The Particular Flammability Hazards of Nightwear

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ABSTRACT

This work examines the pre- and post- UK Nightwear (Fire) (Safety) Regulation (1965 and 1985) trends in available UK fire and burns statistics. Retrospective analysis of the pre-regulation statistics and prospective analysis of the post-regulation statistics indicates that clothing fire fatalities have fluctuated about an almost constant level since the early 1980s. Major conclusions of this study are similar to those of previous studies in the UK and the US in that the very young and very old are at greatest risk, with females involved in 55% of the incidences and loose-fitting garments posing the highest risk.

Currently national and international standards for flammability of nightwear garments have been reviewed and reported. Published and unpublished UK fire statistics of clothing-related fire incidences have been collated and evaluated. Finally, potential textile hazards and factors contributing to burn injuries and deaths in which clothing items are involved are reviewed.

Keywords: Nightwear, fabric flammability, fire statistics, fire (safety) regulations
1 Introduction

Fire fatalities in which clothing being worn is the first product ignited constitute about 11% of all textile fires reported in the UK, of which fires involving furniture are responsible for 4% [1]. Fires in which death arises primarily from burns are those involving clothing and the more severe burns are difficult to treat medically and usually result in deep-seated psychological ramifications affecting the medical, physical and social behaviour of burn victims. Also the medical expenses for severe burn injuries are extremely high and involve long periods of hospitalisation. In the UK alone, about £250m per annum is spent on treating burns every year [2].

It is one of the major objectives of this study to determine potential textile hazards and factors contributing to burn injuries and deaths in which clothing items are involved and thus provide greater understanding of the fabric variables contributing to burn injuries and deaths among the UK population. The present study however, does not include those instances in which another material was first to ignite even though subsequently clothing was responsible for generating most flames or smoke.

Fire injury and death statistics are valuable not only for identifying textile products contributing to such accidents, but also for determining groups of individuals most likely to be involved in fire-related accidents. In addition, they enable identification of recurring accident variables that warrant public concern, and assists in developing consumer awareness programmes that focus on potential fire hazards or flammable textile products presenting unreasonable risks. Analysis of clothing-related statistical data is also beneficial to regulations and standards organisations. Of specific interest to this study are the hazards posed by nightwear for which regulations have been in force for over 35 years in the UK [3]. Pre-and post-regulation burns statistics have been compared to study the effect of the UK Nightwear (Safety) Regulations of 1965 and 1985 as well
as more recent burns statistics for the period 1990-2000 have been analysed and reported in this paper.

2 Flammability Hazard of Clothing Textiles

Normal clothing and textiles are made of fibres which when given the opportunity may burn readily. With the advent of synthetic fibres, however the danger from sudden ignition has been reduced, while introducing another hazard of thermoplasticity and consequent possibility of contact with the molten polymer which can result in painful and dangerous burns. Although not always fatal, burns from fabrics containing thermoplastic fibres may still be serious and difficult to treat. Also the medical expenses from such severe burn injuries are extremely high and involve long periods of hospitalisation.

While all conventional textile fibres burn, the difference between them is only one of degree. The hazard associated with flammable fabrics is dependent on various material parameters such as i) ease of ignition ii) rate of heat release, iii) total amount of heat released iv) rate of flame propagation and v) heat transfer mechanisms and has been extensively reviewed by various researchers [4-16]. However, these individually and collectively are influenced by textile and garment design features as well as factors unique to each wearer which may include age, gender, health, social and ethnic background and educational level.

