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Influence of different definitions of unintentional burns on the prevalence and risk factors in children living in rural areas in Zunyi, Southwest China

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This study aims to summarize the influence of different definitions of unintentional burns on the prevalence and risk factors in rural children. A total of 3548 children living in rural areas were recruited from 12 schools, and questionnaires were used to collect self-reported burn data and related influencing factors in the past 12 months. Burn incidence and risk factors were compared based on two operational burn definitions ("1996 Definition of Burn-related Injury, 1996-DBI" and "2011 Definition of Burn-related Injury, 2011-DBI"). Based on the 1996-DBI, the unintentional burn prevalence was 5.92% (95% confidence interval [95% CI] 5.14–6.70%), which was higher than the 2.23% ([95% CI] 1.74–2.71%) that was calculated using the 2011-DBI ($\chi^2 = 61.90$, $P < 0.001$). The unintentional burn rate ratios ranged from 0.20– to 0.53. Children who were separated from one or both parents accounted for more than half (50.39%) of the sample, and this status was a common risk factor for burns according to the two operational injury definitions. Different operational definitions have significant effects on the reported burn incidence and risk factors.

Keywords Burns, Child, Risk factors, Rural health, Prevalence, Epidemiology

Unintentional injuries among children are a major public health concern and a cause of substantial childhood morbidity and mortality; they not only inflict direct medical costs and economic loss but also cause immeasurable psychological consequences for the children themselves and their families[1]. Paediatric unintentional burns are the third most common cause of injury resulting in death after motor vehicle crashes and falls[2,3]. Survivors of severe burns may require continuing care and suffer from severe long-term consequences in physical, psychological and social dimensions[4,5]. To provide better guidance for the formulation of regional prevention and control strategies, understanding the prevalence of burns and risk factors in the region is particularly important.

Different operational definitions lead to different research results, which hinders the development of injury prevention strategies. There are two definitions of injury in China, one proposed by Prof. Wang Sheng yong in 1996, which considers the accuracy of injury standards and the reasonableness of the amount of information obtained. The criteria for defining injury epidemiology (revised version) were approved at the Third National Conference of Injury Prevention and Control in 2004. After 15 years of practice and research on injuries across our country, another set of criteria was proposed by the 5th Session of the First Standing Committee from The Society for Injury Prevention and Control of the Chinese Preventive Medicine Association, considering that the criteria for defining injury epidemiological investigation and assessment of intervention effects should be as follows: diagnosed with one kind of injury by a medical institution or asked for sick leave for more than one day because of injury.

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However, some researchers still utilize the 1996 Definition of Injury[6,7]. Two studies reported the influence of operational injury definitions on injury prevalence in Changsha city and Guangzhou city[8,9]. These studies made several contributions to the injury field, but the researchers focused on urban residents over the age of 18 and did not mention burns or analyse the risk factors for injury; only the prevalence of injuries was discussed. Our study focused on children living in rural areas under the age of 18, analysed the prevalence and risk factors for burns based on different injury definitions, and conducted an in-depth discussion.

To explore the rationality and practicality of the epidemiological definition criteria for unintentional burns, these data were used to compare and analyse the two criteria for epidemiological definitions of injuries. To a certain extent, our study provides an idea for the epidemiological investigation of unintentional burns, offers a theoretical basis for formulating relevant measures for injury prevention and control, and compares the significance of the application in Zunyi from a survey of injuries among rural children.

Materials and methods

Participants

This research was conducted in Zunyi city, which has jurisdiction over 3 districts and 11 counties. The city covers approximately 11,882 square miles, is a predominantly rural area and has a population of approximately 8.0 million, with and 2.98 million people living in rural areas. The 2018 population census in this area included approximately 1.86 million children under age 18 (accounting for 23.09% of the total population). A multistage cluster sampling approach was used in our study, and participants were chosen from a pool of school students. In the first stage, 5 counties were randomly selected: Zheng'an, Meitan, Huichuan, Yuqing and Tongzi. We then randomly selected 16 schools, and all students aged 7– to 18 years in school from grades 3– to 7 were included. The participants were invited to take part if they were at school during the survey period from June 2012 to June 2016 (Fig. 1). The study protocol was approved by the Ethics Committee of Zunyi Medical University (No. ZMCIRB-2014M001).

