



Nonfatal injury incidence and risk factors among middle school students from four Polynesian countries: The Cook Islands, Niue, Samoa, and Tonga



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ABSTRACT

Introduction: The burden of injuries in Pacific Island countries is understudied despite the known challenges associated with many residents having limited access to advanced medical and surgical care when they sustain a serious injury. This paper examines nonfatal injuries among early adolescent schoolchildren (those primarily ages 13–15 years) from four Polynesian countries.

Methods: Self-reported data from the 5507 middle school students who were randomly sampled for participation in the nationwide Global School-based Student Health Surveys (GSHS) in the Cook Islands (in the year 2009), Niue (2010), Samoa (2011), and Tonga (2010) were analysed with various statistical methods including regression models. Injuries were defined by the GSHS questionnaire as serious if they resulted in a full day of missed school or other usual activities or required medical treatment.

Results: The proportion of students reporting a serious injury in the past year was 43.1% in the Cook Islands, 40.8% in Niue, 73.8% in Samoa, and 49.1% in Tonga. In the Cook Islands and Samoa, boys reported more injuries than girls ($p < 0.01$). The most common types of serious injuries reported were cuts and other skin trauma; broken bones and dislocated joints; and concussions, other head injuries, or difficulty breathing. The most common causes of serious injuries reported were falls; motor vehicle accidents; and attacks, fights, or abuse. For both boys and girls, being bullied in the past month, being physically attacked or in a physical fight in the past year, using alcohol and tobacco, skipping school, and having anxiety or loneliness were associated with a higher likelihood of injuries.

Conclusions: School-based health education programs targeting prevention of intentional and unintentional injuries may benefit from emphasising Polynesian values and promoting personal mental and physical health, healthy behaviours, and healthy family and community relationships.

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Introduction

Unintentional injuries from road traffic accidents, falls, and other causes are responsible for more than 10% of the morbidity, disability, and mortality among adolescents globally [1–4]. Self-inflicted injuries are also concerns among adolescents [5]. However, the burden of injury in adolescents has been understudied because this age group has a lower overall mortality rate than young children and older adults [2], and because injuries have often, but incorrectly, been considered to be unpredictable and therefore unpreventable events [6]. While a variety of modifiable behavioural and environmental risk factors, such as alcohol use

and unsafe roads, have been identified, few studies have systematically examined the risk factors for youth injuries [7].

This paper examines nonfatal injury incidence rates, types, causes, and risk factors among adolescent schoolchildren from the Polynesian region who participated in the Global School-based Student Health Survey (GSHS). The GSHS is a youth risk behaviour survey conducted by ministries of health and/or education of participating countries in collaboration with the World Health Organization (WHO) and the U.S. Centers for Disease Control and Prevention (CDC). The GSHS is similar to the Health Behaviour in School-Aged Children (HBSC) survey: both the GSHS and HBSC are long-running multi-country youth risk behaviour surveys aiming to understand health attitudes and behaviours during the years of middle school (which may alternatively be called intermediate school, junior secondary school, or other names using local terminology). The HBSC has been used for cross-national

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comparison of high-income countries for more than 30 years; the GSHS is primarily implemented in low- and middle-income countries (LMICs). The GSHS aims to quantify the health and risk behaviours of early adolescents – defined by the GSHS protocol as those who are ages 13 to 15 years old or are enrolled in school classes in which the majority of students are in that age range – by surveying a nationally-representative sample of school-going youth. The use of a standard protocol and question bank – one with modules designed to capture the core indicators associated with the emerging field of prevention science [8] – ensure the comparability of results from different countries. GSHS results can be combined with additional data about the social and economic determinants of health, community risk and protective factors, and health outcomes in order to provide an evidentiary foundation for the development of adolescent health policies and interventions [9].

