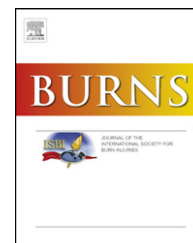


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Review

Burn prevention mechanisms and outcomes: Pitfalls, failures and successes

Bishara S. Atiyeh^{a,*}, Michel Costagliola^b, Shady N. Hayek^c

^a Mediterranean Council for Burns and Fire Disasters – MBC, Plastic and Reconstructive Surgery, American University of Beirut Medical Center, Beirut, Lebanon

^b Department of Plastic Surgery, University of Toulouse, Toulouse, France

^c Plastic and Reconstructive Surgery, Burn Surgery, University of Iowa, Iowa City, IA, USA

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ABSTRACT

Burns are responsible for significant mortality and morbidity worldwide and are among the most devastating of all injuries, with outcomes spanning the spectrum from physical impairments and disabilities to emotional and mental consequences. Management of burns and their sequelae even in well-equipped, modern burn units of advanced affluent societies remains demanding and extremely costly. Undoubtedly, in most low and middle income countries (LMICs) with limited resources and inaccessibility to sophisticated skills and technologies, the same standard of care is obviously not possible. Unfortunately, over 90% of fatal fire-related burns occur in developing or LMICs with South-East Asia alone accounting for over half of these fire-related deaths. If burn prevention is an essential part of any integrated burn management protocol anywhere, focusing on burn prevention in LMICs rather than treatment cannot be over-emphasized where it remains the major and probably the only available way of reducing the current state of morbidity and mortality.

Like other injury mechanisms, the prevention of burns requires adequate knowledge of the epidemiological characteristics and associated risk factors, it is hence important to define clearly, the social, cultural and economic factors, which contribute to burn causation. While much has been accomplished in the areas of primary and secondary prevention of fires and burns in many developed or high-income countries (HICs) such as the United States due to sustained research on the epidemiology and risk factors, the same cannot be said for many LMICs. Many health authorities, agencies, corporations and even medical personnel in LMICs consider injury prevention to have a much lower priority than disease prevention for understandable reasons. Consequently, burns prevention programmes fail to receive the government funding that they deserve.

Prevention programmes need to be executed with patience, persistence, and precision, targeting high-risk groups. Depending on the population of the country, burns prevention could be a national programme. This can ensure sufficient funds are available and lead to proper coordination of district, regional, and tertiary care centres. It could also provide for compulsory reporting of all burn admissions to a central registry, and these data could be used to evaluate strategies and prevention programmes that should be directed at behavioural and environmental changes which can be easily adopted into lifestyle. Particularly in

* Corresponding author.

E-mail address: aata@terra.net.lb (B.S. Atiyeh).

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LMICs, the emphasis in burn prevention should be by advocating change from harmful cultural practices. This needs to be done with care and sensitivity.

The present review is a summary of what has already been accomplished in terms of burn prevention highlighting some of the successes but above all the numerous pitfalls and failures. Recognizing these failures is the first step towards development of more effective burn prevention strategies particularly in LMICs in which burn injury remains endemic and associated with a high mortality rate. Burn prevention is not easy, but easy or not, we have no options; burns must be prevented.

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1. Introduction

Although natural disasters cannot be avoided, accidents can be or at least their effects can be reduced with a large margin of safety [1]. Accidental burns are mostly preventable [2-4], nevertheless, burns and their sequelae continue to be responsible for significant mortality and morbidity worldwide [5,6] and are among the most devastating of all injuries, with outcomes spanning the spectrum from physical impairments and disabilities to emotional and mental consequences [7,8]. Globally, fire-related burns are responsible for about 265,000 deaths annually [7]. Unfortunately, over 90% of fatal fire-related burns occur in developing or low and middle income countries (LMICs) with South-East Asia alone accounting for over half of these fire-related deaths [7,9]. There is clearly a dire need to prevent such large numbers of deaths [4].

Even in well-equipped, modern burn units of advanced affluent societies in developed high-income countries (HICs), management of burns and their sequelae remains demanding despite tremendous advances in surgical techniques and development of tissue-engineered biomaterials available in these burn centers. Undoubtedly, in low and middle income

countries (LMICs) difficulties experienced in burn care are amplified many times precluding high standards of care [5]. In addition to the fact that the social cost of burns in general is high [4,10], it costs approximately U.S.\$ 1000 per patient per day to provide satisfactory burn care in the Western world. This is clearly not possible for most developing country populations due to limited resources, poor knowledge of first-aid treatment, and inaccessibility to timely modern medicine and to sophisticated skills and technologies [5,11,12]. Burn management in these countries is complicated even further because many uneducated households are fraught with superstition, taboos, weird religious rituals, and faith in alternative systems of "medicine" [13]. This observation underscores the importance of primary burn prevention and the necessity to increase current efforts in prevention [12]. The best care for burns, clearly, is prevention [14], the only logical solution to reduce the burden of burns in both LMICs as well as HICs [5,12,15]. It has been amply highlighted that prevention takes time, energy and money but ultimately it is the solution to the world's burns problem [4,11,16]. The present review is a summary of what has already been accomplished in terms of burn prevention highlighting some of the successes but above

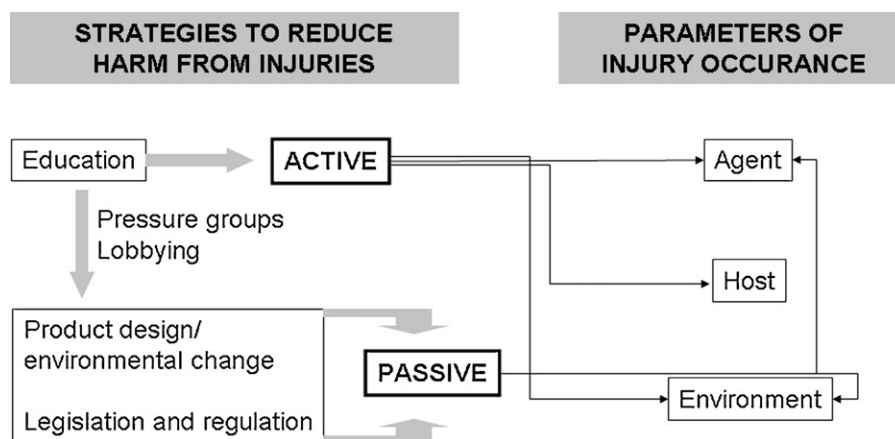


Fig. 1 – Strategies to reduce harm from injury: active prevention aims at educating the individual (host) to adopt measures in order to avoid injury by modifying potential injurious agents rendering them less harmful and by modifying his environment making injury less likely. It aims also at educating the individual about means and ways to minimize injury whenever it occurs. Passive injury prevention entails product and environment modification irrespective of individual (host) participation. This can be achieved either by forced legislation or by voluntary product modification by the industry motivated by market strategies which in turn may be influenced by educating the public to demand safer products. Education may increase also public awareness that may exert pressure on authorities to pass appropriate prevention legislations.

all the numerous pitfalls and failures. Recognizing these failures is the first step towards development of more effective burn prevention strategies particularly in LMICs in which burns remains endemic and associated with a high mortality rate. Burn prevention is not easy, but easy or not, we have no options; burns must be prevented [11].

2. Burn prevention: general strategies

Most individuals who die from injury do so immediately and never have a chance to benefit from acute care. Thus, prevention is a primary venue for reducing the burden of injury-related death and disability [17]. Injury prevention matrices developed few decades ago recognizes three aspects of injury occurrence and thus to prevention: the agent, the host, and the environment [18,19]. Efforts for burn-prevention, whether in HICs or LMICs should hence, in general target the population groups most at risk [13,20,21] and should aim at mitigating the effects of specific risk factors and injurious mechanisms. There are three main strategies to reduce harm from injuries: education, which primarily is an active measure requiring behaviour/lifestyle change, product design/environmental change, and legislation and regulation, both of which primarily are passive measures [14,16,22] (Fig. 1). Furthermore, components and activities of an injury prevention program can be summarized into the ABC's of injury prevention: A, "analyze the data"; B, "build a coalition"; C, "communicate the problem"; D, "develop the interventions"; and E, "evaluate the program" [23].

