CHAPTER 3
Sun, heat and cold

The recreational use of water environments may be associated with extreme temperature conditions. People may be unintentionally exposed to cold water (<15°C) which can result in a debilitating shock response. Or, at the other extreme, high air temperatures may result in heat stroke. As people engage in outdoor activities and recreation by the side of a lake or at a beach, they are often exposed to high levels of ultraviolet radiation (UVR) from the sun for prolonged periods of time. UVR can cause both acute and long-term damage to health. UVR and temperature deserve particular attention, as global climate change and ozone depletion are likely to aggravate existing health risks.

3.1 Exposure to ultraviolet radiation

3.1.1 *UVR and ozone depletion*

Everybody is exposed to UVR from the sun, and an increasing number of people are exposed to artificial sources used in industry, commerce and recreation. Emissions from the sun include visible light, heat and UVR. The UVR region covers the wavelength range 100–400 nm and consists of three bands—UVA (315–400 nm), UVB (280–315 nm) and UVC (100–280 nm). As sunlight passes through the atmosphere, all UVC and approximately 90% of UVB is absorbed by ozone, water vapour, oxygen and carbon dioxide. UVA is less affected by the atmosphere, and almost 70% of the solar emission in this band reaches the Earth's surface. Therefore, the UVR reaching the Earth's surface is largely UVA, with a small UVB component (usually less than 3%).

The amount of UVR at the Earth's surface is influenced by:

- *sun height*: The higher the sun in the sky, the higher the UVR level. Thus, UVR levels vary with time of day and time of year, with maximum levels occurring when the sun is directly overhead. Outside the tropics, the highest levels occur when the sun is at its maximum elevation, at around midday (solar noon) during the summer months.
- *latitude*: The closer the equator, the higher the UVR levels.
- *cloud cover*: UVR levels are highest under cloudless skies. Even with some cloud cover, UVR levels can be high as long as the solar disc is unobscured.
- *altitude*: At higher altitudes, a thinner atmosphere scatters and absorbs less UVR. With every 1000-m increase in altitude, UVR levels increase by approximately 14% (Blumthaler et al., 1994).

- *ground reflection*: UVR is reflected or scattered to varying extents by different surfaces. For example, fresh snow can reflect as much as 80% of UVR, sea foam about 25%, water up to about 15% (depending on the elevation of the sun) and dry beach sand about 15%.

As the ozone layer becomes depleted, the protective filter provided by the atmosphere is progressively reduced. Consequently, human beings and the environment are exposed to higher UVR levels, in particular higher UVB levels. Within the UV region, UVB has the greatest impact on human health, animals, marine organisms and plant life. International treaties to protect the ozone layer, such as the Vienna Convention (1985) and the Montreal Protocol on Substances That Deplete the Ozone Layer (1987), have gradually phased out the production of ozone-depleting substances; their ozone-depleting potential is expected to reach its maximum between 2000 and 2010. Due to the time delays in atmospheric processes, stratospheric ozone depletion will persist for many years (EEA, 1998), and the corresponding increases in UVR reaching the Earth's surface will exacerbate adverse health effects in all populations of the world. Computational models predict that a 10% decrease in stratospheric ozone could cause an additional 300 000 non-melanoma skin cancers (NMSCs), 4500 melanomas and between 1.6 and 1.75 million cataracts worldwide every year (UNEP, 1991).

3.1.2 Health outcomes

Overexposure to solar UVR may result in acute and chronic health effects on the skin, eye and immune system. Chronic effects include two major public health problems: skin cancers and cataracts. Furthermore, a growing body of evidence suggests that current environmental levels of UVR may increase the risk of infectious diseases and limit the efficacy of vaccinations (Halliday & Norval, 1997; Duthie et al., 1999). A comprehensive review and summary of UVR-related health effects can be found in the WHO Environmental Health Criteria monograph *Ultraviolet Radiation* (WHO, 1994) and in the United Nations Environment Programme report *Environmental Effects of Ozone Depletion* (UNEP, 1998).