Fabric ignition, in particular has prompted considerable interest [4-7] not least because textile materials have very high fibre surface area to mass ratios and hence tend to ignite easily and burn faster than other materials. Although different fabrics exhibit different rates of ignition, ease of ignition in general varies with the thermal inertia; that is, the heavier the fabric, the longer it takes to ignite than a light, sheer fabric made of same material. Surface characteristics of course have a bearing on this factor, and loose pile fabrics usually ignite more easily than compact
smooth surface fabric [8]. Raised fibres have a much larger exposed surface and they can ignite easily with a rapid flash of fire across the fabric surface. In some cases, these surface flashes may cause the entire fabric to burn, but in others the surface flash may not produce enough heat to ignite the base fabric. While presenting an overall direct low risk to a domestic wearer, surface flash may also ignite solvent vapours, for example, in industrial environments. However, concern in the UK was that the 1965 UK nightwear regulation effectively removed flannelette cotton fabrics from children’s nightdresses. Thermoplastic fibres, in contrast, such as polyamide and polyester are more difficult to ignite and generally require a highly combustible source such as cotton to sustain ignition. This is because they often self-extinguish as melted polymer falls away, carrying away heat and flaming material from the ignition source and flame zone. While lighter fabrics made from thermoplastic fibres exhibit “self-extinguishing” properties, heavier fabrics often continue to burn readily due to the greater cohesion of the melting polymer. However, the burning of synthetic-natural fibre blends, such as polyester cotton blended textiles, is far more intense and hazardous than expected from the average of the individual blend component flammabilities. This so-called “scaffolding effect” causes extremely intensive burning of polyester cotton blend fabrics which combine the high flame temperature of cotton, the ability of the cellulosic char scaffold to support the melting and burning of the polyester component and the ability to adhere to the victim because of molten polymer present [7].

Moussa et al [9] and Markstein [10] observed different flame-spreading mechanisms for different textile materials and Miller et al have reported on the effects of constructional factors on the burning rates of textile structures and various blends [11,12]. Furthermore, flame spread is influenced by various clothing structural factors such as presence of belts, ties, cuffs and collars and tight fitting areas, since they act as fire stops. Loose fitting/flowing garments exhibit the so-called chimney effect, which makes the flame spread more rapidly up vertical fabrics. Moreover, full-length nightdresses burn more vigorously than knee-length garments of the same fabric.
Also, flame spread is particularly rapid in light-weight fabrics typically selected for nightwear if the more flammable fibres are present.

Flame temperature is a particularly sensitive indicator of interactions that may occur once a material begins to burn. Miller and Meiser [13] have extensively reviewed fabric flame temperatures of blend fabrics. They noted that flame temperatures of blends are often determined by that of the cotton burning component thereby enhancing the burning rate of the normally cooler burning component. They noted that flame temperatures of blends are the same as that of the hotter burning component thereby enhancing the burning rate of the cooler component. This too adds to the previously mentioned “scaffolding effect” hazard. Normally, once the fabric is ignited, the flame size increases and the heat emission reaches its peak value which is followed by heat transfer and rapid cooling thereafter. Only occurs when all the fabric has been ignited and starts to be fully consumed. Burn hazard may be associated directly with this heat release. The heat transfer from burning fabrics has been studied and various methods to measure the heat release rates from different fabrics and fabric blends have been reported [14,15]. Our latest work describes the use of cone calorimetry to measure heat release rates from textiles as ‘thermally thin’ materials and is discussed elsewhere [16].

3 The Need for Regulation

Despite the Nightwear Safety Regulations, current UK fire statistics continue to indicate that ignition of textiles is one of the major concerns amongst dwelling fires and that the nightwear is a frequent recurring garment category.

It has been known for some time that sleepwear, which are usually loose-fitting garments, are the most frequently involved garment category for children [17,18] in clothing-related fires. One often overlooked factor which allows clothing fires to avoid the attention of regulations, is their
individual nature. Clothing fires, more usually occur to single individuals and not to groups and so tend not to draw media attention. Thus, while the effort to control burns accidents is both socially and economically worthwhile, social pressures to do so are limited.

In 1977 Lin et al [19] investigated the necessity for mandatory standards and identified several influencing factors. Their findings suggest that either the consumer is not informed of the underlying hazard and hence, may not perceive the need for protection or the consumer who elects to live dangerously may also be exposing others to the same risk. Moreover, consumer choice is invariably influenced by costs of the material. Also, many consumers do not follow the instructions on hazards and care and therefore may be ignorant or unaware of their implications [20]. Therefore, legislation appears to be the only way to force safety upon the consumer and for nightwear in the UK this has been the chosen cause of action. In the European Union at this present time the need for regulation is being considered [21,22] with a mandate for a potential test method issued [23].