Any prevention program success remains highly dependent on a strong, committed, and well-informed leader who is familiar with the spectrum of traumatic injury and dedicated to reducing injury in the community. It depends also on a

programmatic staff who are culturally sensitive to the communities where the interventions are being conducted [23]. Moreover, the approach to burn prevention most likely to be effective in a particular area should be based on sound knowledge of the prevalent etiological patterns of burn injury and must take into account geographical variations and socioeconomic differences in burn epidemiology [14,22]. Any comprehensive burn prevention campaign therefore cannot be of any value without valid epidemiologic information specific to each country. Moreover, socioeconomic status (SES) indices predictive of burn risk must be considered to better define at-risk populations and identify modifiable factors amenable to change towards which intervention efforts can be targeted [3]. Prevention programmes need to be executed with patience, persistence, and precision. Depending on the population of the country, burns prevention could be a national program. This can ensure sufficient funds are available and lead to proper coordination of district, regional and tertiary care centres. It could also provide for compulsory reporting of all burn admissions to a central registry, and these data could be used to evaluate strategies that should be directed at behavioural and environmental changes which can be easily adopted into lifestyle [13].

Strong government leadership is essential in the effort to solve the "neglected epidemic" of death and disability from injury [17]. Unfortunately, this cannot be taken for granted and is not easily attained. Despite incontrovertible evidence that injury risk is modifiable, injury prevention remains a historically neglected area of public health a condition that the World Health Organization states is due to a lingering adherence to the "traditional view of injuries as accidents or random events" [23]. Political leaders and the community usually are not aware of the frequency and types of injury occurring in the community [23]. Because there is a general lack of appreciation for the magnitude of the injury-related

health burden and for the modifiability of injury outcomes, it is often difficult to mobilize the necessary resources for effective prevention [23] or to mobilize the policy makers enough to pass the necessary guidelines and regulations.

Unfortunately, several of the national injury prevention program sites function in states where legislation governing vital statistics prevents release of some data files. Injury surveillance, however, is still possible in most states through the cooperation of vital statistics departments that process the raw data files [23]. With solid statistics, educational efforts must begin with the education of health professionals serving the community and community leaders. Physicians, public health professionals, and coalition members work to increase public awareness that injuries are a preventable public health problem [23]. Raising the awareness of the problems is instrumental in gaining the support needed to effect environmental change and safer product designs [23]. Once formed, broad-based community coalitions, with data in hand, can begin to recruit the support/resources from the political structure, the outer community (e.g., private foundations), and the media, to accomplish their goals [24].

3. Epidemiology of burn injuries

To develop effective burn prevention programmes, information on its magnitude and determinants is necessary [22]. Like any other injury mechanism, the first step in prevention of burns requires adequate knowledge of the epidemiological characteristics [6]. Epidemiological and statistical investigation extends the understanding of burn accidents and of the real causes underlying them contributing to in-depth research on the questions as to whom these accidents primarily occur, where and when [1]. Well-conducted studies and accurate and timely statistics are crucial for good evaluation of situational factors peculiar to any given community surrounding the burn injury patterns as well as trends in incidence, causes, medical care use, and cost, each of which is necessary for designing effective prevention programs and for implementing influential legislative lobbying [6,12,14,16,25,26]. It is also important to clearly define the social, cultural and economic factors, which contribute to burn causation [7,27]. Identifying vulnerable population groups and relevant risk factors are thus essential in planning prevention strategies [6] which should not be limited to a merely generic exhortation but, rather, should be specific and focused forms of prevention in the family domestic environment and in the community as well [1]. Unfortunately, despite the fact that management of burn injuries remains a formidable public health problem [5], and that regional distribution of fire-related mortality as reported by WHO shows that the majority of burn related deaths occurs in LMICs particularly in South-East Asia (Table 1) [28], there is a palpable lack in most LMICs of comprehensive data to document the extent of the burn problem in order to guide policy makers and medical personnel [5,29]. Existing data is grossly under-reported [5].

Estimates made 2 decades ago related to annual burn incidence and medical care use in the United States (U.S.) include 5500 deaths from fire and burns, 51,000 acute hospital admissions for burn injury, and 1.25 million total burn injuries

Table 1 – Regional distribution of fire-related mortality

South East Asia	53%
Africa	15%
Eastern Mediterranean	10%
Western Pacific	9%
Europe	9%
America	4%

[30]. At present, burns are the fourth leading cause of death from unintentional injury [3]. Children under the age of 10 account for an estimated 22.2% of all fire deaths [3,31] and burns are consistently listed as one of the top ten causes of injury and death for children less than 5 years and adults older than 34 years [3,32]. Visits to the Emergency Department for burns are declining, but rates remain high in men, black individuals, and children [20]. The rates of decline are similar in sample statistics for all burns receiving medical care and for all burns above a reportable level of severity [30] nevertheless, the U.S. still has one of the highest fire death rates in the industrialized world ranking 6th among the 25 developed nations for which fire data is available [31].

Burns are much more common in low and middle income developing countries than in the U.S. and Europe [33] due to poverty, substandard living condition, overcrowding, illiteracy and limited access to burn care [3,5,13,34]. Indeed, low SES has been associated with increased risk of unintentional injury and mortality [3,35–40]. SES indicators impact risk by either modifying human behaviour or by increasing the exposure to environmental hazards [38]. The exact incidence of burns in developing or LMICs is, however, difficult to determine. Judicious extrapolation suggests that India, for example, with a population of over 1 billion, has seven to eight hundred thousand (700,000–800,000) burn admissions annually [13]. The high incidence makes burns an endemic health hazard in these countries [13].

Burn injuries in LMICs are said to possess a different epidemiology than that in the developed world [13]. It has been reported that the preponderance of burns seen during childhood and among the elderly in HICs is rarely seen in LMICs [7]. Children and elderly people may be at relatively less risk because many households still exist as joint families, and the system safeguards these age groups to some extent [13]. More recently, however, studies in LMICs have demonstrated a high number of burns in persons older than 60 years [7,41]. Previously reported low incidence is probably due to lack of data on the elderly [7]. Moreover, children in LMICs, especially those under 5 years of age, have been shown to constitute the highest risk group of burn victims followed by those aged 20–29 years [5,42].

Invariably, children, especially those under 5 years of age whose physical abilities, reasoning, and judgment are still developing [43], are at increased risk for burns and fatalities [3] and constitute the highest risk group for burn injuries [5,44]. The basic factors in all accidents involving children are a combination of imprudence, lack of experience, impulsiveness, curiosity and a desire to imitate adults [1]. When children are young they lack a sense of danger and awareness and they poorly understand cause-and-effect relationships [43,45]. Children become curious as they grow leading them to experimentation. They question how things work and why and take actions without suspicion of detrimental outcomes

from these actions. By late school age and adolescence, children start to engage in risk-taking behaviours, and peer pressure replaces curiosity [43]. Of the studies that reported data on childhood burns, infants and toddlers from birth through 4 years of age were shown to have a disproportionately higher number of burns [7] comprising nearly one-third of the total number of burn cases, all age groups considered [7,41]. In many settings like Brazil, Cote d'Ivoire, and India, this age group accounts for nearly half of all childhood burns [7]. In Cambodia two thirds of the burns occur to children under the age of 10 years having a higher mortality rate compared to adults [12,46,47].