1. Beneficial effects of UVR

Exposure to UVB stimulates the production of vitamin D in the skin. It has been estimated that more than 90% of vitamin D requirement is satisfied by this exposure and less than 10% from diet. Vitamin D has an important function in increasing calcium and phosphorus absorption from food and plays a crucial role in skeletal development, immune function and blood cell formation. Vitamin D deficiency is unlikely for most people, as, for example, a 10- to 15-min daily exposure of face, forearms and hands to normal northern European summer sun is sufficient to maintain vitamin D levels (McKie, 2000). An exception to this would be for people residing at high latitudes, where UVB levels in winter would be very low.

UVR from artificial sources is used to treat several diseases and dermatological conditions, including rickets, psoriasis, eczema and jaundice. While sunbed use for cosmetic purposes is not recommended (EUROSKIN, 2000), therapeutic treatment takes place under medical supervision, and the beneficial effects of therapeutic UVR exposure usually outweigh the harmful side-effects.

2. *Adverse effects of UVR on the skin*

The widespread perception that a tan is healthy and beautiful has led many people to actively seek a tan and expose their skin to excessive levels of UVR. This attitude, changed clothing habits, the popularity of outdoor activities and frequent holidays in sunny locations seem to be the major causes for the dramatic rise in skin cancer rates in all fair-skinned populations. Between 2 and 3 million NMSCs (WHO, Department of Evidence and Information for Policy, unpublished data) and 132 000 melanoma skin cancers (Ferlay et al., 2001) occur globally each year, according to WHO estimates. Since the early 1960s, the incidence of skin cancers has increased by between 3% and 7% in most fair-skinned populations (Armstrong & Kricker, 1994).

The sensitivity of skin to UVR is usually defined by six phototypes (Fitzpatrick et al., 1974). A more recent classification scheme relates skin type to short-term and long-term effects of UVR, based on the finding that 85–90% of registered skin cancers are found in the melano-compromised skin types I and II, while most of the remaining skin cancers are found in the melano-competent skin types III and IV (Fitzpatrick & Bolognia, 1995). These categories relate to the presence of melanin pigment in the epidermis, which determines human skin colour. Melanin absorbs UVR and in this way provides protection against exposure to UVR. Both classification schemes are depicted in Table 3.1.

TABLE 3.1. CLASSIFICATION OF SKIN TYPES[a]

Skin type classification		Burns in the sun	Tans after having been in the sun
I	Melano-compromised	Always	Seldom
II		Usually	Sometimes
III	Melano-competent	Sometimes	Usually
IV		Seldom	Always
V	Melano-protected	Naturally brown skin	
VI		Naturally black skin	

[a] Adapted from Fitzpatrick & Bolognia, 1995.

Many believe that only fair-skinned people need to be concerned about overexposure to the sun. Darker skin has more protective melanin pigment, and the incidence of skin cancer is lower in dark-skinned people. Nevertheless, skin cancers do occur and are often detected at a later, more dangerous stage. The risk of UVR-related health effects on the eye and immune system (see below) is independent of skin type (Vermeer et al., 1991).

Children are at a higher risk of suffering damage from exposure to UVR than adults, in particular because of the following:

- A child's skin is thinner and more sensitive, and even a short time outdoors in the midday sun can result in serious burns.
- Epidemiological studies demonstrate that frequent sun exposure and sunburn in childhood set the stage for high rates of melanoma in later life (IARC, 1992).
- Children have more time to develop diseases with long latency, more years of life to be lost and more suffering to be endured as a result of impaired health. Increased life expectancy further adds to people's risk of developing skin cancers.
- Children are more exposed to the sun. Estimates suggest that up to 80% of a person's lifetime exposure to UVR is received before the age of 18 (Marks et al., 1990; Wakefield & Bonett, 1990).
- Children love playing outdoors but usually are not aware of the harmful effects of UVR.

The most noticeable acute effect of excessive UVR exposure is erythema, the familiar inflammation of the skin commonly termed sunburn. The symptoms of a mild sunburn are reddening of the skin caused by vascular dilatation and some swelling, while in severe cases the skin will blister. In addition, most people will tan from darkening of existing melanin or through the UVR stimulation of melanin production, which occurs within a few days following exposure. A further, less obvious adaptive effect is the thickening of the outermost layers of the skin that attenuates UVR and decreases the penetration to the deeper layers in the skin. Current estimates suggest that a suntan can offer a sun protection factor (SPF) of between 2 and 3 (Young & Sheehan, 2001). Depending on their skin type, individuals vary greatly in their skin's initial threshold for erythema and their ability to adapt to UVR exposure (see Table 3.1).