The Pacific Islands are generally considered to include three regions (Melanesia, Micronesia, and Polynesia) that have distinct cultures but the shared experience of living on geographically isolated islands. Polynesia consists of more than one thousand islands scattered across the South Pacific Ocean east of Australia and south of the Equator. The region includes several independent nations and self-governing states (the Cook Islands, New Zealand, Niue, Samoa, Tonga, and Tuvalu) along with several territories, dependencies, and states or collectivities of other nations (such as American Samoa, Easter Island, French Polynesia, Hawaii, Pitcairn Islands, Tokelau, and Wallis and Futuna). To date, four countries from the Polynesian region have participated in the GSHS and made their GSHS datasets available to the public: the Cook Islands, Niue, Samoa, and Tonga. (GSHS data were collected in Tuvalu in 2011 and Tokelau in 2014, but these datasets have not yet been released for general use.) Samoa and Tonga are both independent nations; the Cook Islands and Niue are self-governing nations in free association with New Zealand. Table 1 provides an overview of the demographic and socioeconomic characteristics of each of the four countries featured in this paper.

Few studies of injury epidemiology have been conducted in Polynesia or, more broadly, among small island nations. Drowning (and near-drowning) is known to be a leading cause of unintentional injury for island nations in the Western Pacific

region [1], and the incidence rate of fatal and nonfatal road traffic injuries has been shown to be increasing as more vehicles are on the roads of Pacific Island countries [4,10]. However, few surveys have investigated the incidence of diverse nonfatal injuries in the Pacific, and adolescent injuries have been the focus of few previous analyses.

Residents of island nations may face a particular burden from injuries because of limited access to advanced medical and surgical care [11]. Urbanisation is occurring in parts of Polynesia, but the population is mostly rural, and rural areas may have extremely limited access to professional medical care (in part due to “brain drain,” the outmigration of healthcare workers [12]). Samoa, in particular, has a severe lack of doctors, nurses, and midwives [12]. Limited access to health services may contribute to the health-related quality of life being lower among adolescents in Samoa and other Pacific Islands than in other countries [13]. In this resource-challenged environment, it is important to understand the population-specific threats to health and to identify low-cost, effective interventions. Although most injuries occur unintentionally, the majority of injuries can be prevented.

The specific aims of this analysis were: (1) to determine the proportion of girls and boys attending middle schools in the Cook Islands, Niue, Samoa, and Tonga who sustained a serious but nonfatal injury in the past year, (2) to identify the most common types and causes of these injuries, and (3) to identify risk factors for injuries among boys and girls that might point to effective interventions for reducing injury incidence.

Methods

Sampling and data collection

All GSHS-participating countries follow the same protocol for drawing a nationally-representative sample of middle school students. A two-stage cluster sampling design is used. In the first stage, whole schools are sampled using a probability proportionate to enrolment method. In small countries, a 100% sample of schools with eligible grade levels may be attempted; in larger countries, only a subset of schools are invited to participate in the GSHS. In the Polynesian region, for example, 23 schools from the Cook

Table 1
Characteristics of the four Polynesian countries that participated in the Global School-based Student Health Survey (GSHS) [54–56].

Country		Cook Islands	Niue	Samoa	Tonga
Year of GSHS data collection		2009	2010	2011	2010
Total number of GSHS participants		1274	141	2418	2211
Total number who answered at least one of the three questions about injuries		1207	134	2146	2020
GSHS participants (%) by sex and age (years)	Female	49.2	56.3	51.7	48.8
	Male	50.8	43.7	48.3	51.2
	≤12	8.9	26.2	5.6	4.4
	13	19.2	9.6	19.2	19.3
	14	19.0	11.4	39.9	29.4
	15	17.7	16.8	28.0	33.6
	≥16	35.1	36.0	7.4	13.3
Geography		15 islands grouped into Northern and Southern chains	1 island	2 main islands (Savai'i and Upolu)	More than 170 islands, of which about 50 are inhabited
Land area (km ²)		236	260	2842	747
Total population (2012)		21,000	1,500	189,000	105,000
% Below age 15 (2013)		28.5	24.7	37.8	37.2
% Urban (2013)		74.0	38.8	19.4	23.6
Life expectancy at birth (2012)		76 years	74 years	73 years	71 years
Physicians per 10,000 population (2006–2013)		13.3	30.0	4.5	5.6
Adolescent birth rate per 1000 females (2010)		24	17	44	20
Gross national income (GNI) per capita (US\$, 2010)		12,653	–	3437	4524
% of the population below basic needs poverty line		28 (in 2006)	13 (in 2002)	27 (in 2008)	22 (in 2009)
Per capita total expenditure on health (US\$, 2011)		511	1820	245	219