In general, the most frequent causes of burns are boiling liquids, followed by contact with hot objects (oven front, electric hot-plate, iron) and electricity [1]. While scald injury is more common in early childhood, flame injury predominates with increasing age and becomes the most common cause of burn in children 6–17 years old [31]. Of the six categories of fire and burn injuries (flames and smoke, scalds, contact, electrical, chemical, and radiation) the first three are more prevalent within the school-age population [31]. In LMICs, however, the commonest mode of burn injury is a flame burn. Most such incidents are related to malfunctioning kerosene pressure stoves [13,29] and homemade kerosene lamps used for lighting [5] or from domestic appliances using flammable fuel [48]. In South Africa it was estimated that from 2002 to 2004 over 46,000 dwellings were destroyed each year. 11–13% of burned households were structures defined as “shacks”. These structures are made of highly combustible and toxic materials such as treated or painted wood and plastics, and are assembled close to one another on irregular ground. The incidence of mortality due to smoke and toxic fumes in such fires is maximal for any age group [48]. Unsupervised and careless handling of firecrackers during festivals leads also to an increased incidence of injuries during festival periods. Fire is also a common injurious agent in homicide and suicide [13]. Unfortunately, self-inflicted burns tend to be more extensive and have a 14 times higher mortality rate than accidental burns owing to the use of accelerants [5,49].

The domestic environment, especially the modern home, is becoming more and more a source of risk, both as a result of technological progress (electricity, gas, chemical substances) and because parents are nowadays more often away from the home and have less time to look after their children [1]. The vast majority of childhood burns in both developed and developing countries is reported to occur in the home and involve scalding liquids, open fires, burning rubbish, and contact with hot surfaces while adult burns are reported to occur in the home, outdoors, and at work places in approximately equal proportions [7,12,34,50]. Very young children or individuals without the ability to withdraw from heated objects, and those without sensation in their extremities, are at the greatest risk for contact burns [2]. For all age groups, the kitchen is the most common scene of burns, followed by the backyard, house yard, or veranda for younger children, and the living room and the home vicinity for older children. Among the elderly population, the bathroom is also reported as a common scene of burns [7]. In India most domestic burns are sustained by women aged 16–35 years and almost 70% of these injuries are due to the traditional practice

Table 2 – Relative impact of risk factors on burn injury incidence

Risk factor	HICs	LMICs
Poverty	+++	+++ More prevalent
Education	++	± High immolation rate associated with higher education
Ethnicity	–	– Association of ethnicity to poverty, low education, and certain cultural habits is the major factor of higher risks
Family patterns	+	±
Type of residence	+++	+++ More prevalent

Invariably, components of low socio-economic status are associated with higher burn injury risk. (+++) High impact, (++) moderate impact, (+) low impact, (±) equivocal impact, (–) no impact.

of cooking at floor level, or over an open fire, compounded by the wearing of loose fitting clothing made from non-flame retardant fabric [4,13,29].

4. Burn injury risk factors

Several risk factors can be identified in a community [51]. As a general rule, high population density, illiteracy, and poverty are the main demographic factors associated with a high risk of burns [13]. Based on studies conducted in both developing and industrialized countries, general conclusions about SES and burn risk can be suggested (Table 2). First, burn risk is associated with poverty, lack of education and unemployment. Second, large and single-parent families are at increased risk of burns. Third, substandard housing, including the lack of running water, and crowding increases the risk for burn [3]. Prevention should aim at modifying these risk factors. Certainly, some are more amenable to change and improvement than others.

4.1. Poverty

Poverty is identified as a major risk factor for many types of injury. Individuals from low-income households or areas with high poverty rates, as in most LMICs, are at increased risk for burns [3,34,52–55]. Children of low income families have more than 8 times risk of sustaining burns than children of higher income families [3,52] and children in the most deprived social class have burn related mortality rates 25 times greater than children in the most affluent social classes [3].

4.2. Education

Level of education is shown to be inversely related to burn risk [3,34,56–58]. Burned children are more likely to have parents with low level of education [34]. In some societies, however, higher immolation rate is associated with higher than primary school education of individuals [59].

4.3. Ethnicity

Though some studies have identified some ethnic groups with higher risks to burn, such as the high rates of bath-related

burns in Japan that provide a good example of how cultural habits, lifestyle, and bathing systems may constitute a high risk factor [14,60], belonging to a certain ethnic group as such does not constitute a risk factor. It is rather the association in certain societies of ethnicity to poverty and low education as well as to certain cultural habits such as for minority groups and immigrants that is the major factor conducive to higher burn injury risks [3,61].

4.4. Family patterns

Family patterns like single parents, large families, recent pregnancies, and mothers' being away from home are associated in most studies with higher burn risk [3,34]. Children from single-parent families are shown to be at increased risk of burn in general [62], or of 'abuse/neglect' in particular [63]. Lapses in child supervision, parental illiteracy, presence of a pre-existing impairment in a child, prior history of a sibling burn, and housing location in slums and congested areas were reported as significant risk factors for childhood burns in Bangladesh and Pakistan [7,27,64]. However, a study of SES influences on burns in Bangladesh did not find a correlation of family size, marital status or number of generations living in the home with burn risk [3,65].

4.5. Type of residence

A myriad of SES factors related to type of residence and/or living conditions associated with burn risk have been described [3]. Substandard housing and poor living conditions are associated with increased risk of burn injury and fatality [3,54,55]. As a general rule, high population density, illiteracy, and poverty are the main demographic factors associated with a high risk of burn injury [13]. Additional factors include perennial fuel scarcity, erratic power supply necessitating the use of kerosene stoves and lamps [66], and local traditional practices such as hot water baths for mothers immediately after childbirth and the treatment of convulsions in children with fire [66]. A study in Peru also reported lack of water supply, low income, and overcrowding as risk factors for childhood burns [7,34].

5. Burn prevention mechanisms and measures

Prevention is a cost-effective strategy [43]. Successful programs in injury prevention can focus on changing an individual's attitude and behaviour or on creating and amending the environment to reduce the likelihood of injury [18]. Different methods to prevent burn injury have been identified. One method is education such as distributing educational brochures and press releases to the public by churches, fire fighters, health agencies, senior agencies, universities, and NGOs [67]. If people are aware of environmental risks, then changes in their prevention behaviour may occur [68]. A second method is environmental modification [43] either as a result of increased public awareness of the potential risk factors or enforced safety codes and legislations.

5.1. Fire and burn safety, legislation and prevention codes

Legislation is a crucial passive prevention tool. The intention is to obtain modifications in the relevant laws by promoting prevention at national and local levels, together with the promulgation of safety standards to be observed not only in the planning and realization of particular structures and buildings, but also in the legal regulation of industrial production to protect the public through product modification especially in the field of baby and children clothing, electric household appliances and toys, etc... [1,69]. This implies active implication of local administrative authorities and social orientation and commitment of politicians for the welfare and well-being of citizens. Legislation can also be instrumental in promoting public education and awareness of fire hazards and burns. In some U.S. states, for example, burn education in public schools is mandated by law [18].

Since the early 1970s, stricter building codes have been developed and applied in most developed countries [14,30,70]. Building codes with "reasonable" rules and regulations have been designed to provide the occupants with maximal comfort and safety safeguarding life and property from fire, explosion and hazardous materials [71]. The construction, maintenance and regulation of exits and fire escapes from buildings and all other places in which people work, live or congregate as well as rules and regulations for the installation and maintenance of equipment intended for fire control, detection and extinguishment are well regulated. Provisions are also made for public and private schools and educational institutions to conduct fire drills prescribing the manner in which such fire drills are to be conducted [71].

Keeping, storage, use, sale, handling, transportation or other disposition of highly flammable materials, including crude petroleum or any of its products, natural gas, and of explosives, including gunpowder, dynamite, fireworks and firecrackers are also strictly regulated. To provide for the public safety the transportation of liquid fuel over public highways is also restricted as well as the use of pyrotechnic devices and materials. Procedures for the reporting of fires and explosions occurring as well as procedures for reporting by health care providers of treatment of second and third degree burn wounds involving 20% or more of TBSA are becoming better standardized and regulated [71]. The regulation of consumer products and occupational safety standards have increased significantly as well in most HICs [14,30,70].

