Maximising protection — Sun protective fabric *and* clothing

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Abstract. UV protection programmes promote the message to cover up and minimise exposure of skin surfaces to the sun. However, from a consumer's perspective what information is available to support selection of garments that will optimise protection? UPF rating provides information about fabrics that have achieved high ratings for protection, and by implication, indicates that garments made from these fabrics will minimise exposure. However, most clothing and textile products are not tested and do not carry UPF ratings. When purchasing such garments what product characteristics are important?

UV intensity and sun protective clothing

Credited with the highest rates of skin cancer in the world New Zealanders and Australians are increasingly aware of the health risks associated with overexposure to UV radiation. The need to slip, slop, slap and wrap has been extensively promoted, along with the importance of utilising shade and personal shade (including clothing) during high UV index times of day and year.

A number of national Standards utilising rating systems are recognised as indicating UV protection capacity provided by fabrics. Such rating systems enable manufacturers label and promote garments made from UPF rated fabric as being sun protective clothing. UPF swing tags can be used on garments rated of fabric as sun protective by accredited programmes such as ARPANSA (Gies *et al.*, 1994)

In spite of the promotional programmes and awareness of rating systems the majority of clothing worn during the high UV exposure months is not UPF rated. Consumers are either choosing UPF rated garments for certain activities only, actively choosing not to purchase UPF rated garments, or are selecting clothing on the basis of non-UV related criteria, e.g. fashion, life style etc.,.

From a consumers perspective what is 'sun protective clothing'? An increasingly common source of consumer information about 'sun protective clothing' is the internet 'Googling' highlights the extensive use of the term. The majority of entries related to promotion and sale of SFP or UPF rated clothing as opposed to advice on how to make informed choices between similar clothing items Such items may provide very different levels of UV protection. Examination of the Wikipedia entry for 'sun protective clothing' defines **Sun protective clothing** as "clothing specifically designed for sun protection and is produced from a fabric rated for its level of ultraviolet (UV) protection". Further examination of the search results lead to official websites of organisations such as the Cancer Society (NZ) website which provides one of the more informative information sheets detailing factors consumers should consider when buying clothing in order to enhanced their overall UV protection (Cancer Society, 2007). While last reviewed in 2007 this information sheet carries the cover up message, provides information on the UPF and the UVI, and basic guidelines for choosing the "best type" of fabric (i.e. advice was regarding fabric weave, colour, weight, stretch and wetness).

However, guidelines for selecting the best fabric and garments (other than reference to UPF ratings) are difficult to find. How has our understanding of factors affecting protection provided by fabric and clothing progressed from 2007 to now? Can we improve recommendations about key factors (e.g. fibre, yarn, fabric and wear) affecting protection provided by fabrics, and garments?

Social and environmental factors other than UV also affect summer clothing selection. Warmer temperatures increase preference for clothing of lighter mass, greater air and water vapour permeability, and lighter colour. Thermal comfort/thermophysiological needs are often at odds with selection of clothing that will provide greater UV protection. Is it possible to balance thermo/physiological and UV protection needs?

Structure — Woven or nonwoven

Much consumer advice focuses on woven textiles stating that the weave of fabrics should be tight as such fabrics provide better protection than loosely woven ones. Yet textiles are available in a variety of structures such as woven and nonwoven (e.g. knitted, fibre mats, films such as neoprene etc.). Knitted fabrics are increasingly used for production of products promoted as suitable for active outdoor and summer wear e.g. Icebreaker; Silkbody etc.

The accepted rule is that the higher the cover factor the greater the UPF regardless of fabric structure. When fabrics with the same cover/tightness were examined a hierarchy of weave structures, in order of increasing UPF, were identified: i.e. plain, twill, satin (Dubrovski *et al.*, 2009), like the twill, jersey was associated with lower levels of transmission (Wilson *et al.*, In preparation) (Wilson et al., In preparation). Differences between plain and twill weaves are attributable to the floating of weft (crosswise) yarns, over one and under two of the warp filling threads creating greater cover/density in twills (Taylor, 1995).