4 Regulations and Standards: Examples and Present Position

Legislation regarding flammability of fabrics for the first time was brought in force on January 27th 1945 in California. In 1945, legislation regarding flammability of fabrics was brought in force for the first time in California. Fabric flammability regulations in different countries are similar in spirit, but they differ in detail. The basic requirement of any flammable fabric regulation is that it should be reasonable, affordable and technologically practicable. Of current textile flammability regulations which have most significant impact on industry and the consumer, are those concerning children’s sleepwear. The criteria for children’s sleepwear are much more stringent than those for general apparel as the statistics indicate that this former group of the population are highly vulnerable [17,18,20,21].
During the past twenty years, the governments of the US, Canada, UK, Australia and other European countries have enacted legislation aimed at reducing the hazard of fabric burning. This issue has been recognised in the UK since the 1960s when regulations, revised in 1985, were first applied to children’s and subsequently to all nightwear [3]. As mentioned earlier, the 1965 UK flammability regulation, for children’s nightwear effectively removed cotton flannelette from girl’s nightdresses [24]. The subsequent UK Nightwear (Safety) Regulations, 1985 included the testing of all nightwear, including pyjamas, and dressing gowns and require adult and children’s nightwear to carry a permanent label showing whether or not each item meets the requirements of BS 5722:1984 [25] (which uses Test 3 of BS 5438: 1976). This latter performance standard defines a maximum permissible burning rate of a vertically oriented fabric. However, it fails to regulate the fabrics according to their heat release properties which is considered to be more realistic when the burning hazard is to be correlated with the burn injury severity [26]. The regulations also contain a criminal implication which makes it an offence for a person to supply any goods which contravene the safety regulations [3].

Some of the past and subsequently revised versions of nightwear regulations are briefly discussed below:

- The US standard DOC FF3-71 and FF5-74, promulgated in 1971 and 1974 issued by the US Department of Commerce for children’s sleepwear is are based on self-extinguishability or limited burning length as which consists of a pass-fail criterion. for extinguishability [27, 28]. These were later adopted by the US Consumer Product Safety Commission (shown below).

- The US Consumer Product Safety Commission (CPSC) flammability test (FF5-74/ standards 16CFR parts 1615 and 1616 for children’s sleepwear are based on flame spread. If the average char length of burning for five specimens exceeds 178 mm (7 inches), the fabric is
deemed not to comply with the flammability regulations. To comply with the standards, garments must pass this test after withstanding 50 launderings [28].

- The US proposed a General Apparel Flammability Standard (GAFS) relying on the concept that the extent of injury appears to be more closely related to garment configuration and fit than to fibre content and fabric burn time and so incorporates garment configuration, ease of ignition and heat transfer [29]. This comprehensive approach to fabric and garment flammability was, however, never formally adopted.

On 30th April In 1996, the US CPSC voted to amend the children’s sleepwear standard under the Flammable Fabrics Act. The amendments permitted the sale of tight-fitting children’s sleepwear for infants aged 9 months and under, even if the garments do not meet the flammability standards ordinarily applicable to such sleepwear. The amendments were based on the fact that there were virtually no injuries associated with single-point ignition incidents of tight-fitting sleepwear, or from sleepwear worn by infants under one year. The data demonstrating this absence of injury were supported by the observations that: i) tight-fitting sleepwear is less likely to come into contact with a flame; ii) even when ignited, tight-fitting sleepwear is not apt to burn readily because it does not trap air that feeds a fire and the proximity of the skin soaks up heat that would otherwise cause the fire to spread; and iii) infants under 6 months are insufficiently mobile to expose themselves to sources of fire. The amendment also proposed strong consumer information and education programmes, which would continue in reducing injuries and deaths from sleepwear ignition [30].

Such relaxation of sleepwear standards has received strong opposition from health care and fire service professionals. Their argument was that the relaxation of the standards removed the serious protection for a highly vulnerable group. Moreover, the average consumer always has the tendency to purchase larger sizes in tight-fitting garments so as to increase comfort, and to allow
a child to grow into the garment thus obviating any possible benefit of the tight-fitting garment as proposed by the amended sleepwear standard [31].