Islands and 24 schools from Tonga were sampled for the GSHS, and the random sample ensured that schools from multiple islands, including rural and urban areas, were represented [14,15]. All of the sampled schools from the Cook Islands, Niue, and Tonga participated; 83% of sampled schools from Samoa participated. In the second stage, classes from the grades that have the highest proportion of 13- to 15-year-old students are randomly sampled from participating schools. All students in those sampled classes are invited to volunteer to complete an anonymous self-report computer-scannable survey form during school hours. The participation rate among students invited to complete the survey was 84% in the Cook Islands, 81% in Niue, 96% in Samoa (for an overall 79% participation rate after accounting for non-participating schools), and 80% in Tonga. Datasets, questionnaires, codebooks, and other study documents are made available to the public about two years after data collection, and they may be freely downloaded from the CDC and WHO websites.

Injury variables

The main variables of interest in this analysis were the three questions about injuries included in the public-use datasets for all four participating Polynesian countries. The GSHS questionnaire module on injuries includes the definition that “An injury is serious when it makes you miss at least one full day of usual activities (such as school, sports, or a job) or requires treatment by a doctor or nurse.” This definition statement is followed by questions about injury frequency (“During the past 12 months, how many times were you seriously injured?”), injury type (“During the past 12 months, what was the most serious injury that happened to you?”), and injury cause (“During the past 12 months, what was the major cause of the most serious injury that happened to you?”). The wording of the close-ended response items for the injury type and cause questions are provided in the results tables.

Most students provided consistent answers to these questions, with all three responses indicating no injury or all indicating at least one serious injury in the past year. For students with incomplete or inconsistent responses to the injury questions, we cleaned the data in three steps to improve the accuracy of the past-year injury incidence rate estimates. First, we coded any student who recorded zero injuries to the frequency question as having had no injury in the past year and any student who reported one or more injuries as having sustained a serious injury in the past year. Second, any student who was missing an answer for the injury frequency question but answered at least one of the type and cause questions was assigned an injury status based on those other answers. The only exception was if one of the questions had a response of “I was not injured in the past year” and the other indicated that an injury had occurred, in which case no injury status was assigned to the student. Third, any student whose response to the injury frequency question indicated one or more injuries but who answered “I was not injured in the past year” to both the type and cause questions was recoded as having not sustained an injury in the past year. Similarly, any student who reported zero injuries for the frequency question but provided both an injury type and cause was recoded as having sustained an injury during the past year. For the type and cause variables, any injured student missing a response to the item was reclassified as having an “Other” injury type or cause.

Other variables

Being physically attacked in the past year, being in a physical fight in the past year, having no close friends, missing class or school without permission during the past month, and use of tobacco or alcohol were explored as possible risk factors associated with injuries. Students who reported smoking cigarettes or using

other tobacco products during the past 30 days and those who reported trying to quit smoking in the past year were classified as tobacco users; all other students who answered one or more of these questions indicated no tobacco use and were coded as non-smokers. Students who reported ever being drunk and those who indicated that they had consumed alcohol in the past 30 days were coded as drinkers; all others who answered one or more questions about being drunk or drinking in the past month reported no alcohol consumption and were classified as non-drinkers. The GSHS questionnaires listed a variety of types of alcohol and noted that “Drinking alcohol does not include drinking a few sips of wine for religious purposes. A ‘drink’ is a glass of wine, a bottle of beer, a small glass of liquor, or a mixed drink.”

Three additional variables were examined as possibly risky exposures: loneliness, anxiety, and bullying. Students who reported that during the past year they felt lonely most of the time or always and those who were so worried about something that they could not sleep most of the time or always during the past year were classified as having high risk for poor health. Both GSHS bullying questions were used to estimate the prevalence of victimisation by a bully. First, any student who answered the question “During the past 30 days, on how many days were you bullied” with one or more day of bullying was classified as having been bullied. The GSHS questionnaire module explains that “Bullying occurs when a student or group of students say or do bad and unpleasant things to another student. It is also bullying when a student is teased a lot in an unpleasant way or when a student is left out of things on purpose. It is not bullying when two students of the same strength or power argue or fight or when teasing is done in a friendly and fun way.” Second, any student missing a response to the bullying frequency question who answered the question “During the past 30 days, how were you bullied most often?” was assigned a bullying status based on the response to that question. Third, any student who reported being bullied for the frequency question but answered “I was not bullied during the past 30 days” to the question about the type of bullying was reclassified as not having been bullied.