Chronic exposure to UVR also causes a number of degenerative changes in the cells, fibrous tissue and blood vessels of the skin. These include freckles, naevi (moles) and lentigines, which are pigmented areas on the skin, and diffuse brown pigmentation. UVR accelerates skin aging, and the gradual loss of the skin's elasticity results in wrinkles and dry, coarse skin.

NMSCs comprise basal cell carcinoma (BCC) and squamous cell carcinoma (SCC). BCC is the commonest but rarely fatal, while SCC can metastasize and be fatal if left untreated. Surgical treatment for NMSC can be painful and is often disfiguring. The temporal trends of NMSC incidence are difficult to determine, because registration of these cancers has not been achieved. However, specific studies carried out in the USA, Australia and Canada indicate that between the 1960s and the 1980s, the prevalence of NMSC has increased by a factor of more than two.

Malignant melanoma (MM), although far less prevalent than NMSC, is the major cause of death from skin cancer and is more likely to be reported and accurately diagnosed than NMSC. Since the early 1970s, MM incidence has increased significantly—for example, an average 4% every year in the USA (American Cancer Society, 2000). A large number of studies indicate that the risk of MM correlates with genetic and personal characteristics and a person's UVR exposure behaviour. The following is a summary of the main human risk factors (WHO, 1994):

- A large number of atypical naevi (moles) is the strongest risk factor for MM in fair-skinned populations.
- MM is more common among people with a pale complexion, blue eyes and red or fair hair. Experimental studies have demonstrated a lower minimum erythema dose and more prolonged erythema in melanoma patients than in controls.
- High, intermittent exposure to solar UVR appears to be a significant risk factor for the development of MM.
- The incidence of MM in white populations generally increases with decreasing latitude, with the highest recorded incidence occurring in Australia, where the annual rates are 10 and over 20 times the rates in Europe for women and men, respectively.
- Several epidemiological studies support a positive association with history of sunburn, particularly sunburn at an early age.
- The role of cumulative sun exposure in the development of MM is equivocal. However, MM risk is higher in people with a history of NMSC and of solar keratoses (areas of skin marked by overgrowth of horny tissue), both of which are indicators of cumulative UVR exposure.

3. *UVR effects on the eye*

The eye is recessed within the anatomy of the head and shielded by the brow ridge, the eyebrows and the eyelashes. Bright visible light activates the constriction of the pupil and the squinting reflex to minimize the penetration of the sun's rays into the eye. However, the effectiveness of these natural defences in protecting against UVR exposure is limited under certain conditions, such as sunbed use or strong ground reflection from fresh snow and sometimes sand and water.

Acute effects of UVR exposure on the eye include photokeratitis and photoconjunctivitis. These inflammatory reactions are comparable to a sunburn of the very sensitive skin-like tissues of the eyeball and eyelids and usually appear within a few hours of exposure. Both can be very painful but are reversible and do not result in any long-term damage to the eye or vision. An extreme form of photokeratitis is snow blindness.

Sun exposure, in particular exposure to UVB, also appears to be a major risk factor for cataract development, although cataracts appear to different degrees in most individuals as they age. Cataracts occur when proteins in the eye's lens unravel, tangle and accumulate pigments that cloud the lens and eventually lead to blindness. They are the leading cause of blindness in the world, affecting some 12–15 million people. According to WHO (1994) estimates, up to 20% of cases of cataract-related blindness may be caused or enhanced by sun exposure, especially in India, Pakistan and other countries of the "cataract belt" close to the equator. As the world's population ages, cataract-induced visual dysfunction and blindness are on the increase; reducing ocular exposure to UVR and smoking prevention are the only interventions that can reduce risk of developing cataracts (Brian & Taylor, 2001).

4. *UVR effects on the immune system*

The immune system is the body's defence mechanism against infections and cancers and is normally very effective at recognizing and responding to an invading microorganism or the onset of a tumour. Although the data remain preliminary, there is increasing evidence for an immunosuppressive effect of both acute high-dose and chronic low-dose UVR exposure on the human immune system (Duthie et al., 1999).

Animal experiments have demonstrated that UVR can modify the course and severity of skin tumours (Fisher & Kripke, 1977). Also, people treated with immunosuppressive drugs have a greater incidence of SCC than the normal population. Consequently, beyond its role in the initiation of skin cancer, sun exposure may reduce the body's defences, which normally limit the progressive development of skin tumours.