In contrast, Australian regulations incorporate labelling of all the children’s night-clothes to display an appropriate hazard classification [32]. The Australian philosophy about consumer protection is to inform consumers of the hazard and hence permit them to make their own judgement as to whether the risk is acceptable. The standard AS 1176 [33] comprises three test methods: Part 1: ease of ignition; Part 2: burning time and heat output; and Part 3: surface burning times for pile fabrics. The results of these tests are used in conjunction with standards for fit for children’s nightwear and for labelling. Conversely, Canadian regulations for children’s sleepwear are more prescriptive and dictate use of fabrics such as polyester, nylon and modacrylic as preferred fibres for manufacturing children’s nightgowns and robes rather than cotton and wool [8]. The probable reason is the difficulty in ignition and lower rate of flame spread in 100% polyester and nylon fabrics [34].

Recently, following concern across the European Community of the hazard posed by nightwear, an EU mandate [21] required the European Committee for Standardisation Committee CEN 248 to investigate the feasibility of introducing nightwear flammability regulations. Two task groups reported respectively on the nightwear standards currently available (see Table 1) and possible toxicological hazards associated with flame retardant treatments available for nightwear [22]. For instance, the Dutch and French standards in Table 1 are derived from an ISO-standard (ISO 6941) on measurement of flame spread properties and ISO 6940 on determination of ease of ignition. The Swedish and Norwegian regulations are based on the American ASTM 1230 standard test-method for flammability of clothing textiles. Although Most of the national test methods listed in Table 1 are based on existing national standards, which outside of the respective country of origin, they do not have acceptance. With the harmonisation of the
European community there is an urgent need to develop a common test method for nightwear safety regulations. The second task group of the Committee CEN 248 considered the possible toxicological consequences of using a number of most appropriate flame retarded textiles in nightwear. Because of the nature of the end-use involved, the antimony-bromine based flame retardants causing concern at present in furnishing and related applications were excluded from the study [22,25]. For the established durable phosphorus-containing finishes for cotton-based fibres and inherently flame retardant viscose and synthetic (eg., polyester, modacrylic) fibre-containing fabrics, respective toxicological hazards were considered to be low and hence toxicological risk negligible. As a consequence of the submitted report [22] this same CEN 248 Committee has been tasked with drafting an appropriate test method and standard by September 2003 [23].

5 Clothing Fire Statistics

Across the world, very few comprehensive statistics exist, especially those which attempt to relate deaths and injuries to textile properties such as ignition resistance and flame spread. International reporting of fire statistics is not standardised and no common international basis exists for the gathering and interpreting of such information. Textile-related burns statistics of the late nineteen sixties and early seventies produced by various organisations in the US, Australasia, and the UK have been reviewed and analysis of some of these studies and conclusions are listed below:

- In 1969, Yeoman from Department of Health, Education &Welfare (HEW) [36], reported 4900 cases of textile fires of which approximately 1200 were due to fabric ignition. In this study, 24% of the fires starting due to fabric ignition involved ignition of nightwear. Cotton
was found to have been the cause in 75% of the cases, blends in 7%, nylon in 8% and other synthetics in 8%.

- Cornog from the National Burn Information Exchange conducted a similar survey for the year 1969. Her survey included 12000 cases of fire deaths [37]. Fabric was believed to be the cause or a contributing factor in about 8000 incidences and the remaining 4000 or so, fabric was believed to be the sole cause of injury and death.

- The US Department of Commerce has analysed data from 406 cases investigated by US Department of Health, Education &Welfare (HEW). The statistical report for the year 1970 indicated that in the 406 cases, 713 separate garments were ignited causing deaths of 76 persons and injury to 504. It was also reported that children in the age group 0-5 are injured at particularly high frequencies by burning of sleepwear [38].

- The Nebraska burn study during 1975 revealed that of the 719 burn accidents studied, 160 were clothing-related incidents. Ignition sources were known in 134 cases and major sources of ignitions were open fires (17.9%), internal space combustion engines (17.2%), matches and lighters (11%) [39].

- Burn statistics collected by the Australian and New Zealand Burn Association in the late 1970’s revealed that clothing was the primary agent ignited in 25% of children’s flame burn cases and 14% for adults. For both children and adults, day clothes were involved four times as often as nightclothes [40].