Data analysis

Data analyses were conducted with SPSS and Epi Info, with a significance level of $\alpha = 0.05$. Because of the two-stage cluster sampling method used for recruitment of schools and classrooms, the CDC recommends that complex sample analyses be used when analysing GSHS data [16]. Three variables are provided with each dataset to account for the cluster sampling method and to adjust for minor within-country demographic differences between participants and each country's total population of middle school students: weight, stratum, and primary sampling unit (PSU). All counts reported in this paper are unweighted, but all proportions and statistical tests are weighted. Because the number of GSHS participants from each country is not proportionate to the total population of adolescents in the country – that is, because 1000 GSHS participants might represent nearly all of the middle school students in one country but less than 1% of the student population in another country – GSHS data from multiple countries are not intended to be merged into one dataset for combined analysis. Accordingly, the results in this analysis are presented separately by country. Niue's small number of participants did not provide sufficient statistical power for the calculation of odds ratios for risk factors and injuries, so these results are not presented in the tables.

Results

In total, data from 5507 students from the Cook Islands, Niue, Samoa, and Tonga and were included in the analysis (Table 1). The

total percentage of students reporting an injury in the past year that required medical attention or caused a full day of missed school or other usual activities was 43.1% in the Cook Islands, 40.8% in Niue, 49.1% in Tonga, and a much higher 73.8% in Samoa (Table 2). The proportion of boys reporting an injury in the Cook Islands and Samoa was significantly higher than the proportion of girls reporting an injury in those countries. There were no significant differences by sex in the proportion of students reporting a serious injury in the past year in Niue and Tonga. There were no significant differences in injury incidence rates by age in any of the four countries.

The most common types of injuries reported were skin traumas (cuts and stab wounds) and orthopaedic traumas (broken bones and dislocated joints) (Table 3). In Samoa, the most common types of injuries reported were in the category of “concussions or other head or neck injuries, being knocked out, or being unable to breathe”. However, in all countries a plurality of students did not select one of the specific injury types listed as response options for the GSHS, selecting “other” instead. The most common causes of injuries were falls, either the student falling or something falling on the student. Motor vehicle accidents (as driver, passenger, or pedestrian) and injuries from physical fights, attacks, or abuse were also frequently reported. The reported types and causes of injuries were similar by sex and age.

Several risk behaviours and other exposures were associated with a higher likelihood of reporting a serious injury in the past year (Tables 4 and 5). For both boys and girls, being the victim of a bully in the past month, being physically attacked in the past year, and being in a physical fight in the past year were strongly associated with injuries, even though few of the attacked students indicated that their most serious injury in the past year was due to being attacked. Tobacco use, alcohol use, truancy, anxiety-related insomnia, and loneliness were also associated with injury.

Discussion

The annual injury incidence rates in three of the four GSHS-participating countries from the Polynesian region were about 45%, which is similar to proportions reported in Southeast Asian GSHS countries [17] and in HBSC countries [18]. The 74% incidence rate in Samoa was considerably higher than is typically reported for adolescent health studies, but it is similar to the proportions reported from some African GSHS countries [19]. The reasons for the significantly higher injury incidence rate in Samoa are not readily apparent. Samoa has the largest population of the four countries, but has the lowest income per capita. These factors may contribute to the injury incidence rate in some way. Most injury studies find a higher injury incidence rate among boys [17,19,20], and this was also observed in parts of Polynesia, although in Tonga the injury incidence rates for boys and girls were similar.