Several studies have demonstrated that exposure to current environmental levels of UVR alters the activity and distribution of some of the cells responsible for triggering immune responses in humans. Consequently, sun exposure may enhance the risk of disease resulting from viral, bacterial, parasitic or fungal infections and may modify the course of disease progression in both animals and humans (Halliday & Norval, 1997; Yamamoto et al., 1999, 2000). Furthermore, especially in countries of the developing world, high UVR levels may reduce the effectiveness of vaccines.

3.1.3 Interventions and control measures

Damage from UVR to the skin, eyes and immune system is mostly preventable. Reducing both the occurrence of sunburn and cumulative UVR exposure can decrease harmful health effects and significantly reduce health care costs.

Spending a sunny day at the beach, sunbathing by the side of a lake or engaging in different kinds of water sports frequently lead to prolonged exposure to UVR, often including the time of day when UVR levels are highest. This can be exacerbated by the lack of shade and reflection of the sun's rays by water and sand—both can reflect up to about 15% of incident UVR. Sun protection consideration should take these particular environmental conditions into account.

1. *Personal protection against UVR*

It is the individual's choice as to whether to adopt sun protection or not. Simple protective measures are available and should be adopted to avoid adverse health effects on the skin, eyes and immune system caused by sun exposure (Box 3.1).

Children require special protection, as they are at a higher risk of suffering damage from exposure to UVR than adults. Encouraging children to take simple precautions will prevent both short-term and long-term damage while still allowing them to enjoy the time they spend outdoors. Shade, clothing and hats provide the best protection

BOX 3.1 EXAMPLE OF ACTION STEPS FOR SUN PROTECTION (US EPA, 2000)

LIMIT TIME IN THE MIDDAY SUN

The sun's UV rays are the strongest between 10 a.m. and 4 p.m. To the extent possible, limit exposure to the sun during these hours.

WATCH FOR THE UV INDEX

This important resource helps you plan your outdoor activities in ways that prevent overexposure to the sun's rays. While you should always take precautions against overexposure, take special care to adopt sun safety practices when the UV index predicts exposure levels of moderate or above.

USE SHADE WISELY

Seek shade when UV rays are the most intense, but keep in mind that shade structures such as trees, umbrellas or canopies do not offer complete sun protection. Remember the shadow rule: "Watch your shadow—No shadow, seek shade!"

WEAR PROTECTIVE CLOTHING

A hat with a wide brim offers good sun protection for your eyes, ears, face and the back of your neck. Sunglasses that provide 99–100% UVA and UVB protection will greatly reduce eye damage from sun exposure. Tightly woven, loose-fitting clothes will provide additional protection from the sun.

USE SUNSCREEN

Apply a sunscreen of SPF 15 or more liberally and reapply every 2 h, or after working, swimming, playing or exercising outdoors.

for children; applying sunscreen becomes necessary on those parts of the body that remain exposed, like the face and hands. Infants of less than 12 months should always be kept in the shade.

2. *Information and education*

   Information should be provided to the public on UVR and variation in UVR levels with time of day, time of year and geographical location; health effects of sun exposure on the skin, eyes and immune system; and available protective measures (see Box 3.1).

   The global solar UV index (International Commission on Non-Ionizing Radiation Protection, 1995; WHO, 2002) is an important vehicle to raise public awareness of UVR and the risks of excessive UVR exposure and to alert people about the need to adopt protective measures (see Box 3.2). The UV index describes the level of solar UVR at the Earth's surface. The values of the index range from zero upward. The higher the index value, the greater the potential for skin and eye damage following exposure to UVR, and the less time it takes for harm to occur.