Sample size estimation

The sample size was calculated for a cross-sectional survey. The initial sample size of 2,750 was estimated by using the formula $N = Z_{\alpha}^{2} \times p \times q/(d^2)$, where α (alpha) was the probability of type I error ($\alpha = 0.05$, $Z_{\alpha} \approx 2$), $p \times q$ was the maximum possible estimate of variance ($q = 1-p$), and d (delta, δ) was the permissible error ($d = 0.1p$). The burn incidence was 12.7% in our previous research, and considering missing answers in the questionnaire and nonresponse, we added 20% to the estimated sample; therefore, the final estimated sample size needed for our study was 3,300.

Definition of burns

In this study, a burn injury was defined using two criteria. (1) Prof. Wang Shengyong proposed in 1996 that the definition requires that any of the following conditions be met to define it as a burn-related injury event (in this study, these criteria were assessed if they occurred within the last year): (1) received diagnostic and treatment services from medical institutions and were diagnosed with one kind of burn-related injury; (2) asked for sick leave for more than half a day; and (3) received emergent treatment and was nursed by family, teachers, colleagues or companion. This definition is referred to as "1996 Definition of Burn-related Injury", abbreviated as 1996-DBI. (2) The other was proposed in 2011, which required any of the following conditions be met to define it as a burn-related injury event (in this study, these criteria were assessed if they occurred within the last year):1) diagnosed with one kind of burn-related injury by a medical institution; and 2) asked for sick leave for more than one day because of burns. This definition is referred to as "2011 Definition of Burn-related Injury", abbreviated as 2011-DBI.

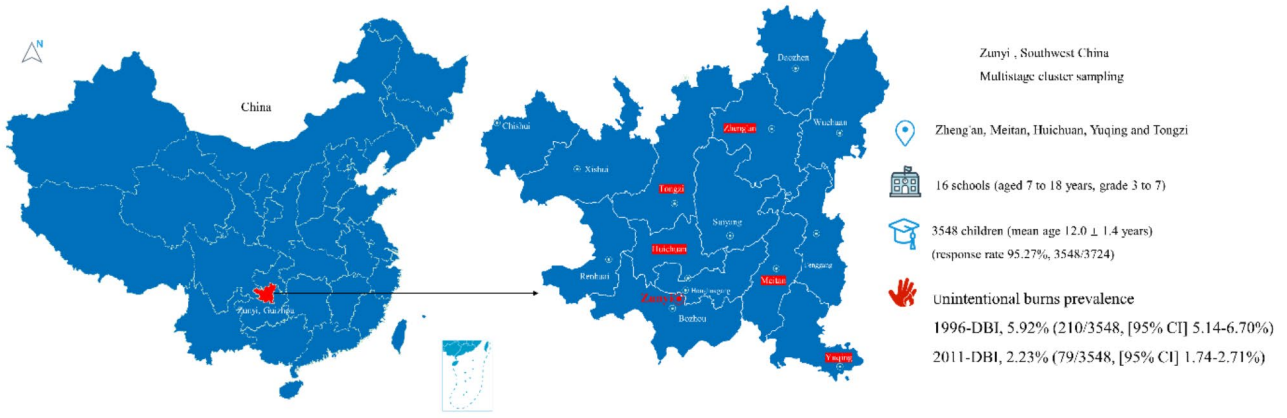

Fig. 1. Schematic diagram representing the influence of different definitions of unintentional burns on the prevalence and risk factors in children living in rural areas in Zunyi.

Data collection and quality control

The methods of data collection and quality control were generally consistent with our previous articles published in Scientific Reports[1]; in particular, trained interviewers entered each classroom, explained the purpose of the survey, and distributed the paper questionnaires. The questionnaires asked approximately (1) demographics, including children's age, sex, school grade level, height and weight (students who could accurately report height and weight could fill out the information by themselves, for those who could not provide this information, we helped them with the measurements); and (2) family living arrangements (children in rural areas who experienced separation from one or both of their parents for more than 6 months were defined as left-behind children, and we classified family status into 4 subgroups: living with both parents, living with fathers only, living with mothers only, and living with someone other than parents). Whether someone had unintentional burns during the 12 months prior to the survey was our primary outcome variable of interest. The treatment methods and rest times after unintentional burns were also collected and used to judge the burn definition standard. Before the students were asked to fill out the questionnaire, the interviewers explained the definition of unintentional burns (burns were usually defined as skin wounds caused by thermal/heat exposure, electricity, chemical materials, radiation exposure, or others, and unintentional burns were produced by external causes that were not deliberately self-inflicted or perpetrated by another person). This research was based on self-reported data; therefore, the total body surface burn area was not determined because the true proportion could not be determined in this survey. The interviewers and teachers were present in the classrooms during the interviews to help the children understand the questions if necessary.