Strengths and limitations

A major strength of the GSHS is that the use of standard methods and survey items allows for the direct comparison of participating countries from across the globe. However, there are several limitations in the protocol that may require cautious interpretation of the results in this analysis. The sampling approach is intended to ensure a study population that is representative of all middle school students in each country, but students who are not attending school as a result of a serious nonfatal injury and those who have died because of an injury are not able to participate. Thus, the students who suffered the most serious injuries are not included in this tally, even though those students would make up only a very small proportion of the early adolescents in participating countries. Some bias in the results may also arise from only 79% to 84% of the students in sampled schools

Table 2

Proportion of GSHS-participating students by sex and age who reported that they sustained at least one serious injury in the past year that caused at least one full day of usual activities (such as school, sports, or a job) to be missed or required treatment by a doctor or nurse.

Country	Total % injured	By sex			By age (years)					
		Female	Male	2-sided Chi-square test <i>p</i> -value	≤12	13	14	15	≥16	2-sided Chi-square test <i>p</i> -value
Cook Islands	43.1	39.0	47.1	<0.01	39.9	47.8	43.7	47.9	38.3	0.20
Niue	40.8	40.8	45.7	0.53	50.2	14.8	59.7	47.3	40.0	0.70
Samoa	73.8	67.2	79.9	<0.01	80.9	72.4	71.9	72.3	86.5	0.46
Tonga	49.1	50.5	47.6	0.37	50.6	52.3	46.6	48.4	52.0	0.91

Bolded cells are statistically significant ($p < 0.05$).

Table 3

Type and cause of most serious injury in the past year, by sex and country, among GSHS participants who reported at least one serious injury within the previous 12 months.

		Cook Islands		Niue		Samoa		Tonga	
		Females	Males	Females	Males	Females	Males	Females	Males
Injury type	Cut or stab wound	16.8	21.5	15.2	30.7	13.6	18.0	19.8	21.5
	Broken bone or dislocated joint	14.4	25.0	23.7	22.9	17.8	15.5	11.8	16.9
	Concussion or other head or neck injury, was knocked out, or could not breathe	2.6	5.1	0.0	5.3	18.1	18.0	8.4	8.3
	Gunshot wound	0.4	0.3	0.0	0.0	4.0	6.5	2.5	3.0
	Bad burn	3.1	3.6	0.0	0.0	5.2	6.7	3.8	3.6
	Poisoned or took too much of a drug	0.3	0.6	0.0	0.0	2.5	3.8	1.8	2.4
	Other/type not specified	62.4	44.8	61.1	41.0	38.7	33.2	52.2	44.4
Injury cause	I fell	23.4	16.6	30.7	17.8	17.3	14.9	25.2	25.8
	Something fell on me or hit me	8.5	16.2	24.1	13.8	17.2	19.1	18.2	18.0
	I was in an motor vehicle accident or hit by a motor vehicle	17.6	6.6	12.3	9.5	13.3	17.0	6.4	9.7
	I was attacked or abused or was fighting with someone	4.2	5.9	3.7	4.7	10.7	11.8	8.0	7.0
	I inhaled or swallowed something bad for me	0.4	1.0	0.0	2.6	3.1	3.2	2.5	2.6
	I was in a fire or too near a flame or something hot	1.9	1.2	0.0	0.0	6.3	5.9	1.5	4.5
	Other/cause not specified	43.9	52.4	29.2	51.6	32.1	28.1	38.2	32.4

Table 4

Bivariate associations between various exposures (independent variables) and sustaining a serious injury in the past year (dependent variable) among boys.