Regulatory legislations have been extremely efficacious in most HICs, however, similar regulations and safety codes with genuine concerns for the safety and welfare of citizens, unfortunately, are severely lacking in most LMICs, and even when present they are not enforced or are widely not respected.

5.2. Education and prevention campaigns

Prevention campaigns are of fundamental importance. Similar strategies may be used to reach both children and adults [1]. Traditionally, burn prevention efforts have been directed at public education [25] considered to be an effective tool to reduce burn injury risk factors [51]. Education of the public can evoke awareness of dangers and formulate a code of conduct

as to how one must act and behave in certain situations [51]. Numerous burn prevention campaigns have been undertaken during the past 30 years [25] with effective messages pertinent to the common causes of burn [12] and stressing general awareness building in the population through "School Education Programs" and "Community Awareness Programs" that target high risk population groups [4].

Responsibility for burn and fire education is multifaceted, involving professionals, educators, and caretakers [43]. It is of extreme importance that educators not only take an active role in education but also must make sure this education is at a level the targeted population group can understand [51]. Different means at different moments may be adopted. These must concentrate above all on two basic points: first, they must educate people how accidents can be prevented by observing certain techniques and guidelines; and second, they must illustrate in detail what to do when an accident has actually happened [1].

School children are a logical target of burn prevention campaigns. They constitute the largest high-risk group subject to burn injury in both HICs and LMICs [12]. Unfortunately, significant inadequacies in school children's knowledge on burn prevention and first-aid treatment for burn injuries exist constituting a great educational need. Luckily, a tremendous interest for learning about burn prevention and first-aid has been demonstrated among school-age children [43,67,72] thus primary prevention and health promotion efforts directed at the school-age population have the potential of yielding high returns [43,72]. Indeed many burn prevention programs targeting children's education were claimed to be generally successful in increasing their knowledge [12,73]. Most important, children must learn to understand the consequences of certain actions; in this way the likelihood of future fire-play, for example, will be diminished [1,31]. The amount of time required to adequately convey a burn-injury prevention curriculum is age dependent. Shorter instruction periods have been tried in elementary schools, often by incorporating games or by shifting instruction to outside the classroom through take-home exercises [31,74,75]. Making the sessions as part of the extra curricular activities on a regular basis is of utmost importance [4].

Ideally, the educational tool developed should be easy to implement by all involved with the elementary school child. Teachers should have access to the tool so they can integrate it into their curriculum as time allows [43]. Most educational programs teach burn and fire safety by relying on lectures, activity books, demonstrations, and age-appropriate activities such as having the children simulate crawling under smoke or pretending the children's clothes are on fire and have them perform the "stop, drop, and roll" technique [43]. For children 6 through 12 years of age games would be an effective medium for education because of their limited attention span and high energy level [40]. Burn and fire prevention games are a successful strategy for burn and fire education. They are easily understood and are adaptable to a variety of situation. Most children enjoy the games and ask to play them again [76]. By focusing on a priority health issue these games may "teach" life-saving tactics and seem to propagate positive behaviours. "Play is a very serious

matter . . . it is an expression of our creativity; and creativity is at the very root of our ability to learn, to cope, and to become whatever we may be" [43,76]. Moreover, school and family members are indicated as main sources of information for children a burn prevention campaign should also explore these avenues [12]. Effective prevention campaigns will need to incorporate family education [25]. Adults, including not only parents and educators but also university and senior school students, teachers and all persons who may find themselves in a position of responsibility for the safeguard of children, must become safety-minded. They must be made aware of the possible risks that exist in the domestic and outdoor environment and of how to mitigate their effect [1]. They must be trained in basic first-aid procedures to be carried out immediately at the scene of an accident [1].

Posters are a simple and inexpensive medium to convey the burn prevention message. They can be distributed with ease by handing them out. The short message and colourful illustration teach the concept of fire safety effectively [77]. Studies have shown also the effectiveness of using the mass media and multimedia for other health-related prevention programmes [78-80]. Burn prevention is no exception. It must make use of modern information dissemination tools such as audio-visual presentations [4] and televised campaigns that could be an effective method to better convey information and knowledge, especially if it is endorsed by an authority figure [12]. The Press, television and media are always keen to help in accident prevention, particularly if this fits in with a recent story or political pressure [81]. Face to face interactions regarding structure and arrangements in the kitchen, floor level cooking, clothing while cooking, careful use of electrical appliances, pressure stoves, etc. . . are also extremely helpful same as various competitions for the target group that provide valuable feedback on the programs [4]. Prevention curriculum should include also discussions of the medical and social consequences of burn injuries [31] as well as suicidal and homicidal burns prevention strategies [4]. As with any effective health prevention program, burn prevention must focus on both prevention and damage limitation. Issues related to damage limitation include first aid knowledge, prevention of delay of presentation and multi-disciplinary hospital care to promote early return to pre-injury level of functions [78,82].

For a lasting impact producing social changes, it is believed that burn prevention programs must become part and parcel of community activities and there is a need for them to be constantly reviewed and repeated on a regular basis to reinforce the messages. Changing the nature of the programs from "outreach" to "community-based", with the local community taking responsibility for manpower, material and infrastructure required for the project greatly strengthens their impact [4]. Furthermore, the campaign must not be just one prevention week or safety month but an intensive and extensive long duration project seeking to include all residents through contact with all students, letters from the health authorities to all homes and the formation of community councils [25]. Since it is not possible to prevent all types of burns simultaneously, there is also a need to focus attention from broader issues to specific targets. [4,16,78,83,84]. The

project must be focused on one single type of occurrence and not on preventing of all burn injuries [25].

6. Target-specific prevention

Target-specific legislation and education rather than general ill-focused burn prevention campaigns have been most successful. Improvements have been recognized across targeted intervention areas for both intentional and unintentional injuries in general while rates for nontargeted injury mechanisms remain high [23,24,85]. By narrowing the field of attention, better awareness of the specific burn risk may be expected preparing the grounds for more effective education for active prevention and most importantly for better mobilisation of social and political wills conducive of passive prevention measures.

6.1. Prevention of burns from residential fires

House fires are responsible not only for property loss but also for major burn injuries. Most residential fires are caused by careless cigarette smoking, heating equipment, electrical malfunction, cooking, and children playing with matches and lighters [2,14]. Prevention tips include safe storage of flammable material, keeping matches and lighters out of the reach of children, never leave small children unattended next to a heat source, never leave candles unattended, use extreme caution when cooking, avoid wearing loose clothing that could catch on fire, install smoke detectors and automatic sprinklers, and practice EDITH—Exit Drills in the Home, so that everyone will know the meeting place and how to escape in case of a fire [2,14].

6.2. Prevention of scald burns

Scald burns are due to contact with hot food or liquid, including steam and hot semi liquids, such as tar [2]. Although hot water in the domestic setting has long been known to cause burns, it was not until the 1970s that the epidemiology of tap water burn injury was studied in any detail [14]. Prevention tips include reducing the hot water heater temperature to between 120 and 130 F (49–54 °C), a relatively safe temperature range yet still adequate temperature for household needs, and install anti-scald devices in shower heads and faucets, which automatically restrict the flow of water when a preset water temperature is reached to reduce scald injuries in the shower, bathtub, and sink [2,14]. Other effective strategies to prevent hot water scald burns include the use of large round handles or push-and-turn type handles to prevent young children from turning on the hot water [14]. In the U.S., some states have introduced legislations requiring the installation of appropriate tempering valves in all new domestic dwellings, and water from shower heads and bathtub inlets cannot exceed 115 F (46 °C) by law [14,86]. Small children and persons with physical and/or mental impairments should be constantly and adequately supervised when close to hot water [2]. Further specific prevention measures should be adopted in the kitchen as well. The microwave oven, for example, can place people at potential scald risk. Caution should be when removing

warmed foods, especially liquid or when removing a lid from a container heated in the microwave to avoid a steam scald burn. Furthermore appliances that contain hot liquids should be pushed far back on a counter [2].