Statistical analysis

Epi Data 3.0 (Epi Data Association, http://www.epidata.dk/, Denmark) was used to build this study's database. All the data were double-entered before statistical analysis, which was performed using SPSS v22.0 (IBM Corp., Armonk, NY, USA). Statistical results are reported as numbers (percentages) and means ± SDs (standard deviations). Risk factors for burns were identified by univariate logistic regression analysis. All variables that met the statistical significance level of a P value of 0.10 in the univariate analyses were examined in an unconditional multivariate logistic regression. All the statistical significance tests were two tailed, and a P value < 0.05 or 95% confidence interval (95% CI) of the OR not containing 1 was considered statistically significant.

Results

Different operational definitions of the unintentional burn prevalence rate

According to the 1996-DBI, the unintentional burn prevalence was 5.92% (210/3548, 95% confidence interval [95% CI] 5.14–6.70%), which was obviously higher than the 2.23% (79/3548, [95% CI] 1.74–2.71%) calculated using the 2011-DBI ($\chi^2 = 61.90$, $P < 0.001$).

General characteristics of the survey population

A total of 3548 children (mean age 12.0 ± 1.4 years) were interviewed (response rate 95.27%, 3548/3724) in 16 schools. Among the interviewed students, 51.52% (1828/3548) were male, and 48.48% (1720/3548) were female. Those aged 8 to 10 years accounted for 16.60%, those aged 11 to 13 years accounted for 67.39%, and those aged over 14 years accounted for 16.01%. The proportion of left-behind children and those living with two parents accounted for 53.39% of the sample. BMI (body mass index) was calculated using the standard formula of weight in kilograms divided by the square of the height in metres. For paediatric patients (2 to ≤ 18 years of age), the BMI was plotted on the Centers for Disease Control and Prevention BMI-for-age growth charts (for both girls and boys) to obtain a percentile ranking[10]. Overall, 4.93% (175/3548) of children were categorized as underweight, 90.08% (3196/3548) of children were categorized as normal weight, and 4.99% (177/3548) were categorized as obese (Table 1).

Comparison of unintentional burn prevalence among school-aged children living in rural areas based on different operational definitions

Subgroup analysis of the demographic variables revealed that the unintentional burn prevalence based on the 2011-DBI was lower than that based on the 1996-DBI; the unintentional burn rate ratios ranged from 0.20– to 0.53, which fluctuated greatly. Sex, age, left-behind child status, normal weight and obesity status were significant ($P < 0.05$) (Table 2).

Comparison of unintentional burn risk factors based on different operational definitions

Figure 2 presents the results of the univariate analysis, and 4 potential risk factors for burns were identified. Age (years) and left-behind children were associated with the risk of burns according to the 1996-DBI. Children who were left-behind children were significantly more likely to suffer burns than non-left-behind children were. Based on these two criteria, different research results were obtained.

Discussion

The reasons why we chose these factors as research factors were that most of the referenced studies[1,10–12] used age, sex, left-behind children and BMI as related predictors in burn studies; sex and age were the most relevant factors for the study sample, and left-behind children represented a common phenomenon in northern Guizhou. Moreover, a study conducted in 2009 revealed that the dietary structure of left-behind children was inadequate[13] and that obesity was one of the fastest growing diseases in modern civilization; therefore, we chose BMI as a research variable.

Variables	*N* (%)
Sex	
Male	1828 (51.52)
Female	1720 (48.48)
Age (years)	
8–10	589 (16.60)
11–13	2391 (67.39)
14–18	568 (16.01)
Left-behind children[a]	
No	1760 (49.61)
Yes	1788 (50.39)
BMI (kg/m^2)[b]	
Underweight	175 (4.93)
Normal weight	3196 (90.08)
Obese	177 (4.99)

Table 1. Characteristics of school-aged children living in rural areas in Zunyi, Southwest China. [a]Parent(s) were away in cities, while their children were left behind to be cared for by a single parent or other family members. [b]BMI was plotted on the Centers for Disease Control and Prevention BMI-for-age growth charts (for either girls or boys) to obtain a percentile ranking. The weight status categories used with children and adolescents were underweight (< 5th percentile), normal weight (5th to < 95th percentile), and obese (≥ 95th percentile).