	Cook Islands			Samoa			Tonga		
	% of inj.	% of not inj.	OR (95% CI)	% of inj.	% of not inj.	OR (95% CI)	% of inj.	% of not inj.	OR (95% CI)
Bullied in the past month	35.8	22.2	2.0 (1.3, 2.8)	72.9	34.5	5.1 (3.4, 7.7)	58.3	21.0	5.3 (3.5, 7.9)
Physically attacked in the past year	48.0	34.8	1.7 (1.2, 2.4)	80.9	47.7	4.7 (2.5, 8.6)	66.3	30.7	4.4 (3.2, 6.2)
In a physical fight in the past year	45.7	36.8	1.4 (1.0, 1.9)	79.9	49.6	4.0 (2.8, 5.9)	67.7	30.4	4.8 (3.4, 6.7)
Has had more than a few sips of alcohol	54.0	45.0	1.4 (1.0, 2.0)	70.8	28.7	6.0 (3.6, 10.2)	34.9	15.1	3.0 (2.1, 3.2)
Has smoked cigarettes	32.6	22.8	1.6 (1.1, 2.2)	65.0	22.0	6.6 (3.8, 11.5)	40.6	19.8	2.8 (2.0, 3.8)
Missed class or school without permission during the past month	40.8	33.9	1.3 (1.0, 1.9)	68.3	38.4	3.5 (2.3, 5.3)	51.3	24.0	3.3 (2.5, 4.4)
Was so worried about something that most of the time or always could not sleep at night during the past year	11.4	6.0	2.0 (1.2, 3.8)	31.2	12.2	3.3 (2.1, 5.1)	22.4	10.5	2.5 (1.7, 3.5)
Felt lonely most of the time or always during the past year	9.6	4.9	2.0 (1.1, 4.0)	27.8	10.0	3.4 (1.8, 6.5)	22.9	14.9	1.7 (1.2, 2.4)
No close friends	8.0	4.2	2.0 (0.9, 3.7)	16.1	22.2	0.7 (0.4, 1.3)	11.6	8.1	1.5 (0.9, 2.6)

Bolded cells are statistically significant ($p < 0.05$).**Table 5**

Bivariate associations between various exposures (independent variables) and sustaining a serious injury in the past year (dependent variable) among girls.

	Cook Islands			Samoa			Tonga		
	% of inj.	% of not inj.	OR (95% CI)	% of inj.	% of not inj.	OR (95% CI)	% of inj.	% of not inj.	OR (95% CI)
Bullied in the past month	36.6	22.5	2.0 (1.3, 3.0)	74.3	28.7	7.2 (5.1, 10.2)	62.0	22.0	5.8 (4.0, 8.2)
Physically attacked in the past year	47.8	27.3	2.4 (1.8, 3.6)	81.1	45.4	5.2 (3.6, 7.4)	66.8	39.1	3.1 (2.4, 4.1)
In a physical fight in the past year	37.9	22.0	2.2 (1.5, 3.2)	78.2	35.5	6.5 (4.3, 9.8)	64.8	36.7	3.2 (2.4, 4.2)
Has had more than a few sips of alcohol	55.1	45.3	1.5 (1.1, 2.1)	49.2	17.9	4.5 (3.2, 6.3)	29.5	20.2	1.6 (1.2, 2.2)
Has smoked cigarettes	31.5	27.3	1.2 (0.9, 1.9)	50.7	12.6	7.1 (5.0, 10.1)	37.1	25.9	1.7 (1.3, 2.1)
Missed class or school without permission during the past month	43.4	25.0	2.3 (1.7, 3.5)	60.3	30.5	3.4 (2.6, 4.6)	52.3	34.0	2.1 (1.7, 2.7)
Was so worried about something that most of the time or always could not sleep at night during the past year	21.2	9.0	2.7 (1.7, 4.3)	34.7	15.9	2.8 (2.0, 4.0)	17.0	14.0	1.3 (0.8, 1.9)
Felt lonely most of the time or always during the past year	13.4	5.2	2.8 (1.6, 5.3)	25.5	16.0	1.8 (1.3, 2.5)	19.5	11.7	1.8 (1.3, 2.7)
No close friends	3.7	2.6	1.4 (0.6, 3.6)	15.3	16.8	0.9 (0.6, 1.4)	10.0	7.7	1.3 (0.8, 2.1)

Bolded cells are statistically significant ($p < 0.05$).

completing the survey. The GSHS is a self-report survey that is not validated by physical exams, reviews of medical records, parent or teacher surveys, or other approaches. Additionally, the cross-sectional nature of the survey means that it is not possible to explore whether various potential risk factors increased the likelihood of being injured or were adopted after an injury had been sustained.