6.3. Prevention of clothing-ignition burns

Certain clothing styles continue to be a burn hazard worldwide [11,14,87,88]. Changes in fashion designs toward closer-fitting outfits resulted in a decrease in the incidence and mortality of clothing-related burns [14]. During the 1960s, a milestone in fire safety was achieved through research on various types of natural and synthetic fiber clothing ignition characteristics and regulatory activities for flammable fabrics [14,89]. The Flammable Fabric Act was instituted in the U.S. in 1967 to permit the regulation of a broad range of consumer products, including carpets, mattresses, upholstered furniture, tents, curtains, sleeping bags, and children's clothing [69]. Safety standards for children's sleepwear in sizes 0 through 6X were also imposed [14].

6.4. Specific miscellaneous prevention measures

Many burns are product-related and can be prevented by proper product design [14,90,91]. Burn hazards from fireworks can be effectively diminished by regulatory restrictions. Alternatives to legislation and regulation for preventing firework-related burns include toys that “snap, crackle, and pop” but do not explode or produce heat and encouraging people to attend professional public displays instead of private use of fireworks [14]. Contact burns as well as chemical burns can be avoided by adopting appropriate preventive measures, and electrical injuries can be minimized by strict adherence to the safety regulations regarding household wiring, electrical outlets, and appliance cords [2].

6.5. Prevention measures in LMICs

Concerns in most LMICs are of a different nature. Most domestic burns in some developing countries, for example, are sustained by women aged 16–35 years due to the traditional practice of cooking at floor level, or over an open fire, compounded by the wearing of loose fitting clothing made from non-flame retardant fabric [5,13,92–94]. In other countries, most flame burns are related to malfunctioning kerosene pressure stoves [13,29] and homemade kerosene lamps used for lighting [5,95,94]. Unsupervised and careless handling of firecrackers during festivals leads also to an increased incidence of injuries during festival periods [13]. Preventive measures in these countries should therefore be directed at the specific and peculiar risk factors inherent to the local customs, traditions and practices [66]. Prevention of flame burns caused by hazardous makeshift kerosene bottle lamps as an example should focus on the promotion of safer lamps, ideally with a protective glass around the flame, that are cheap lamps but represent a great improvement on the existing dangerous improvised devices [96]. The emphasis in burn prevention, particularly in LMICs, should be by advocating change from harmful cultural practices. This needs to be done with care, tact, and sensitivity [66].

7. Outcome of active and passive prevention measures

How successful have these campaigns been? There are many poorly documented reports of success of prevention campaigns but unfortunately with little scientific evidence to support them [81]. Ideally the effectiveness of a successful prevention campaign should be measured by decrease in mortality and morbidity rates. Unfortunately, data on burn, fire and injury frequency are in general extremely difficult to access [25] and reporting of burn is not equally thorough and consistent from country to country. One of the main problems to measure the outcome of prevention measures particularly in LMICs is the lack of data and general or governmental registries. In certain parts of the world, there is clearly a need for better, more reliable data on the nature and extent of injury [28]. National vital registration data are available, for example, for only 19% of the countries in the African Region [28].

If individuals consider burn to be preventable, it would be naturally logical to assume that they would change their behaviour in order to avoid these injuries [68]. This assumption, however, is not always true. The low base rate of injuries discourages people from engaging in preventative behaviours [51]. In other words, individuals may unintentionally put themselves or their children at an increased risk for injuries because the perceived effort required to engage in preventative behaviours exceeds the perceived degree of injury risk. If on the other hand, they are made aware of environmental risks, then changes in their prevention behaviour may possibly occur [51,68].

The mortality from burns is decreasing in economically developed countries. It is claimed that this is due to the implementation of effective burn prevention programs and regulations, as well as improved burn treatment [14,90]. It is not clear though if this decrease experienced by these countries is the result of effective prevention programs and not primarily due to advances in technology and improved burn treatment modalities [25]. Some prevention programs undoubtedly have been successful. Declining burn incidence rates, for example, has been largely attributed to prevention strategies, such as safe sleepwear, proper use of smoke alarms, more stringent building codes, etc... [3,97]. While much has been accomplished in the areas of primary and secondary prevention of fires and burns in many developed or HICs due to sustained research on the epidemiology and risk factors as well as to relative abundance of resources and availability of necessary expertise, the same cannot be said of many LMICs [7,98-100] in which lack of government initiative and low literacy rates preclude effective prevention programs [13]. There are very few reports about the impact of burn prevention programs implemented in LMICs [4,12].

It has been noted by some investigators that education may increase knowledge but does not necessarily lead to behavioural and/or lifestyle change [25] and that an increase in knowledge about burns does not necessarily translate into a decreased incidence or severity of burn injuries [25,101]. Burn prevention campaigns aimed at public education failed to provide the expected decrease in burn injuries [25]. In one prevention program consisting of a media campaign, a school-initiated intervention and a community-initiated intervention,

analysis of burns during and after the intervention did not detect any reduction in incidence or severity [4,83]. Another study showed that although the public generally realized the potential for tap water scald burns within the home, there was no action to lower their home hot water thermostat temperature settings despite public awareness programs [67,102]. Others investigators, on the contrary, provided evidence that a burns prevention program can improve knowledge as well as clinical outcomes [78,67,103,101]. The observed steady increase in the number of patients who use cold water as first aid following burn in one study speaks for growing awareness about burns prevention and for the success of prevention strategies among school children and community members [4]. There is also a strong suggestion that the educational campaign, particularly the community presentation, can be successful in modifying burn preventive knowledge in the kitchen, bathroom, and home [67]. Irrespective of this controversy, WHO stills considers fire safety education to be a major component of burn prevention [12]. Each community needs to perceive burn and fire injuries as a major problem and implement provisions and educational programs suitable to its own needs. These programs must be easy to implement, accessible to a variety of educators, and hold the interest of the concerned individuals [43]. A restructuring of current burn prevention programs is therefore needed. Modern techniques of motivational theory must be used to promote public concern and action for individual behaviour change and pertinent legislation and product safety [25].

Many studies particularly in developed countries were completed to evaluate the effects of education and the incidence of pediatric burns. It concluded that prevention can make a difference if the education is consistent and well received [43,72]. Multiplicity of messages, brevity of the campaign, and separation of the interventions, have all been cited as probable causes for a prevention program's failure to reduce the number of injuries significantly [25]. Even though behavioural changes to prevent fire-related burns could be adopted without major changes in lifestyle [14,104], it is evident at present that education alone most often does not result in changes in behaviour and life style to significantly decrease burn rates [14]. Many research findings have documented the striking limitations of health education alone in motivating people to change their behaviour [25]. Passive measures protecting the public through product modification, environmental redesign or control, and legislation, generally have been more effective in preventing burns in terms of cost and injury reduction than have active measures that require persistent, long-term behavioural or lifestyle change [25]. Whether in HICs or LMICs, burn prevention efforts should emphasize therefore implementing passive injury prevention strategies [14]. Although educational efforts to prevent tap water burns, for example, have been successful, it is believed that passive prevention strategies, not requiring "correct behaviour" by the potential victim, tend to be more effective in injury control [14]. In addition to promotion of legislation for environmental and product design modifications, public education remains, nevertheless, essential. For example, education is necessary to mitigate the severity of burn, such as the messages to "stop, drop and roll," "apply cool water to a burn," and "crawl under smoke." In addition, education is

necessary to prevent burns for which passive approaches are unavailable or have not been implemented. In fact, many of the more effective burn prevention programs have been multi-pronged, including both passive and active measures. An example of the latter is the prevention of tap water burns by lowering tap water temperature through educational campaigns and legislation [14].