   A standard graphic representation of UV index has been proposed (WHO, 2002) in order to promote consistency in reporting and improve understanding of the

BOX 3.2 GLOBAL SOLAR UV INDEX (WHO, 2002)

UV index values are grouped into exposure categories:

UV index values	Exposure category	Level of sun protection required	'Sound bite' messages
≤2	Low	None required	You can safely stay outside
3–5	Moderate	Protection required	Seek shade during midday hours. Slip on a shirt, slop on sunscreen and slap on a hat.
6–7	High		
8–10	Very high	Extra protection required	Avoid being outside during midday hours. Make sure you seek shade. Shirt, sunscreen and hat are a must
11+	Extreme		

Even for very sensitive, fair-skinned people, the risk of short-term and long-term UVR damage below a UV index of 3 is limited, and under normal circumstances no protective measures are needed. Above the threshold value of 3, protection is necessary and should include all protective means available. At the very high or extreme exposures of UV index values of 8 and above, this message must be reinforced, and people should be encouraged to use more sun protection and avoid being outdoors during midday hours.

concept. Ready made materials, such as those shown in Figure 3.1, are available from WHO.

The levels of UVR and therefore the values of the index vary throughout the day. In reporting the UV index, most emphasis is placed on the maximum UVR level on a given day. This generally occurs during the 4-h period around solar noon. Depending on geographical location and whether daylight saving time is applied, solar noon takes place between noon and 2 p.m. The media usually present a forecast of the maximum UVR level for the following day. In many countries, the UV index is reported along with the weather forecast in newspapers, on TV and on the radio. However, this reporting usually occurs during the summer months only, unless the location lies within or close to the tropics.

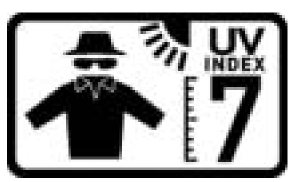

FIGURE 3.1. UVI GRAPHIC REPRESENTATION (WHO, 2002)

Information relating to the UV index should be especially targeted at vulnerable groups within the population, such as children and tourists, and should inform people about the range of UVR-induced health effects, including sunburn, skin cancer and skin aging and effects on the eye and immune system. Daily UV index levels can easily be presented on signboards and signposts on beaches or by the side of lakes and should be accompanied by a simple message encouraging people to adopt sensible sun behaviour. Furthermore, simple flyers could be made available free of charge at the entrance, at cashiers or at kiosks. Lifeguards, first aid providers and other employees should be educated about UVR and sun protection and trained to act as role models for the users of recreational water environments, in particular children. They may help to disseminate information about the dangers of UVR and could be important partners for organizations that are planning to hold educational events or skin cancer screening initiatives. Further information can be found on the website of WHO's INTERSUN Programme (http://www.who.int/peh/uv/).

Public education aims to improve people's knowledge about the health risks of excessive sun exposure and to achieve a change in attitudes and behaviour. Educational activities in the context of recreational water environments should mainly address children, adolescents and their parents. The best way of generating interest is through activities and games. The main message should be that the enjoyment of outdoor sport and recreation activities should not be compromised, but can even be enhanced by sun-protective behaviour. Sensible behaviour is relatively simple to incorporate and can eliminate sunburn and heat stroke, which are often associated with being in the sun for prolonged periods of time.

Reducing the occurrence of sunburn and cumulative UVR exposure during childhood and over a lifetime will eventually cause skin cancer rates to decline. It has been estimated that four out of five cases of skin cancer could be prevented by sensible behaviour (Stern et al., 1986). An effective campaign can have an enormous impact on public health: it has been estimated that the regular use of sunscreen with SPF 15+ up to the age of 18 could decrease the frequency of skin cancer in Australia by more than 70% (Stern et al., 1986).

The SunSmart Campaign of the Anti-Cancer Council of Victoria, Australia (Anti-Cancer Council of Victoria, 1999b), has made significant achievements in raising awareness of the issues of sun protection and skin cancer as well as encouraging changes in sun-related behaviour. Evaluations of the programme show that fewer people see tanning as desirable or attractive and more people wear hats, use sunscreen and cover up to avoid the sun. Most significantly, research during the 1990s revealed an 11% decrease in the incidence of common skin cancers in 14- to 50-year-old people (Staples et al., 1998).

Low-cost interventions can significantly decrease costs to the healthcare system. Skin cancer is the most costly of all cancers to the Australian health system. The direct costs of treatment have been estimated at US$5.70 per head per annum, while the cost of prevention campaigns has been calculated at US$0.08 per head per annum. Assuming that a 20-year prevention campaign costing US$0.17 per head per annum reduced UVR exposure by 20%, that melanoma rates began to fall after a 5-year lag and that NMSCs and solar keratoses began to fall after a 15-year lag, the predicted annual saving would be US$0.17 per person (Carter et al., 1999). This would mean that every dollar spent would save a dollar.