However, this relationship is not linear and is instead dependent on the colour of the fabric and other factors, e.g. extensibility, which affect the size of the interstitial spaces. More extensible fabrics will require higher set, effective recovery, and garments styled to ensure positive rather than negative ease, in order to maintain protection during use

Colour

Preference for lighter colours in summer is associated with greater reflection of the infra-red (IR) part of the light spectrum (Dubrovski and Golob, 2009; Shkolnik *et al.*, 1980). While perceived as cooler, lighter colours result in increased UV transmission as the greater the 'depth' of colour the better the resulting UV protection (Wilson *et al.*, 2008). Many light colours can not be produced with sufficient depth to provide adequate levels of protection. Interactions between cover and colour suggest that choosing a fabric in a lighter colour with a tighter sett or higher knitting stiffness (smaller gauge needles) may partially offset the effect of colour alone. High temperatures in the clothing layers increases may also be offset using appropriate fabric (e.g. selected fibre types; air (AP) and water vapour (WV) permeability and design decisions (e.g. loose fitting, well ventilated garments) so that while clothing temperature increases skin temperature does not (Shkolnik et al., 1980).

Air and water vapour permeability

Choosing fabrics with structures and set/knitting stiffness associated with small interstitial spaces has implications in terms of AP and WV permeability. Low AP and WV permeability are associated with greater discomfort. However, alternative pathways for air and WV venting facilitating microclimate and environmental exchange e.g. loose fit; larger sleeve volumes; selection of hydrophilic (e.g. 'natural') rather than hydrophobic (synthetic) fibres; or use of hydrophilic finishes; may improve physiological comfort.

Natural, synthetic or blended fabric

Synthetic fibres are more permeable than natural fibres . Differences in UV transmittance through natural, synthetic or blended high UPF fabrics was shown to depend on fibre classification (found for UVA and UVR transmission only) Natural and blended fibre types transmitted significantly less UV than that which occurs through synthetics yet while the natural fabrics were significantly heavier the synthetic and blended fabrics did not differ significantly in their mass (Wilson et al., In preparation). That polyester provides better protection than nylon or cotton (Hilfiker *et al.*, 1996; Reinert *et al.*, 1997) was not apparent in the high UPF fabrics examined by Wilson *et al.*, (In preparation). Further clarification is needed.

Mass and thickness

UPF has been shown to be strongly, positively correlated with weight per surface unit and thickness of the fabrics (Algaba *et al.*, 2008). However, as with other variables affecting UV protection the effect is dependant on other variables. For example changes in thickness also need to be considered in terms of packing density and set/cover.

Garment style, surface area covered and conditions of use e.g. quick drying

Style and conditions of use variables have also been identified as important contributors to reducing UV transmission and exposure e.g. layering of fabric, wetting, fit etc. (Wilson, 2006; Wilson *et al.*, 2006).

Many activities result in single and multiple layer fabric arrangements becoming wet e.g. exposure to: rain, wetting when swimming etc. Wetting has been widely promoted as reducing a fabrics sun protection in comparison to that when dry (Gies et al., 1994). Yet differences in UV exposure will depend on the surface area wet, the degree of wetting (e.g. partial or saturated), and time to dry (Wilson and Parisi, 2006). Consumers wanting to maintain protection need to consider: changing from wet clothing as quickly as possible, selecting clothing that will still provide an acceptable level of protection when wet, and/or selecting products that will dry quickly e.g. synthetics which tends to dry faster than natural fibres (Gies et al., 1994; Wilson and Parisi, 2006).

Conclusions

Consumers selecting products intended to maximise protection should be identifying fabrics that have been designed and garments constructed in a manner to maximise protection.

Improved understanding of the relationship between fibre, yarn and garment properties means that it is now possible to develop decision matrices to aid consumers in their choices while at the same time recognising that protection provided by textiles and clothing is confounded by interactions among variables. Outreach to the public on what fabrics, garments and wear practices are desirable is recommended.

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