Unfortunately, most burn prevention campaigns are still directed at increasing knowledge and awareness, moreover, success of the program is based on an evaluation of pre and post scores. Positive results are thus judged on an increase in knowledge of the individual or group and not on change of behaviour or lifestyle, and seldom on a documented decrease in the incidence rate of burn injuries [25]. An important concept to remember in any health education program is the attenuation effect that occurs normally from implementation of an educational program on prevention. After implementation of the program, only a portion of the target population will actually be exposed to the program, of these only a portion will change their behaviour in a persistent manner over time. Publicity, teaching, etc. may have a short-term impact, but this is unlikely to be sustained without repetition [81]. It is postulated that the prevention program needs to be repeated 11 times to convert 80% of the targeted population to a new way of thinking and action [25].

8. Conclusion

Injuries have traditionally been regarded as random, unavoidable "accidents". Within the last few decades, however, a better understanding of the nature of injuries has changed these old attitudes, and today both unintentional and intentional injuries are viewed as largely preventable events. As a result of this shift in perception, injuries and their health implications have demanded the attention of decision-makers worldwide and injury policy has been firmly placed in the public health arena. Furthermore, the growing acceptance of injuries as a preventable public health problem over the past decade or so has led to the development of preventative strategies and, consequently, a decrease in the human death toll due to injuries in some countries [28].

The value of etiologic research and epidemiologic studies cannot be over-emphasized. Increasing the understanding of why certain injuries occur is essential in order to develop effective prevention strategies [3,105]. Conducting injury surveillance allows communities to make informed decisions regarding the categories and mechanisms of injury for which there is the greatest need for intervention [23]. Knowledge assessment can guide the development of prevention programs in terms of their content and structure [68]. In addition to helping identify priorities, surveillance provides a mechanism for monitoring the effectiveness of injury prevention initiatives [23]. The gathering of data, however, is just the first step towards achieving the ultimate goal of injury prevention. Available data must be used to inform decision- and policy-makers about the nature of the problem and, in turn, to argue for greater attention and the allocation of more resources for prevention efforts [28].

On the whole, the main goals of any effective burn prevention campaign should be to (1) encourage accurate investigation and research, (2) promote a wide-reaching information campaign, (3) promote a government regulating safety legislation, and (4) promote the production of safe equipment and products by the industry [1]. While this may seem an ambitious plan even in HICs, it is totally unrealistic in most LMICs with critical shortages in human, infrastructure, and financial resources, without mentioning the security and aggravating political situations and the endemic corruption plaguing most low and middle income developing countries. More modest attainable targets based on a priority scale must be set in such situations, focusing on specific issues that can be modified without the need of excessive resources that certainly cannot be provided. In fact, both intentional and unintentional injuries can be significantly decreased through community-oriented, issue-focused interventions [23]. This is probably the attitude that must be adopted in future burn prevention measures. Specific targets and details of these measures must be dictated by peculiarities of each situation and must be tailored to fit local conditions. Furthermore, since community involvement is an effective way to create and sustain change, community coalitions must be formed to become instrumental in fomenting change in hazards in both the physical and the social environments that are conducive to injury [23,24]. Successful community collaboration requires (a) identification of all community organizations/groups interested in the targeted injury or defined program; (b) agreement of all participants on the process; (c) acknowledgment of community concerns and ideas; (d) community definition of the activities that promote good health and prevent injuries; (e) an openness to criticism and to change in program or process as necessary; and (f) acknowledgment of the contribution of all parties. In short, such community-based coalitions must develop a level of trust [24]. The impacts of coordinated coalition efforts are certainly greater than the efforts realized by any one member organization [23]. Physicians, public health professionals, and coalition members must work also to increase public awareness that injuries are a preventable public health problem and to empower the community to work for change [23]. Once a program has been initiated, evaluation, modification as necessary, and reevaluation must become ongoing activities [23].

It remains painfully clear that people living in poorer economic situations suffer disproportionately from burns, as well as from many other types of injuries and diseases [14]. Poverty, lack of parental education, large families, and substandard housing have all been associated with increased risk of burns, in particular childhood burns. Thus prevention efforts should be focused primarily toward children with lower SES [3] that constitute the largest and most vulnerable group at high risk of burn injury. Despite the few reported successes after few decades of public education efforts, education alone has seldom resulted in marked decrease in burn injuries [25]. A multi-pronged active and passive approach to burn prevention is likely to be the most effective [12,14]. Injury prevention approach, combining injury surveillance with education and community activism, has been demonstrated to be effective in reducing injury across a wide spectrum of injury mechanisms [23].

Even though many risk factors are still not easily modifiable [3], it is clear that to prevent burn injuries, reduce burn care expenses, and relieve the social burden from long term disability, a multifaceted solution for burn prevention must include not only the commitment of health workers that promote burn prevention directly but also requisite complements to these programs that alleviate educational deficits, poverty, overcrowding, poor housing, family stress and violent behaviour, and that target high risk people living in these conditions [14,106]. Supporting the health system in a LMIC must also be part of the prevention program [106].

Unfortunately, changes do not happen overnight, especially changes in attitudes and behaviour patterns [4]. Ongoing research is necessary to improve the outcome of injury prevention and identify problem areas to secure a safe environment for all. By assessing the community's needs and development of interactive burn and fire prevention materials injuries can be further minimized if not effectively prevented [43]. Despite all odds, development of a successful and comprehensive injury prevention program of national scope is feasible through a voluntary coalition of trauma centers, private foundation financial and technical support, and a local injury prevention model [23].

