ARTICLE

Multiple Risk Behavior and Injury

An International Analysis of Young People

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Background: Multiple risk behavior plays an important role in the social etiology of youth injury, yet the consistency of this observation has not been examined multinationally.

Objective: To examine reports from young people in 12 countries, by country, age group, sex, and injury type, to quantify the strength and consistency of this association.

Setting: World Health Organization collaborative cross-national survey of health behavior in school-aged children.

Participants: A multinational representative sample of 49 461 students aged 11, 13, and 15 years.

Main Exposure Measures: Additive score consisting of counts of self-reported health risk behaviors: smoking, drinking, nonuse of seat belts, bullying, excess time with friends, alienation at school and from parents, truancy, and an unusually poor diet.

Main Outcome Measure: Self-report of a medically treated injury.

Results: Strong gradients in risk for injury were observed according to the numbers of risk behaviors reported. Overall, youth reporting the largest number (≥5 health risk behaviors) experienced injury rates that were 2.46 times higher (95% confidence interval, 2.27-2.67) than those reporting no risk behaviors (adjusted odds ratios for 0 to ≥5 reported behaviors: 1.00, 1.22, 1.48, 1.73, 1.98, and 2.46, respectively; $P<.001$ for trend). Similar gradients in risk for injury were observed among youth in all 12 countries and within all demographic subgroups. Risk gradients were especially pronounced for nonsports, fighting-related, and severe injuries.

Conclusions: Gradients in risk for youth injury increased in association with numbers of risk behaviors reported in every country examined. This cross-cultural finding indicates that the issue of multiple risk behavior, as assessed via an additive score, merits attention as an etiological construct. This concept may be useful in future injury control research and prevention efforts conducted among populations of young people.

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INJURY IS the leading cause of death in young people.[1] Nonfatal injuries occur at least 1000 times more often than fatal injuries,[2] and their impact, in terms of disability and the costs of treatment, rehabilitation, and lost productivity, is substantial.[3] The etiology of youth injury involves a complex interplay between behavioral and environmental factors. Patterns of injury vary according to demographic factors, including age, sex, residence, and socioeconomic status,[2] all of which are difficult to modify. Consequently, behavioral explanations of the etiology of injury are of interest and may offer hope for prevention strategies.

Risk-taking behavior can be viewed as a vehicle by which adolescents begin to make the transition to adulthood. Biologically based theories attribute risk-taking behavior to genetic predispositions and hormonal and psychosocial changes mediated through pubertal timing.[4,5] Psychological theories suggest that sensation seeking, reflecting a need for varied, novel, and complex experiences, encourages an active willingness to take physical and social risks.[4,6,7] These perceptions and behaviors do not usually occur in isolation,[8] and are often associated with peer group activities.[4,9]

Relationships between adolescent injuries and individual risk behaviors, such as drinking,[10,11] drug use,[12,13] and different types of sexual behavior, have been examined.[14,15] Some research has examined the association between smoking and in-

PARTICIPANTS AND METHODS

The 1998 HBSC is a study of nationally representative samples of adolescents in 29 countries. In each country, a cluster sample design was used, with the school class being the basic cluster. Schools and classes within schools were selected to be representative by age level and regional geography. Three age groups of young people were sampled. Age group levels were "designed to represent the onset of adolescence—age 11; the challenge of physical and emotional changes—age 13; and the middle years when very important life and career decisions are beginning to be made—age 15."[30(p9)] Recommended sample sizes for each country were 1536 students per age group. Sample sizes ensured a 95% confidence interval of ±3% for prevalence estimates, with a design effect of no more than 1.44 in any country.[30] All national samples, with the exception of Israel, were selected to be self-weighting.

Full descriptions of the questionnaire items assessed during 1998 and their development appear elsewhere.[30,31] The overall goal of the HBSC study is to "gain insights into and to increase our understanding of health behaviors, lifestyles and context in young people."[30(p1)] This occurs in part by identifying characteristics of youth that influence their health and well-being. Major categories of variables addressed in the survey include the following: demographics, general health and well-being, family and peer relationships, school environments, exercise and leisure-time activities, diet, substance use, and sexual behavior.[30]