- In the UK, analysis of the data for the year 1978 show that of the 733 total fire deaths in home, 361 were textile related and 66 were related to the clothing on the person [41]. While the cause of death in UK fires is more generally associated with inhalation of fire gases as
those earlier and very recent statistics compare [42], those associated with clothing are predominantly burns-related.

5.1 UK Burns Statistics: Sources

For the purpose of this review, a number of sources, some published and others not have been consulted and these are outlined below. In order to study the effect of both the 1965 and 1985 nightwear regulations on clothing related fire deaths in the UK, data for the period 1955-1962 has been compiled from the work of Bull et al [43] and Lawrence [44] where they have studied the severities of burn casualties from Birmingham Burns Unit, UK and also referenced the national data available from hospital in-patient archives [45].

A statistical review of fires starting in textiles or furniture in dwellings in the United Kingdom, for the period 1962-1978 was published in 1980 [42] by the Home Office. The purpose of this review was to identify the changes in the pattern of the dwelling fires and casualties before 1978 after which an improved fire reporting system was introduced with fuller and more precise information. The statistical data from this review has been compiled to study the effect of 1965-Nightwear Regulations and pre-1985-Nightwear Regulations on clothing fire fatalities.

From the year 1978 onwards, the UK Home Office has been publishing annual UK fire statistics collected from UK Fire Services [46]. While these annual UK fire statistics report the number of fatal and non-fatal casualties associated with all textiles as the first ignited item, a broader review of changes in the trends of clothing fires may be obtained by a more detailed examination of the statistical information available on clothing fire casualties for the period 1990-2000. For this purpose, the database of the Consumer Safety Unit [1], which comprises of the data collected from the Home Accident Surveillance System (HASS), UK Burns Units and accidents registered by the Home Office (based on fire brigade reports), has been used. For the present study on the particular hazard of nightwear, the less detailed Home Office data [46], supplemented by more
recent HASS data (obtained directly from the Department of Trade and Industry (DTI) for the period 1995-1998 and the data on accidents involving burns and scald injuries over a period 1992-1996 [2] has enabled 108 clothing fire accident data involving nightwear to be collated and analysed over the period 1990-2000. Using these available sources, attempts have been made to ensure that the data is as complete as possible. Careful cross-checking of fatal and non-fatal cases has been undertaken so as to avoid double counting and in many cases improve the level of relevant detailed information.

5.2 Analysis of UK burns statistics

Collection and collation of the UK Fire Statistics from the above-mentioned statistical reviews and sources enable comparison of the risks posed by all textile materials and in the case of clothing, in particular. Analysis before and after enforcement of both 1965 and the later 1985 nightwear regulations is discussed in this section.

Figure 1 for the period 1955 to 1962 shows the fatalities from burning accidents in England and Wales. The total fire fatalities were between 700-1000 of which fire fatalities due to clothing on person catching fire were 250-350 (about 322 deaths per annum). However, it is obvious for persons who fall into open fires or those exposed to conflagrations to suffer burns from their clothes catching fire. Thus, if all the fatal incidences involving clothing fires are taken together (shown as solid bars in Figure 1), the number of deaths per annum were then recorded as high as 500-550. These figures during this period drew attention to the importance of design of clothing in determining risk of burning injury. The danger of nightdresses made of flammable fabrics was then repeatedly emphasised by coroners, consumers and standards organisations, Members of Parliament, and the press. As a result flammable children’s nightdresses were banned from October 1964 and the UK nightwear regulation which effectively removed flannelette cotton fabrics from children’s nightdresses was brought in force in 1965 [3].
Figure 2 compiles the UK dwelling fire incidences for the period 1962-2000 from UK Fire Statistics [46], with a textile as first item of ignition. The first hand-analysis of the data in Figure 2 clearly shows that the fire incidences involving all textiles (which includes upholstery and furnishing fabrics) increased from the year 1962 through to 1974. The large increase in the number of fires from 10500 to 14700 in dwellings between 1962 and 1974, respectively, is mainly due to ‘open-flame’ fires (including open flames of cooking fires as well as the coal fires). The subsequent fall in dwelling fires over the period 1974-1978 can be attributed to introduction of central heating systems in UK homes, thus reducing the hazard posed by the open fire flames. This increase and subsequent decrease in fire incidences involving all textiles is also seen in fire incidences related to all other clothing textiles. However, by 1978 clothing fire incidences had decreased to a level which remained almost constant until 1993. This period coincides with the introduction of the revised UK nightwear (safety) regulations in 1985, although there is no obvious effect of its introduction over the period 1986-1993. The step increase to a second almost consistent level in 1994 to the present time is difficult to explain except that fire incidence reporting process changed to one of sampling across the UK after 1993 [46].

