübelbeck, wikipedia.org

Wheelchair basketball players have very different clothing requirements from able-bodied players. ©wikipedia.org

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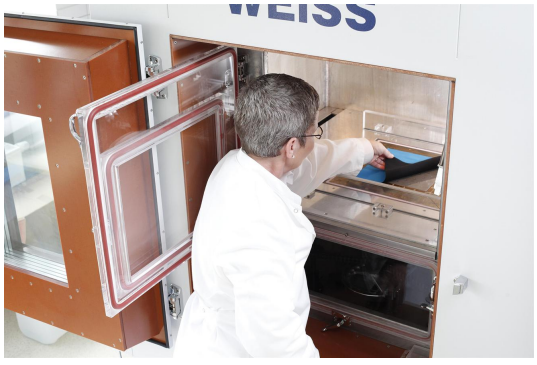
3D scanners were used to optimise the cut for the posture of athletes engaging in specific sports.



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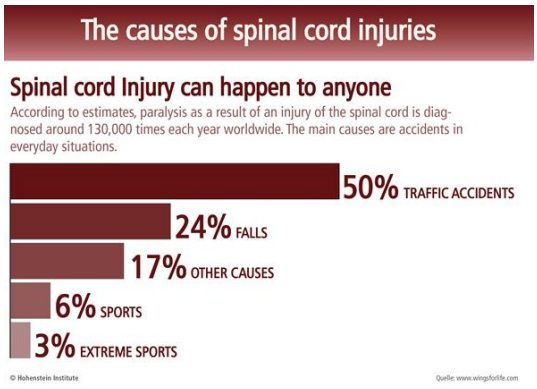
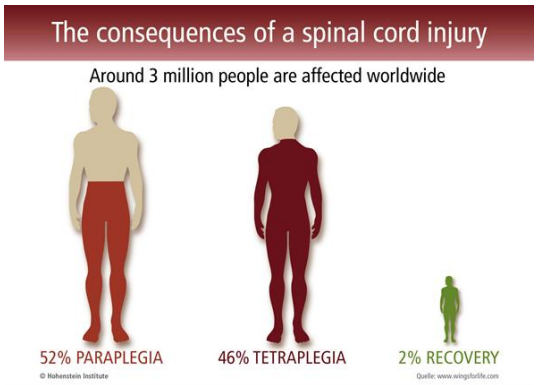
Established test methods such as measuring with the Hohenstein skin model were used to work out how heat and sweat were transported in specific target groups, so that clothing could be optimised accordingly.



The causes of spinal cord injuries.



According to estimates, every year about 130,000 people worldwide receive the terrible diagnosis of "paraplegia" as a result of a spinal cord injury. The main causes are accidents which occur in everyday situations.