INJURY

Reports describing medically treated injuries were collected in 12 of the 29 countries only: Belgium (Flemish sample), Canada, England, Estonia, Hungary, Israel, Lithuania, Poland, Republic of Ireland, Sweden, Switzerland, and the United States. Injury questions were derived from the 1988 child health supplement to the US National Health Interview Survey[32] and a previous version of the HBSC.[33] Injured youth were defined as those providing a response of 1 or more times to the question: "During the past 12 months, how many times were you injured and had to be treated by a doctor or nurse?" Students then described their single most serious injury, if any. Supplementary questions asked about the nature of the injury (medical sequelae), injury type (eg, sports or fighting related), treatment(s) administered, and number of days lost from school or other normal activities. Using a modified approach to the classification of severity,[34] severe injuries were operationally defined as those leading to 1 or more of the following: (1) 1 or more days missed from school or usual activities, (2) hospitalization overnight, (3) the use of casts or stitches, and/or (4) a surgical operation (these descriptors were only collected in 8 of the 12 countries).

MULTIPLE RISK BEHAVIOR SCORE

A list of health risk behaviors common to adolescents, as suggested by the literature, was compiled from the available questions in the HBSC. The following close-ended items were used (responses in parentheses were interpreted as the presence of the risk factor): smoking,[10,35] "How often do you smoke tobacco at present?" (currently smoking from once a week to daily); drinking,[10,11,15,16,36-38] "Have you ever had so much alcohol that you were really drunk?" (≥1 time); seat belts,[39,40] "How often do you use a seat belt when you sit in a car?" (never, rarely, or sometimes); bullying,[41] "How often have you taken part in bullying other students in school this term?" (more than once or twice); excess time with friends,[31] "How many evenings per week do you usually spend out with your

Continued on next page

jury-related fatalities[16] and between aggressive sporting behavior and injuries.[17,18] Engaging in one form of risk behavior may indicate an increased likelihood to engage in others.[19-21] Increases in adolescent risk-taking behavior have been reported in international trend analyses.[22,23] These increases, together with the association between different types of risk behaviors, have been referred to as "risk behavior epidemics,"[24] "risk syndromes," or "multiple risk activities."[25]

Various approaches to the assessment of risk-taking behaviors in youth have been proposed, and additive risk scores are one such approach. Notable proponents of additive scores include Jessor,[26] who used a social-psychological framework (Problem Behavior Theory) to model proneness to problem behaviors that were consolidated into an additive scale. Others[27] have criticized the use of additive scales and, instead, have created behavioral constructs that are multidimensional. Still others[28] have cautioned that predictive factors are specific to individual behaviors and that the health consequences of risk behaviors are best modeled individually. For youth injury, it is, therefore, unknown how behavioral risk factors should be optimally measured and considered in etiological models. If an additive scale is used, it is also not understood whether the numbers of risk behaviors engaged in are more important than the nature of the individual risks themselves.

Consistent with the theoretical approach of Jessor,[26] a recent analysis of young Canadians[29] showed that the likelihood of youth injury increased in accordance with the number of risk behaviors reported. This supported the use of an additive risk model, but whether this is a universal phenomenon is unclear. The present analysis built on Jessor's theories and this Canadian study by examining associations between risk behaviors and youth injury in 12 countries. *Health Behavior in School-aged Children* (HBSC), a World Health Organization cross-national study,[30] provided the opportunity to explore these associations.

Focused objectives of this international analysis were to examine (1) the strengths and consistencies of associations between individual health risk behaviors and the occurrence of injury between countries and (2) whether risks for youth injury increased in accordance with the number of risk behaviors identified in an additive scale. This was done to provide data that might affirm or re-

friends?" (5-7 evenings); alienation at home,[31] "How easy is it for you to talk to your father/mother about things that really bother you?" (difficult or very difficult for all parents in the home); alienation at school,[31] "I feel I belong at this school." (disagree or strongly disagree); truancy,[42] "How many days did you skip classes or school this term?" (≥2 days); and an unusually poor diet,[37] "How often do you eat or drink cola/sweets/potato chips or crisps?" (at least once a day for all 3).

Some of the preceding factors were selected as risk behaviors that could directly lead to injury. Others were selected as more generic indicators of a risk-taking lifestyle. Although there were several additional risk behaviors that optimally could have been included in the score (illicit drug use, nonuse of bicycle helmets, and unprotected sex), these were not assessed by most participating HBSC study countries. The 9 available risks were combined into an unweighted multiple risk behavior frequency score. Because of their low relative frequency, scores from 5 to 9 were collapsed subsequently into a single category, leaving 6 levels (0 to ≥5 behaviors).