While Figure 2 compares number of dwelling fire incidences over the period 1962-2000, Figure 3 shows the number of textile-related fire fatalities for the period 1979-2000. Fatality data for the period 1962-1979 is not available for comparison as the number of fatalities and non-fatalities were not published during that period. Thus, while Figure 2 shows that the dwelling fire incidences have fluctuated between 10639-13695 for the period 1979-2000, fatality data in Figure 3 shows clearly shows that over last 20-year period (1979-2000), there has been a general decrease in textile-related fatalities and total dwelling fires with significant decreases occurring since 1988 in particular. As thoroughly reviewed by Stevens [47] and cited by Horrocks [35], this reduction in dwelling fire incidences and fatalities from textile-related fires and upholstered
furnishing fabrics is a result of the 1988 UK legislation associated with the mandatory sale of flame retarded upholstered furnishing fabrics [48]. However, the fatality rate for the incidences involving clothing on person has practically remained the same and within the range 50-90 per year. This is despite the revised Nightwear (Safety) Regulations [25] of 1985 and independent of the effects of the enforcement of the UK Furniture and Furnishings (Fire) (Safety) Regulations [48] and the mandatory inclusion of smoke alarms in the domestic properties which is considered to have had a significant effect in decreasing the textile-related fires in dwellings [47].

Table 2 presents a fatal and non-fatal casualty comparison for the years 1994-2000 taken from the UK fire statistical data [46,49]. From these figures, we can calculate annual (percentage) fatalities per incident to reflect the risk of death for each textile in a fire incident. While the number of non-fatal casualties are much greater than number of fatalities for all these categories, the average fatality to total casualty ratio over the period, especially for clothing and nightwear is much higher than all textiles, in general about 1:16. By dividing these ratios, the chance of being killed in a clothing-related fire is about seven times greater than for all textiles on average and for nightwear, nine times. Thus, although Table 2 comprises a small data set (1994-2000) and hence raises questions about the accuracy of the same, these figures are indicative of the particular hazard of clothing and nightwear.

An analysis of the more detailed data from the UK, DTI Consumer Unit database via HASS [1] and published sources [50-53] enables other risk factors to be assessed.

**Type of clothing involved:** Figure 4 shows the involvement of various garment types in clothing fire incidences considered in this study for the period 1990-1998. More than 50% of the clothing fire incidences involve nightdresses followed by dressing gowns and pyjamas. Frequency of accidents caused by ignition of nightdresses and dressing gowns taken together add up to a far greater lot (80%) than pyjamas (20%). Moreover, 50% of fires involving pyjamas are considered
to have been caused by the ignition of bedding. It has also been observed that burns involving the ignition of clothing (loose fitting garments in particular) usually prove to be more severe because of the intimate nature of such textiles [50]. Feller et al [51] concluded in their study that the patients in whom burns were associated with clothing ignition had a fourfold increase in mortality (24 vs. 6 per cent) and a prolonged hospital stay (21 days longer) compared to those patients whose clothing was not burned. Moreover, the body surface area involved for the clothing-related injuries is twice as great than for non-clothing-related burns, and the area of full-thickness skin injury is six times greater than that associated with non-clothing-related burns.

Belshaw and Jerram [52] subjectively classified the garments involved in burns accidents during the period 1969-1976. Their findings reported in Table 3 show that the free flowing garments such as nightdress and dressing gowns have higher risk of fatalities as compared to tight fitting garments.