REFERENCES

- [1] The philosophy of a burns prevention campaign. www.burnet.org Accessed on January 1, 2008.
- [2] American Burn Association. Burn prevention. <http://www.kumed.com/bodyside.cfm?id=2027> Accessed on January 1, 2008.
- [3] Edelman LS. Social and economic factors associated with the risk of burn injury. *Burns* 2007;33:958-65.
- [4] Ghosh A, Bharat R. Domestic burns prevention and first aid awareness in and around Jamshedpur, India: strategies and impact. *Burns* 2000;26:605-8.
- [5] Lau YS. An insight into burns in a developing country: a Sri Lankan experience. *Public Health* 2006;120:958-65.
- [6] Aldemir M, Kara IH, Girgin S, Güloğlu C. Factors affecting mortality and epidemiological data in patients hospitalised with burns in Diyarbakir, Turkey. *S Afr J Surg* 2005;43:159-62.
- [7] Forjuoh SN. Burns in low- and middle-income countries: a review of available literature on descriptive epidemiology, risk factors, treatment, and prevention. *Burns* 2006;32: 529-37.
- [8] Atiyeh BS, Gunn SW, Hayek SN. State of the art in burn treatment. *World J Surg* 2005;29:131-48.
- [9] Murray CJL, Lopez AD, editors. The global burden of disease a comprehensive assessment of mortality and disability from diseases injuries and risk factors in 1990 and projected to 2020, vol. I. World Health Organization; 1996.
- [10] Judkins K, Pike H. Prevention and rehabilitation: the community faces of burn care. *Burns* 1998;24:594-5.
- [11] Keswani MH. Burns in India 1974-1999. *Burns* 2000;6: 63-4.
- [12] Hsiao M, Tsai B, Uk P, Jo H, Gomez M, Gollogly JG, et al. "What do kids know": a survey of 420 Grade 5 students in Cambodia on their knowledge of burn prevention and first-aid treatment. *Burns* 2007;33:347-51.
- [13] Ahuja RB, Bhattacharya S. Burns in the developing world and burn disasters. *BMJ* 2004;329:447-9.
- [14] Liao CC, Rossignol AM. Landmarks in burn prevention. *Burns* 2000;26:422-34.
- [15] Cohen AD, Gurfinkel R, Glezinger R, Kriger Y, Yancolevich N, Rosenberg L. Pediatric burns in the bedouin population in southern Israel. *Sci World J* 2007;12:1842-7.
- [16] MacLoughlin E. A simple guide to burns prevention. International Society for Burn Injuries in collaboration with the World Health Organization. *Burns* 1995;21:226-9.
- [17] Mullins RJ. A historical perspective of trauma system development in the United States. *J Trauma* 1999;47(Suppl. 3):S8-14.
- [18] Hammond J. The status of statewide burn prevention legislation. *J Burn Care Rehabil* 1993;14:473-5.
- [19] Haddon W. The changing approach to the epidemiology, prevention, and amelioration of trauma. *Am J Public Health* 1968;58:1431-8.
- [20] Fagenholz PJ, Sheridan RL, Harris NS, Pelletier AJ, Camargo Jr CA. National study of Emergency Department visits for burn injuries, 1993 to 2004. *J Burn Care Res* 2007;28: 681-90.
- [21] Diop-Ndoye M, Bodjona JP, Diouf E, Beye MD, Ngom G, Fall I. Management of thermal severe burns in children in Le Dantec University Teaching Hospital. *Dakar Med* 2005;50:194-7.
- [22] Mashreky SR, Rahman A, Chowdhury SM, Giashuddin S, Svanström L, Linnan M, et al. Epidemiology of childhood burn: yield of largest community based injury survey in Bangladesh. *Burns* 2008;34:856-62.
- [23] Pressley JC, Barlow B, Durkin M, Jacko SA, Dominguez DR, Johnson L. A national program for injury prevention in children and adolescents: the injury free coalition for kids. *J Urban Health Bull N Y Acad Med* 2005;82:389-402.
- [24] Laroque D, Barlow B, Durkin M, Heagarty M. Injury prevention in an urban setting: challenges and successes. *Bull N Y Acad Med* 1995;72:16-30.
- [25] Linares AZ, Linares HA. Burn prevention: the need for a comprehensive approach. *Burns* 1990;16:281-5.
- [26] Palmieri TL, Alderson TS, Ison D, O'Mara MS, Sharma R, Bubba A, et al. Pediatric soup scald burn injury: etiology and prevention. *J Burn Care Res* 2008;29(January-February):114-8.
- [27] Kalayi GD. Mortality from burns in Zaria: an experience in a developing economy. *East Afr Med J* 2006;83:461-4.
- [28] Department of Injuries and Violence Prevention Noncommunicable Diseases and Mental Health Cluster World Health Organization. The injury chartbook; 2002. <http://whqlibdoc.who.int/publications/924156220X.pdf>.
- [29] Dongo AE, Irekpita EE, Oseghale LO, Ogbebor CE, Iyamu CE, Onuminya JE, et al. A five-year review of burn injuries in Iruua. *BMC Health Serv Res* 2007;23(7):171.
- [30] Brigham PA, McLoughlin E. Burn incidence and medical care use in the United States: estimates, trends, and data sources. *J Burn Care Rehabil* 1996;17:95-107.
- [31] Dougherty J, Pucci P, Hemmila MR, Wahl WL, Wang SC, Arbabi S, et al. Survey of primary school educators regarding burn-risk behaviors and fire-safety education. *Burns* 2007;33:472-6.
- [32] National Center for Injury Prevention and Control. 10 leading causes of nonfatal injury, United States, Office of Statistics and Programming, NCIP, CDC, 2000. Available at http://www.cdc.gov/ncipc/wisqars/nonfatal/quickpicks/quickpicks_2000/allinj.htm Accessed on January 1, 2008.
- [33] Rajabian MH, Aghaei S, Fouladi V. Analysis of survival and hospitalization time for 2057 burn patients in Shiraz, southwestern Iran. *Med Sci Monit* 2007;13:353-5.
- [34] Delgado J, Ramirez-Cardich ME, Gilamn RH, Lavarello R, Dahodwala N, Bazán A, et al. Risk factors for burns in

- children: crowding, poverty, and poor maternal education. *Inj Prev* 2002;8:38-41.
- [35] Swart LA, Seedat M. An epidemiological study of injury in a low socioeconomic context: implications for prevention. *Inj Control Saf Promot* 2001;8:241-9.
- [36] Pomerantz WJ, Dowd MD, Buncher CR. Relationship between socioeconomic factors and severe childhood injuries. *J Urban Health* 2001;78:141-51.
- [37] Kelly SM, Miles-Doan R. Social inequality and injuries: do morbidity patterns differ from mortality? *Soc Sci Med* 1997;44:63-70.
- [38] Cubbin C, LeClere FB, Smith GS. Socioeconomic status and the occurrence of fatal and nonfatal injury in the United States. *Am J Public Health* 2000;90:70-7.
- [39] Petridou E, Tursz A. Socio-economic differentials in injury risk. *Inj Control Saf Promot* 2001;8:139-42.
- [40] Strand BH, Kunst A. Childhood socioeconomic position and cause-specific mortality in early adulthood. *Am J Epidemiol* 2007;165:85-93.
- [41] Adamo C, Esposito G, Lissia M, Vonella M, Zagaria N, Scuderi N. Epidemiological data on burn injuries in Angola: a retrospective study of 7230 patients. *Burns* 1995;21:536-8.
- [42] Laloë V, Ganesan M. Self-immolation a common suicidal behaviour in eastern Sri Lanka. *Burns* 2002;28:475-80.
- [43] Mondozi M, Harper M. In search of effective education in burn and fire prevention. *J Burn Care Rehabil* 2001;22:277-81.
- [44] Atiyeh BS, Saba M. Cost/benefit value of a burn unit at AUB-MC. *Ann Burns Fire Disasters* 1995;8:164-216.
- [45] Kuhn MA. Gaming: A technique that adds spice to learning? *J Contin Educ Nurs* 1995;26:35-9.
- [46] Burd A, Yuen C. A global study of hospitalized paediatric burn patients. *Burns* 2005;31:432-8.
- [47] Morrow SE, Smith DL, Cairns BA, Howell PD, Nakayama DK, Peterson HD. Etiology and outcome of pediatric burns. *J Pediatr Surg* 1996;31:329-33.
- [48] Paraffin Safety Association of Southern Africa, 2003 SABS Stove Test Report (www.pasasa.org); 2005.
- [49] Pelaez Mata DJ, Medina Villanueva A, Garcia Saavedra S, Prieto Espuñes S, Concha Torre JA, Menéndez Cuervo S, et al. Importance of initial management in severe pediatric trauma. *Cir Pediatr* 2005;18:17-21.
- [50] Razzak JA, Luby SP, Laflamme L, Chotani H. Injuries among children in Karachi, Pakistan—what, where and how. *Public Health* 2004;118:114-20.
- [51] Tremblay GC, Peterson L. Prevention of childhood injury: clinical and public policy challenges. *Clin Psychol Rev* 1999;19:415-34.
- [52] Istre GR, McCoy M, Carlin DK, McClain J. Residential fire related deaths and injuries among children: fireplay, smoke alarms, and prevention. *Inj Prev* 2002;8:128-32.
- [53] Quayle KS, Wick NA, Gnauck KA, Schootman M, Jaffe DM. Description of Missouri children who suffer burn injuries. *Inj Prev* 2000;6:255-8.
- [54] Sha D. Income, housing, and fire injuries: a census tract analysis. *Public Health Rep* 2006;121:149-54.
- [55] Shai D, Lupinacci P. Fire fatalities among children: an analysis across Philadelphia's census tracts. *Public Health Rep* 2003;118:115-26.
- [56] Mabrouk AR, Mahmood Omar AN, Massoud K, Magdy Sherif M, El Sayed N. Suicide by burns: a tragic end. *Burns* 1999;25:337-9.
- [57] Groohi B, Rossignol AM, Barrero SP, Alaghebandan R. Suicidal behavior by burns among adolescents in Kurdistan, Iran: a social tragedy. *Crisis* 2006;27:16-21.
- [58] Kumar V, Tripathi CB. Burnt wives: a study of homicides. *Med Sci Law* 2004;44:55-60.
- [59] Shin SD, Suh GJ, Sung J, Kim J. Epidemiologic characteristics of death by burn injury from 1991 to 2001 in Korea. *Burns* 2004;30:820-8.
- [60] Fukunishi K, Maruyama J, Takahashi H, Kitagishi H, Uejima T, Maruyama K, et al. Characteristics of bath-related burns in Japan. *Burns* 1999;25:272-6.
- [61] Parker DJ, Sklar DP, Tandberg D, Hauswald M, Zumwalt RE. Fire fatalities among New Mexico children. *Ann Emerg Med* 1993;22:517-22.
- [62] Werneck GL, Reichenheim ME. Paediatric burns and associated risk factors in Rio de Janeiro. *Braz Burns* 1997;23:478-83.
- [63] Andronicus M, Oates RK, Peat J, Spalding S, Martin H. Non-accidental burns in children. *Burns* 1998;24:552-8.
- [64] Daisy S, Mostaque AK, Bari TS, Khan AR, Karim S, Quamruzzaman Q. Socioeconomic and cultural influence in the causation of burns in the urban children of Bangladesh. *J Burn Care Rehabil* 2001;22:269-73.
- [65] Karim K, Alam I, Hasan N, Khan A. The socio-economic factors of burn injuries in children. *Burns* 1975;1:145-8.
- [66] Opaluwa AS, Orkar SK. Emphasise burns prevention in developing countries. *BMJ* 2004;329:801.
- [67] Tan J, Banez C, Cheung Y, Gomez M, Nguyen H, Banfield J, et al. Effectiveness of a burn prevention campaign for older adults. *J Burn Care Rehabil* 2004;25:445-51.
- [68] Piazza-Waggoner C, Adams CD, Goldfarb IW, Slater H. An Assessment of burn prevention knowledge in a high burn-risk environment: restaurants. *J Burn Care Rehabil* 2002;23:342-50.
- [69] Desouches C, Salazard B, Romain F, Karra C, Lavie A, Volpe CD, et al. Analysis of burns caused by pre-filled gas canisters used for lamps or portable camping stoves. *Burns* 2006;32:1028-31.
- [70] Thompson RM, Carrougher GJ. Burn prevention. In: Carrougher G, editor. *Burn care and therapy*. New York: Mosby; 1998. p. 497-524.
- [71] Kansas Fire Prevention Code. <http://www.accesskansas.org/firemarshal/Statutes/KSA31.pdf>. Accessed on January 2, 2008.
- [72] Bartfay W. Reading, writing and health. *Can Nurs* 1994;90:29-32.
- [73] Warda L, Tenenbein M, Moffatt MEK. House fire injury prevention update. Part II. A review of the effectiveness of preventive interventions. *Inj Prev* 1999;5:217-25.
- [74] Corrarino JE, Walsh PJ, Nadel E. Does teaching scald burn prevention to families of young children make a difference? A pilot study. *J Pediatr Nurs* 2001;16:256-62.
- [75] Mondozi MA, Harper MA. In search of effective education in burn and fire prevention. *J Burn Care Rehabil* 2001;22:277-81.
- [76] Rogers F, Sharapan H. How children use play. *Educ Digest* 1994;59:13.
- [77] Maguina P, Palmieri T, Curri T, Nelson K, Greenhalgh D. The circle of safety: a campfire burn prevention campaign expanding nationwide. *J Burn Care Rehabil* 2004;25:124-7.
- [78] Wong P, Choy VY, Ng JS, Yau TT, Yip KW, Burd A. Elderly burn prevention: a novel epidemiological approach. *Burns* 2007;33:995-1000.
- [79] Vidanapathirana J, Abramson MJ, Forbes A, Fairley C. Mass media interventions for promoting HIV testing. *Cochrane Database Syst Rev* 2005;3. CD004775.
- [80] Glang A, Noell J, Ary D, Swartz L. Using interactive multimedia to teach pedestrian safety: an exploratory study. *Am J Health Behav* 2005;29:435-42.
- [81] Roberts AHN. Burn Prevention—where now? *Burns* 2000;26:419-21.
- [82] Demling RH. The incidence and impact of pre-existing protein energy malnutrition on outcome in the elderly burn patient population. *J Burn Care Rehabil* 2005;26:94-100.