COVARIATES

Factors selected as potential confounders were age (in years), sex, socioeconomic status (5 categorical responses to the following: "How well-off do you think your family is?"), country of origin, and, because sports injuries are common among youth, hours of sports activity or exercise per week outside of normal school hours (0 to >7). This list was based on previous analyses[29] and exploratory analyses for colinearity within the international HBSC data set.

STATISTICAL ANALYSES

Analyses were initially conducted within individual countries for comparative purposes. Correlation analyses were used to examine the strengths of associations between individual risk factors contained in the multiple risk behavior score. Internal consistency analyses were performed by country, using Kuder-Richardson formula 20 (range, 0-1.0; with a score of >0.6 viewed, conservatively, as acceptable) and computer software (Statistical Product and Service Solutions; SPSS Inc, Chicago, Ill). This was done to explore the reliability of the multiple risk behavior score and the individual high-risk behaviors used to construct the score.

The etiological analysis was conducted in 2 stages. First, unconditional logistic regression (the conventional form for unmatched data analyses) was used to examine each high-risk behavior (individually) as a potential risk factor for injury. Second, the same analytical technique was used to examine the strength of associations between the additive risk score and the occurrence of youth injury. For the individual risk behavior and additive score analyses, crude and adjusted odds ratios (ORs) and associated 95% confidence intervals were calculated for each level of exposure compared with baseline (the referent level: multiple risk behavior score of 0).

Because consistent findings were obtained from the 12 countries, a combined logistic regression analysis was then performed using the overall sample. This involved calculation of adjusted ORs for each level of the multiple risk behavior score relative to baseline, controlling for the 5 covariates identified a priori, including country of origin. Stratified analyses were then performed to examine the consistency of the risk estimates by sex and age group. Restricted analyses were conducted to examine variations in risks for severe, nonsevere, sports, nonsports, and fighting-related injury.

All data management was performed using computer software (Excel 97; Microsoft, Redmond, Wash). The statistical analyses were conducted using computer software (Statistical Product and Service Solutions).

fute the importance of the multiple risk concept for studies of youth injury. It also explored whether use of the additive risk score was helpful when applied to a large international sample of young people and an etiological study of youth injury.

RESULTS

A total of 50691 youth in the 12 countries responded to the injury questions, and 49461 completed records were considered in the final analysis. There were variations between countries in the types and numbers of health risk behaviors reported and the prevalence of medically treated and severe injuries (**Table 1**). Strong variations were observed between countries for the following behaviors: excess drinking, nonuse of seat belts, bullying, excess time spent with friends, an unhealthy diet, and truancy. There was considerably less variation between countries in the numbers of health risk behaviors reported by youth.

The internal reliability of the additive scale varied between countries (Kuder-Richardson formula 20 range, 0.50 [Estonia] 0.63 [Sweden]). The inspection of the corrected item-total correlation for the different risk behaviors showed rather modest correlations ($\rho<0.50$).

Adjusted ORs that describe risks for injury associated with individual risk behaviors were all larger than unity (OR>1.0) (**Table 2**). Risk estimates that were consistently higher were associated with smoking, drinking, and bullying; yet, even these ORs were modest. Within each country, risks for injury increased in accordance with the multiple risk behavior score (**Table 3**). Because all crude ORs calculated were within the bounds of the associated adjusted confidence intervals, only adjusted ORs are presented in Tables 2 and 3. These results suggest the presence of fairly strong associations between the additive risk score and the occurrence of injury.

A graphical summary of the combined analysis of data from the 12 countries (**Figure 1**) shows the overall gradient in risk for injury associated with the numbers of risk behaviors reported ($P<.001$ for trend). The risk gradients were also observed among male and female subjects and within each of the 3 age groups. A stronger risk gradient was observed for severe vs nonsevere

injuries, nonsports vs sports injuries, and injuries attributable to fighting (**Figure 2**).

COMMENT

This international analysis of young people found that the risk for reported injuries increased in direct association with increasing frequency of reported risk behaviors. These gradients were observed in the combined multinational analysis; within young people from every country that collected these data (12 of 12 countries); in the restricted analyses of severe, nonsevere, sports, nonsports, and fighting-related injuries; and within all demographic strata defined by age and sex. The gradients were observed with and without adjustment for potential confounders, including indicators of socioeconomic status. Consistency across countries with different cultures suggests that this is a robust finding for affirming the relationship between risk-taking behavior and injuries.