In order to change people's sun exposure habits and the societal view that associates a tan with good health and beauty, long-term strategies are required. To create a supportive environment for the integration of sun protection considerations in the use of recreational water environments, it is important to establish working relationships with authorities and organizations such as community health services, sporting clubs, skin cancer associations, and the service and tourism sector, including public transport services and restaurants. Efforts should be made to learn from and integrate existing community initiatives to promote sun protection in the planning and implementation process.

3. *Infrastructure and planning*

While it is the decision of the individual as to whether to adopt sensible sun behaviour or not, the management of recreational water environments has the responsibility to facilitate a positive choice through adequate structural and policy measures. One important infrastructural consideration is the provision of shade structures and the integration of shaded areas in the vicinity of recreational water bodies. This is especially important in areas where a lot of people congregate—e.g., at a snack stand where people may queue for prolonged periods of time. Shade can be either permanent or portable and can come from natural sources such as trees or hedges or from artificial structures such as gazebos, canopies or shelter sheds. An inexpensive means of shade provision is to give users of recreational water environments the opportunity to hire portable parasols at low cost.

An example of a guide for local government is shown in Table 3.2.

3.2 Exposure to cold

Cold water removes heat from the body 25 times faster than cold air. The immediate effects of sudden immersion in cold water (<15 °C) can be a debilitating, short duration (approximately 2–3 minutes), reflex response called cold shock. This response includes life-threatening respiratory and cardiovascular effects. The respiratory effect involves quick onset (less than 30 seconds) uncontrollable rapid breathing, which impairs breath-holding and facilitates aspiration of water (which can lead to drowning). The cardiovascular response involves an immediate constriction (closure) of the blood vessels near the surface of the body, an increase in heart rate and a surge in blood pressure. These factors may lead to incapacitation from a cardiovascular incident, such as heart attack or stroke and/or death from drowning following aspiration (Golden & Tipton, 2002; International Life Saving Federation, 2003).

If sudden immersion in cold water does not cause death immediately, the related effects will impair swimming ability. Research has shown that even strong swimmers can experience difficulty and drown within minutes of cold-water immersion unless they are habituated to cold (Golden & Hardcastle, 1982). These initial responses occur long before body temperature begins to fall and are believed to be responsible for the majority of sudden cold-water immersion deaths.

TABLE 3.2. AN EXAMPLE OF A RECREATIONAL FACILITY SUN PROTECTION GUIDE FOR LOCAL GOVERNMENT[a]

SunSmart components	Desirable actions/outcomes
Education	• Erect signage about the importance of sun protection • Ensure that employees are role models for users of facilities • Conduct sun protection information sessions for employees • Ensure that sun protection information is available to patrons and clients
Clothing	• Ensure that employees wear broad-brimmed hats, sunglasses and long-sleeved shirts on patrol • Sell broad-brimmed hats in kiosks
Sunscreen	• Sell low-priced (or subsidized) SPF 30+[b] broad-spectrum, waterproof sunscreen • Provide employees with SPF 30+ broad-spectrum sunscreen
Shade	• Review available shade at local government recreational facilities • Ensure that sufficient shade, either natural or built, is available or planned for when developing new recreational facilities or centres • Investigate the opportunities to make available portable shade structures to schools and organizations using local government-controlled facilities
Schedules	• Allow users to leave in the middle of the day and then return without extra cost
Policy guidelines	• Change any rules (e.g., clothing restrictions for employees or patrons) that prevent people from being adequately protected • Adopt the SunSmart Sport or Pool Policy available from the Anti-Cancer Council of Victoria, Australia • Promote and encourage schools or sporting clubs using local government facilities to introduce a sun protection policy of their own • Ensure that no facilities that increase the risk of skin cancer operate within local government recreation facilities (e.g., solariums)

[a] Source: Anti-Cancer Council of Victoria (1999a).

[b] IARC (2001) recommends the use of sunscreen with an SPF of 15 or higher. In geographical locations where UVR levels are always high, such as Australia, a sunscreen with SPF 30+ may be necessary.