Characteristics	All students (*N*)	Unintentional burn incidence (%)		Rate ratio(b/a)	Chi-square test	*p*-valve
		1996-DBI (a)	2011-DBI (b)			
Sex						
Male	1828	102 (5.58)	43 (2.35)	0.42	25.00	< 0.001
Female	1720	108 (6.28)	36 (2.09)	0.33	37.57	< 0.001
Age (years)						
8–10	589	47 (7.98)	18 (3.06)	0.38	13.69	< 0.001
11–13	2391	138 (5.77)	49 (2.05)	0.36	44.08	< 0.001
14–18	568	25 (4.40)	12 (2.11)	0.48	4.72	0.030
Left-behind children						
No	1760	65 (3.69)	27 (1.53)	0.41	15.90	< 0.001
Yes	1788	145 (8.11)	52 (2.91)	0.36	46.46	< 0.001
BMI						
Underweight	175	15 (8.43)	8 (4.49)	0.53	2.28	0.131
Normal weight	3196	185 (5.80)	69 (2.16)	0.37	55.17	< 0.001
Obese	177	10 (5.52)	2 (1.10)	0.20	5.52	0.019
Overall	3548	210 (5.92)	79 (2.23)	0.38		

Table 2. Comparison of unintentional burn prevalence rates among school-aged children living in rural areas in Zunyi, Southwest China, based on different operational definitions.

This study revealed that the unintentional burn incidence calculated based on the 1996-DBI was 2.65 times greater than that calculated based on the 2011-DBI, and the prevalences of different sexes, ages, left-behind children and BMIs were greater than those calculated based on the 2011-DBI, except for BMI (< 5th percentile), which was not statistically significant. These results indicate that the following criteria affected the overall results: asked for sick leave (stop working, leave or absence from school, rest) for more than a half of day or received emergent treatment and was nursed by family, teachers, colleagues or companions. This result was similar to the findings of domestic researchers[8,14,15], and these authors suggested that the injury incidents of "family, teachers, colleagues or companions deal with easily" and "taking half a day" were mostly minor injuries, causing less harm and thus having less impact and burden on individuals, families and society. Such injuries have greater flexibility in practical operations, so the authors suggested that the impact of this part of the injury should be negligible[8].

In 1986, the American National Center for Health Statistics proposed the criteria for defining injury as receiving diagnostic services from a medical institution or having limited activity for at least one day. In 1997, a national health investigation conducted by the American National Center for Health Statistics revised the criteria for defining injury as follows: injury leads to the wounded seeking medical help. In 1999, several

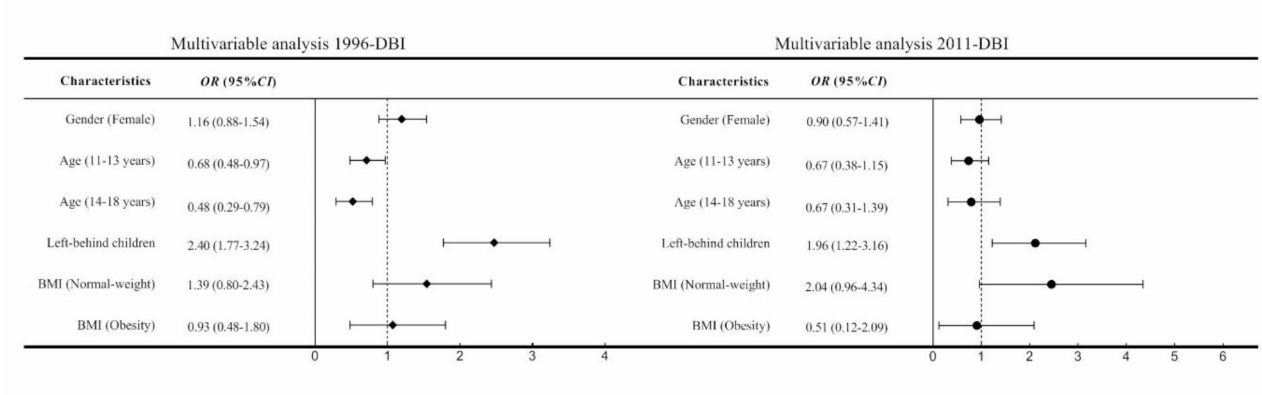

Fig. 2. Comparison of unintentional burn risk factors based on different operational definitions.

researchers proposed the criteria for students' injury as follows: those who have absented for at least a half-day or who have received medical treatment. In developing countries or underdeveloped regions (especially rural areas), the prevalence of injury is clearly underestimated[14,15].