- [83] Mackay AM, Rothman KJ. The incidence and severity of burn injuries following Project Burn Prevention. *Am J Public Health* 1982;72:248-52.
- [84] Smith BJ, Ferguson C, McKenzie J, Bauman A, Vita P. Impacts from repeated mass media campaigns to promote sun protection in Australia. *Health Promot Int* 2002;17:51-60.
- [85] Davidson LL, Durkin MS, Kuhn L, O'Connor P, Barlow B, Heagarty MC. The impact of the Safe Kids/Healthy Neighborhoods Injury Prevention Program in Harlem, 1988 through 1991. *Am J Public Health* 1994;84:580-6.
- [86] Stephen FR, Murray JP. Prevention of hot tap water burns—a comparative study of three types of automatic mixing valve. *Burns* 1993;19:56-62.
- [87] Sorensen B. Prevention of burns and scalds in a developed country. *J Trauma* 1976;16:249-58.
- [88] Davies JWLD. The problems of burns in India. *Burns* 1990;16(Suppl. 1):S1-24.
- [89] Silverstein P. Burn prevention: recollections. *J Burn Care Rehabil* 1993;14:281-3.
- [90] Rossignol AM, Locke JA, Boyle CM, Burke JF. Consumer products and hospitalized burn injuries among elderly Massachusetts residents. *J Am Geriatr Soc* 1985;33:768-71.
- [91] Rossignol AM, Boyle CM, Locke JA, Burke JF. Hospitalized burn injuries in Massachusetts: an assessment of incidence and product involvement. *Am J Public Health* 1986;76:1341-3.
- [92] Sawhney CP. Flame burns involving kerosene pressure stoves in India. *Burns* 1989;15:362-4.
- [93] Gupta K, Srivastava AK. Study of fatal burns cases in Kanpur (India). *Forensic Sci Int* 1988;37:81-9.
- [94] Kalayi GD, Muhammad I. Clothing burns in Zaria. *Burns* 1994;20:356-9.
- [95] Chamania S. Burn prevention in Indore, India. *Burns* 2007;33(Suppl. 1):S106-7.
- [96] Laloë V. Epidemiology and mortality of burns in a general hospital of Eastern Sri Lanka. *Burns* 2002;28(8):778-81.
- [97] Chapman JC, Sarhadi NS, Watson ACH. Declining incidence of paediatric burns in Scotland: a review of 1114 children with burns treated as inpatients and outpatients in a regional center. *Burns* 1994;20:106-10.
- [98] McLoughlin E, Marchone M, Hanger L, German PS, Baker SP. Smoke detector legislation: its effect on owner-occupied homes. *Am J Public Health* 1985;75:858-62.
- [99] Katcher ML. Prevention of tap water scald burns: evaluation of a multi-media injury control program. *Am J Public Health* 1987;77:1195-7.
- [100] Forjuoh SN. Injury control in developing nations: what can we learn from industrialized countries {Opinion}? *Inj Prev* 1996;2:90-1.
- [101] Peleg K, Goldman S, Sikron F. Burn prevention programs for children: do they reduce burn-related hospitalizations? *Burns* 2005;31:347-50.
- [102] Adams LE, Purdue GF, Hunt JL. Tap-water scald burns. *J Burn Care Rehabil* 1991;12:91-5.
- [103] Skinner AM, Brown TLH, Peat BG, Muller MJ. Reduced hospitalisation of burns patients following a multimedia campaign that increased adequacy of first aid treatment. *Burns* 2004;30:82-5.
- [104] Waller JA. *Injury control: a guide to the causes and prevention of trauma*. Lexington, MA: Lexington Books; 1985. p. 3189.
- [105] Rivara FP. An overview of injury research. In: Rivara FP, et al., editors. *Injury control: a guide to research and program evaluation*. Cambridge, UK: Cambridge University Press; 2001. p. 1-14.
- [106] Merwe EVD, Steenkamp I. Recent burn prevention in South Africa: evaluation by an adult burn unit. *Burns* 2007;33(Suppl. 1):S36.