**Causes of ignition:** Various causes of nightwear flammability accidents analysed for this study suggests that the smoker's materials such as cigarettes, lighters and matches, taken together (matches, 14% + cigarettes, 10% + lighters, 5%) are as responsible for clothing fires as cooker flames and naked flames of the fire heaters. Figure 5 reveals that naked flames from cookers (29%) and open flame fire heaters (23%) are the major sources of ignition. Candles were involved in 3% of the incidences and in 16% of cases the cause was unknown. Fire started by smoking materials is in general more likely to result in deaths than other fires. Smokers materials have always been reported as the overwhelming cause of ignition in fatal fires related to upholstered furniture, bedding and mattresses [2,22,39]. Nevertheless, cookers, heaters or a fireplace are also identified as major sources of ignition in clothing fires causing fatalities.

**The sex of clothing fire victims:** The HASS data analysed for this study shows that one-third of the clothing fire accidents start in the kitchen (Figure 5), and also it can be seen from Figure 6
that females are involved in almost 70-80% fatal and non-fatal fire accidents. This is very much in agreement with the finding of the Consumer Safety Unit HASS report on 1994 accident data and safety research [1]. The main reason for higher levels of severe/fatal accidents in the high-risk female group is that they tend to take more domestic responsibilities and also because of the potentially loose fitting/flowing garments associated with them. Literature suggests that approximately 40% of the dwelling fires happen in the kitchen [39], so if all females over the age of 20 are arbitrarily labelled “homemakers”, with an added probability of females wearing loose fitting garments, the chances of them getting involved in a clothing-related fire is significantly high.

**Age of clothing fire victim:** Previous studies [43,53] have indicated that the children and those individuals 65 years of age and older were more likely to suffer more severe burn injuries. Graphical representation of the HASS data (1990-1998) in Figure 7 also confirms these findings. The most unexpected and unfortunate finding of the study revealed that large number of teenagers suffer serious injuries in clothing fires which are often disfiguring, and require long hospital treatments. Clothing fire fatalities for the age group 21-65 are lowest (8%), however, their proportion rises sharply for minor accidents. Thus, adults appear to be more able to deal with fire situations and putting out the flames once the clothing catches fire. Higher severity of injuries and increased number of deaths in the extreme age groups can be attributed to their lower dexterity and inability to prevent accidents or removing themselves from situations of serious injury when the accidents occur. Moreover, in case of children, victims panic more rather than attempting to put the flames out.

6 **Conclusions**

From the analysis of the various clothing fire statistics in this study, it is evident that the impact of the 1985 Nightwear (Safety) Regulations have been minimal. The findings of the current
analysis of the HASS data in this study confirms conclusions drawn from the earlier 1994 analysis [1], in that the clothing and nightwear victims in particular have a higher death rate. Females are more vulnerable in clothing flammability accidents and children under 18 and elderly people over 65 years of age are mostly involved in domestic fires as a result of their clothes catching fire.

Although not always fatal, burns from fabrics containing thermoplastic fibres may still be serious and difficult to treat in spite of their having passed established nightwear/clothing test methods such as BS 5438:Test 3 [3]. Also, for the survivors of the clothing fires, burning causes scarring both mentally and physically such that even the best modern plastic surgical practices is challenged. The medical expenses and socio-economic cost of treating non-fatalities resulting from clothing burns can therefore be exceptionally high. Social and political pressures to control the clothing fires are very limited as clothing fire victims and incidences tend to be of an individual nature and so receive little public attention and hence legislative pressure unless common groups of hazard are identified.

It is evident from this study that clothing fires is one of the major concerns amongst the dwelling fires and that the nightwear is still the most vulnerable garment category. It is hoped that our conclusions will inform the current debate in Europe regarding the need for and character of proposed EU regulations [21-23]. Given the apparent lack of influence of present UK nightwear regulations, it is proposed that any test regime for adoption by the EU should be more severe than in the present UK Nightwear (Safety) Regulation of 1985.