A validation study in Fiji showed that the behavioural items from the GSHS questionnaire bank have good validity in that country [21], and hundreds of other global GSHS analyses have confirmed the validity of the survey instruments across countries and cultures. However, there are also some weaknesses in the GSHS questionnaire. Students may not have understood the characterisation of a “serious” injury, even though a definition was provided. Some students with only moderate injuries incorrectly may have believed that their level of impairment from an injury met the threshold for being serious. Some students with severe injuries may not have reported them if the injuries occurred when school was not in session so the injuries did not cause school absence. Some students may have inaccurately recalled the month in which a serious injury was sustained, failing to report some past-year injuries or incorrectly reporting injuries that occurred more than one year prior to the survey. Additionally, the most popular answer to the injury type and cause questions was “Other,” so the GSHS provides a limited description of the nature of injuries among early adolescents. Future versions of the GSHS

injury module would benefit from expansion of the number of response categories for the injury type and cause items so that fewer students would need to use the “Other” response. It would also be helpful to add questions that distinguish among various levels of severity, as the risk factors for life-threatening injuries may be different from those for milder traumas. Even so, these GSHS results point toward a set of appropriate injury prevention recommendations for students in the study countries and perhaps also for other Pacific Island youth. The key points are summarised in the following paragraphs.

Falls

Falls were one of the most common injury causes reported in GSHS-participating Polynesian countries and in most previous GSHS studies from across the globe [17,19]. Serious injuries among youth resulting from falls from trees and rooftops and falls into wells have been reported from countries in Polynesia [22]. Some fall injuries may occur while adolescents are engaged in agriculture, fishing, or other work activities. Adolescent falls may also occur during sports practices and games. Rugby is popular in the Polynesian region, and rugby and other sports have relatively high rates of associated injuries [23]. Additionally, natural disasters may be the root of some fall injuries. Tropical cyclones are common in the region. Cyclone Oli inflicted substantial damage on the Cook Islands in 2010 (after the GSHS

was conducted). The region also has some risk of earthquakes, such as the one that caused significant damage to Samoa and Tonga, including some loss of life, in March 2009 (more than one year before either country collected data for the GSHS). Storms and other natural disasters may create fall hazards associated with debris and the need to climb unsafe structures during clean-up. While most falls are unintentional, it is also possible that some were the result of an attack. The Healthy Behaviour and Lifestyle of Pacific Youth (HBLPY) study, which was conducted in Micronesia, Tonga, and Vanuatu, found a high prevalence of relationship abuse inflicted by parents and by boyfriends and girlfriends [20]. Successful interventions for preventing injuries from falls among adolescents might include on-the-job safety training and enforcement, use of protective sports gear, improved emergency response plans, and school-based education about healthy relationships [24].

Road traffic injuries

More than 10% of the injuries among adolescents from the Polynesian GSHS-participating countries were reported to be road traffic injuries (RTIs). All four of the participating countries have laws concerning drunk driving, speeding, and motorcycle helmets, but enforcement is uneven [25]. The Cook Islands, Niue, and Tonga do not have seatbelt, child restraint, or mobile device traffic laws [25]. Many adolescents in the Pacific Islands report rarely or never using seat belts when riding in motor vehicles [26]. Additionally, traffic studies conducted in the Pacific Island region have suggested that risk-taking behaviours, overcrowding of passengers in vehicles, and the popularity of open-backed trucks might contribute to the public health burden associated with RTIs [10,27]. Strengthening transportation laws – including seatbelt and helmet requirements – and enforcing traffic regulations may improve road safety for drivers, passengers, bicyclists, and pedestrians [25,28].

Peer aggression

Bullying is commonly reported by early adolescents participating in the GSHS and the HBSC [29–31]. Victims of bullies report a variety of physical and psychological symptoms more often than their non-bullied peers [31–33]. Based on this GSHS analysis of four countries in Polynesia and a previous study conducted in Micronesia, Tonga, and Vanuatu [20], bullied students may also have a higher likelihood of reporting a serious injury in the past year. Additionally, Polynesian GSHS participants who were physically attacked (that is, those who were victims) and those who were in a physical fight (that is, those who were aggressors) in the past year reported more injuries than their classmates, even though less than 10% of the injured GSHS participants reported that their most serious injury in the past year was related to being attacked or abused or fighting with someone. Other studies of youth have found a similar association between fighting and injuries [19,34]. Much of this excess risk may be attributable to bullied students and those who participate in physical fights engaging in riskier behaviours than non-victims, including more use of drugs and alcohol [31,35–37]. School-based anti-bullying campaigns and those that promote self-esteem and violence-free relationships may help reduce the risk behaviours that lead to injuries.