With respect to the definition of unintentional burns among rural school-age children in epidemiological investigations, most researchers use the 2011-DBI, but this approach underestimates the prevalence of unintentional burns and limits the overall understanding of the mechanism of burns and the development of burn injury prevention. First, from the perspective of injury prevention, injury mechanisms for burns of different severities may differ; if we focus only on more serious injuries, we will be unable to fully understand the mechanism of burns, which is not conducive to the formulation of burn prevention strategies. The pattern of the injury spectrum of Chinese residents shows that minor injury events are at the bottom of the injury pyramid[9]; if minor burn injuries are ignored, the prevalence of burns will be significantly reduced, which is even worse for the prevention of burns among rural school-age children, who are currently underrecognized in China. Second, studies have shown that even for minor injuries that have not been addressed by a medical institution, physical and social functions are still affected even 3 months after the injury has occurred. To obtain a comprehensive understanding of the burden of illness caused by injuries, researchers should not focus only on the injuries treated[16]. Finally, the prevalence of unintentional burns is not high; if minor injuries are ruled out, the minimum sample size and research costs required for the study will inevitably increase, which will limit the development of projects with insufficient funding support.

We found that the unintentional burn risk factors were not all the same based on different operational definitions. Multivariate logistic regression analysis revealed two burn risk factors (age, left-behind children) based on the 1996-DBI and only one burn risk factor (left-behind children) based on the 2011-DBII. Notably, left-behind children were a common risk factor for unintentional burns. Undoubtedly, left-behind children are a unique social problem in modern rural China that puts millions of children at high risk for unintentional injuries. Our finding of burn prevalence among left-behind children was significantly greater than that among children who lived with both parents, which is consistent with reports by Shi et al.[3] and Shen et al.[17]; a study in Kurdish children reported similar findings[18]. Adult supervision plays an important role in paediatric burn prevention, and left-behind children were at significantly greater risk of burns than other children in our study, perhaps because of a lack of appropriate adult supervision[19].

Our research revealed that 8 to 10 years of age was a risk factor for burns. In China, young children are often cared for by their grandparents, who usually lack burn-related knowledge. However, young children are curious of their surroundings and unaware of danger. In contrast, children at higher school levels have obtained a basic understanding of danger and have fewer chances to encounter danger. Therefore, the burn prevalence among young children was greater than that among older children. Therefore, education on burn prevention should be individualized by age[20].

Conclusions

In summary, minor burns should be reported in the epidemiological investigation of unintentional burns, but when reporting results, it is more appropriate to adopt the 2011-DBI as the operational definition of unintentional burns, which can not only meet the purpose of comparison with international research but also analyse the characteristics of burns of different severities.

Because this study is a cross-sectional survey, there are several limitations to consider. First, we collected data about burns that occurred in the past year, as we were unable to verify the accuracy of the data. Second, the outcome measure (whether the student suffered a burn or not) relied exclusively on self-reported questionnaire data, which might underestimate the problem because some minor burns might be forgotten. Finally, this survey was conducted among children living in rural areas aged 7– to 18 years in Zunyi. Thus, our results may not be unhesitatingly generalizable to all children in Southwest China, such as children in urban cities, preschool-aged children, those who dropped out of school, and those with physical disabilities who could not attend school normally.

Data availability

The original contributions presented in the study are included in the supplementary material, further inquiries can be directed to the corresponding author.

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Author contributions

S.P., N.Q. and X.Q. completed the research design. S. P., N. Q., Z. X., and M. Q. performed the experiments. S.P. and N.Q. conducted the literature search and data collection. S.P. and N.Q. performed the statistical analysis and interpretation of the data. S.P., N.Q., Z.X., M.Q., and X.Q. were responsible for writing the manuscript. All the authors contributed to the article and approved the submitted version.

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Declarations

Competing interests

The authors declare no competing interests.

Ethical approval and consent to participate

All guardians and participants provided written informed consent before the survey was conducted. This study was approved by the Ethics Committee of Zunyi Medical University (No. ZMCIRB-2014M001). Research was carried out in accordance with the Helsinki Declaration. All methods were performed in accordance with the relevant guidelines and regulations.

Additional information

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1038/s41598-024-78617-7.

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