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References


50. Federal Register, Rules and Regulations, 61, No. 175, 47634-47648, September; 1996.


Captions

Tables:

Table 1: Selected test standards for nightwear (safety) regulations [21]

Table 2: Casualties from textile-ignited UK dwelling fires [49]

Table 3: Percentage of deaths resulting from burns accidents in 1969-1976 [52]

Figures:

Figure 1: Pre-1965 regulation UK dwelling fire (clothing) statistics [43,44]

Figure 2: UK dwelling fire incidences with a textile as the first item of ignition [46]

Figure 3: UK dwelling fire fatalities with textile as first item of ignition [46]

Figure 4: Garment types involved in clothing fire incidences (complied from HASS data for the period 1990-1998)

Figure 5: Various causes of clothing fires (complied from HASS data for the period 1990-1998)

Figure 6: Male/female involvement in clothing flammability accidents (complied from HASS data for the period 1990-1998)

Figure 7: Age-wise distribution of clothing fatalities (complied from HASS data for the period 1990-1998)
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<td>AS 2755/2</td>
<td>F-E</td>
<td>40</td>
<td>Flame spread</td>
<td>5-15</td>
<td>ISO V</td>
<td>Yes</td>
</tr>
<tr>
<td>Denmark, Finland, Island, Norway, Sweden</td>
<td>NT FIRE 029</td>
<td>F</td>
<td>16</td>
<td>Flame spread</td>
<td>1-20</td>
<td>45°</td>
<td>-</td>
</tr>
<tr>
<td>Germany</td>
<td>DUTCH CONVENANT</td>
<td>F</td>
<td>40</td>
<td>Flame spread, Flash Flaming debris</td>
<td>5 spread</td>
<td>ISO</td>
<td>Yes</td>
</tr>
<tr>
<td>United States of America, Norway, Sweden</td>
<td>ASTMD1230</td>
<td>F</td>
<td>16</td>
<td>Flame spread</td>
<td>1</td>
<td>45°</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 2: Casualties from textile-ignited UK dwelling fires [49]

<table>
<thead>
<tr>
<th>Year</th>
<th>Clothing on person</th>
<th>Nightwear</th>
<th>All textiles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fatalities</td>
<td>Non-fatalities</td>
<td>Fatalities</td>
</tr>
<tr>
<td></td>
<td>/incident (%)</td>
<td>/incident (%)</td>
<td>/incident (%)</td>
</tr>
<tr>
<td>1994</td>
<td>25</td>
<td>79</td>
<td>24.0</td>
</tr>
<tr>
<td>1995</td>
<td>40</td>
<td>78</td>
<td>33.9</td>
</tr>
<tr>
<td>1996</td>
<td>30</td>
<td>16</td>
<td>65.2</td>
</tr>
<tr>
<td>1997</td>
<td>29</td>
<td>81</td>
<td>26.4</td>
</tr>
<tr>
<td>1998</td>
<td>31</td>
<td>76</td>
<td>28.9</td>
</tr>
<tr>
<td>1999</td>
<td>31</td>
<td>70</td>
<td>27.9</td>
</tr>
<tr>
<td>2000</td>
<td>23</td>
<td>70</td>
<td>22.7</td>
</tr>
<tr>
<td>Average</td>
<td>30</td>
<td>67</td>
<td>33</td>
</tr>
</tbody>
</table>
Table 3: Percentage of deaths resulting from burns accidents in 1969-1976 [52].

<table>
<thead>
<tr>
<th>Garments</th>
<th>Accidents</th>
<th>Deaths</th>
<th>% Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nightdresses</td>
<td>34</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Pyjamas</td>
<td>29</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Dress</td>
<td>41</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Shirt</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dressing gown</td>
<td>6</td>
<td>2</td>
<td>33</td>
</tr>
<tr>
<td>Trousers</td>
<td>42</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Jumper</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other specified</td>
<td>8</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Total specified</td>
<td>175</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td>Total unspecified</td>
<td>77</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>252</td>
<td>28</td>
<td>11</td>
</tr>
</tbody>
</table>
Figure 1: Pre-1965 regulation UK dwelling fire (clothing) statistics [43,44]
Figure 2: UK dwelling fire incidences with a textile as the first item of ignition [46]
Figure 3: UK dwelling fire fatalities with textile as first item of ignition [46]
Figure 4: Garment types involved in clothing fire incidences (complied from HASS data for the period 1990-1998)
Figure 5: Various causes of clothing fires (compiled from HASS data for the period 1990-1998)
Figure 6: Male/female involvement in clothing flammability accidents (compiled from HASS data for the period 1990-1998)
Figure 7: Age-wise distribution of clothing fatalities (compiled from HASS data for the period 1990-1998)