Mental health

Injured boys and girls participating in the GSHS reported more symptoms of poor mental health than non-injured students. Prospective studies in adult populations have found that depression,

which was not evaluated in the GSHS studies conducted in the Polynesian region, is a risk factor for subsequent unintentional injuries [38,39], and this causal relationship might also be true for adolescents and for other mental health conditions. In the GSHS, students reporting worry-induced insomnia had higher self-reported injury incidence rates than their classmates. Studies conducted on Fiji have found that sleepy drivers have a significantly increased risk of RTIs [40]. Sleep-deprived adolescents have decreased physical and mental health and engage in more risky behaviours than their peers [41], which may increase the risk of injuries. School-based and community-based mental health promotion interventions for adolescents have been shown to be effective at improving student wellbeing [42]. There is a need to develop culturally-appropriate clinical mental health resources for use in Pacific Island communities and to make these resources widely available across the region [43,44].

Substance use

Both injured boys and girls in the four Polynesian GSHS-participating countries were more likely than non-injured students to report using alcohol and tobacco, and these relationships have been consistently observed in other GSHS and HBSC analyses [17,19,45]. Because the GSHS is a cross-sectional survey, it is not possible to determine whether an injured student's risk behaviours or other exposures were present before the onset of the injury and may have contributed to the event or if the injury led to the student adopting riskier behaviours. Other studies have found that substance use increases the likelihood of both unintentional and intentional injuries in young people. Alcohol-related impairment increases the rate of road traffic injuries [10] as well as falls, drownings and near-drownings, and burns [46]. Adolescents using alcohol and tobacco also report more injuries related to violence [18,20]. But it is also possible that some students who were not substance users prior to sustaining a serious injury adopted these unhealthy behaviours after becoming injured, perhaps as a coping mechanism for physical pain; social isolation; mental health issues such as depression, anxiety, and post-traumatic stress disorder; or role changes associated with disability [47]. School-based substance abuse education programs may be a useful component of adolescent injury prevention and rehabilitation efforts. Non-smoking Pacific Island youth report higher confidence and happiness than their peers, so one possible goal of these programs might be to build up the self-confidence and social connections of youth as a protective strategy [48]. To be successful, these health promotion interventions must address individual-level behaviours as well as the community environment [49]. Thus, family-based interventions [50,51] and region-wide efforts to implement culturally-appropriate, evidence-based prevention strategies at the community and national levels [52] may also play an important role in reducing substance abuse and, by extension, decreasing the injury incidence rate.

Conclusions

If each year about half of Polynesian middle school students sustain an injury that causes at least one full day away from usual activities, and about half of the days on the calendar are school days, then approximately one in four students misses at least one day of school annually because of an injury. Some of these boys and girls may be out of school for an extended period of time. The cumulative impact of these short- and long-term absences due to injury-related disabilities may have a significant adverse effect not only on the quality of life of the injured adolescents, but also on their families, classmates, communities, and nations [13].

In Polynesian culture, individual health is considered to be strongly tied to social relationships and spiritual harmony [53]. To be effective, preventive health interventions for injuries related to falls, road traffic injuries, peer aggression, mental health, substance use, and other instigators must be designed around these communal values [53]. School-based health education should equip middle school students with strategies for developing and maintaining self-esteem and confidence, effective interpersonal communication skills, and healthy relationships, in addition to providing instruction about how to prevent injuries, be safe on the road, recognise and seek help for abuse and for mental health disorders, and avoid harmful substances. Schools, clinicians, public health professionals, social workers, police, and other government officials and community servants can work with families, communities, and nations to develop, test, and implement culturally-appropriate, affordable, and effective interventions that address a diversity of threats to adolescent mental and physical health and reduce the risk of serious injuries and related short- and long-term disability among middle school students.

Conflict of interest statement

We have no conflicts of interest to declare.

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