After about three minutes, the initial effects of sudden cold-water immersion decline. Thereafter, progressive whole-body cooling occurs, leading to a gradual fall in deep body temperature—hypothermia. Before a significant level of hypothermia develops, however, there is a progressive cooling of the muscles and joints in the exposed limbs resulting in shivering and stiffening. This impairs locomotion and thus swimming performance (Tipton et al., 1999), which will likely lead to drowning before a life-threatening level of hypothermia develops—unless the victim is wearing a lifejacket or personal flotation device (PFD) capable of keeping the airway clear of the water. This impairment of locomotion also impedes the person's ability to assist in his or her own rescue effort.

For those wearing a proper lifejacket, drowning may be prevented; however, without timely rescue, hypothermia will eventually lead to loss of consciousness and death from cardiac arrest (Golden, 1973). Time to death in such victims will be influenced by body insulation (thickness of clothing worn and the amount of body fat, with men generally having less than women), age (young and elderly fair less well), water state (breaking waves increase the chances of water aspiration) and time to rescue. A person who has consumed alcohol will succumb to the effects of hypothermia more rapidly (Haight & Keatinge, 1973).

One very rare complication of contact with cold water is cold urticaria. This condition is an allergy-like reaction to contact with cold water, as well as other sources of cold (Bentley, 1993). Within minutes, the skin may become itchy, red and swollen. Fainting, very low blood pressure and shock-like symptoms can present.

Prevention is the best cure. Attempts should not be made to swim in cold water unless habituated to it or wearing suitable protective garments (such as a wet suit or survival suit). If at risk of immersion, precautions should be taken against becoming immersed (such as by use of a safety line). On boats, suitable clothing and a proper lifejacket (with sufficient buoyancy to keep the airway clear of the water even when unconscious) should be worn.

3.3 Exposure to heat

Human body temperature is maintained within a narrow range, despite extremes in environmental conditions and physical activity. In healthy individuals, an efficient heat regulatory system will normally enable the human body to cope effectively with a moderate rise in ambient temperature. Within certain limits of mild heat stress and physical activity, thermal comfort can be maintained. In extreme temperatures, the human body is able to react with a series of adaptation mechanisms. The most significant are sweating, dilatation of the peripheral blood vessels, an increase in some hormones (antidiuretic hormone and aldosterone) and an increase in respiratory rate and pulse. In the meantime, the body tries to lose as few salts as possible and decreases the blood flow to the kidney.

Heat acclimatization usually takes from 7 to 14 days, but complete acclimatization to an unfamiliar thermal environment may take several years (Babayev, 1986; Frisancho, 1991). Acclimatization lowers the threshold for sweating, which is the most effective natural means of combating heat stress and can occur with little or no change in the body core temperature. As long as sweating is continuous, people can withstand remarkably high temperatures, provided water and sodium chloride (the most important physiological constituents of sweat) are replaced.

Disorders due to heat most frequently occur with rapid changes in thermal conditions, especially in low latitudes and in densely populated urban areas (Weiner, 1984; WHO, 1990). This was well illustrated by the 1980, 1983, 1988 and 1995 heat waves in the USA (CDC, 1995) and the 1987 heat wave in Athens, Greece (Katsouyanni et al., 1988, 1993). The following population groups seem to be disproportionally affected by such weather extremes, probably because they have a lesser physiological coping ability (CDC, 1995):

- the elderly;
- the very young (0–4 years);
- persons with impaired mobility;

- persons suffering from pre-existing chronic diseases (such as arteriosclerosis, previous heart failures, diabetes and congenital absence of sweat glands); and
- frequent consumers of alcohol (Schuman, 1964; Kilbourne, 1982).

A comfortable temperature for most people is around 20–28 °C. Factors influencing thermal comfort include air temperature, humidity, wind speed and fluxes in shortwave and longwave radiation. Under normal conditions, recreational water bodies may influence people's perception of ambient temperature conditions, such that a middle-aged person walking on the beach at midday copes better with heat exposure than the same person walking on an urban road at midday (Jendritzky et al., 1997).

In recreational water areas, steps that can be taken to reduce body temperature are similar to those for reducing exposure to sun and include wearing lightweight clothing and broad-brimmed hats, seeking shady areas and swimming in cool water. Other initiatives to help cope with exposure to heat include ensuring an adequate supply of safe drinking-water and replenishing any salt loss. Educating people with increased susceptibility to heat exposure (e.g., the elderly) would also be useful.

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