There are several reasons why youth engage in risk behaviors. One reason is that risk-taking behavior represents a means by which independence can be asserted.[4] The extent of this independence seeking is influenced by individual personality and cultural norms that imperil or protect the growing child.[38,43] Personal behavior is influenced by peers, parents, the school, and the neighborhood in which adolescents reside.[44] Normative behavior may be related to protective concepts of social capital, including social networks, civic responsibility, perceptions of resources, and local identity.[45] The ability to predict health outcomes, such as injury from risk behavior alone, is tempered by these protective factors.[46]

Risk behavior may also be of social benefit to the growing adolescent. Experimentation is normal and reflects a willingness on the part of the adolescent to move away from dependence on family to a peer orientation. Problem Behavior Theory and Primary Socialization Theory[47] postulate that adolescent risk taking largely takes place within peer groups that provide a means of social support. Further understanding is required about the positive impacts of these social networks. The negative impacts of risk-taking lifestyles include elevated long-term risks for cardiovascular disease, cancer, and other debilitating illnesses. Our findings show that risk behaviors also have more immediate consequences in terms of injury, irrespective of the country and related cultural setting. Although associations were stronger for certain types of injury, the general association between numbers of behaviors and risk for injury was consistently positive.

Our analysis was unique in that we used a multiple risk behavior score to predict a negative health outcome: injury. While the dimensions and structure of adolescent risk-taking behavior still need to be identified, it may be fruitful to include additional risk behaviors, rather than fewer, in such indexes. Furthermore, behavioral risks may be grouped into categories, such as (*a*) active risk seeking: consumption of alcohol or tobacco or bullying; (*b*) passive safety and health risk seeking: lack of seat belt use or adherence to a nutritious diet; and (*c*) independence seeking and/or nonsupportive environments: alienation from parents or school, truancy, or excess time spent with friends. These groupings of risk behaviors need to be confirmed in other contexts using formal statistical techniques (such as factor analyses). Associations between the multiple risk index and other health outcomes, both positive and negative, require similar confirmation.

Table 1. Frequency Distribution of Respondents Reporting the Presence of Selected Health Risk Behaviors and Injuries

Variable	% of Respondents Within Countries*		
	Median	Minimum	Maximum
Health risk behavior			
Type			
Smoking	18	12	20
Excess drinking	26	18	45
Nonuse of seat belts†	26	11	49
Perpetrator of bullying	14	4	34
Excess time spent with friends	16	5	28
Alienation			
At home	20	11	23
At school	16	11	29
Unhealthy diet	11	4	38
Truancy‡	15	3	35
No. of behaviors			
0	24	18	50
1	27	24	29
2	20	11	23
3	13	7	17
4	8	4	10
≥5	7	4	10
Injury			
≥1 Medically treated injury	39	24	48
Severe injury§	16	9	28

*Percentages are based on the median and range of results for individual countries.
†Data not available for Switzerland.
‡Definition varies for Switzerland.
§Data not available for 4 countries.

Our findings provide indirect support for the targeting of multiple forms of risk behavior simultaneously in health interventions. By themselves, individual risk behaviors may be only modestly associated with poor health outcomes because they may be mere markers for the development of a more involved behavioral complex. Our results suggest that, rather than the individual risk behaviors that are engaged in, what seems to be important is the total number of different risk behaviors that are experienced. The latter may be more important in the etiology of injury, especially if they eventually lead to overt risk-taking behaviors, such as physical abuse or impaired driving. A failure to address concurrent forms of risk behavior in interventions may lead to naive preventive strategies.

Common forms of bias warrant consideration as explanations for the observed associations. The population-based nature of the samples limited the extent to which selection bias could account for the gradients. The multivariate analysis simultaneously

Table 2. Logistic Regression Analysis Examining Associations Between Individual Health Risk Behaviors and Youth Injury*

Health Risk Behavior	Belgium (Flemish Sample) (n = 4361)	Canada (n = 6110)	England (n = 5288)	Estonia (n = 1624)	Hungary (n = 3238)	Israel (n = 3736)†	Lithuania (n = 3965)	Poland (n = 4606)
Smoking	1.73 (1.45-2.07)	1.74 (1.51-1.99)	1.62 (1.39-1.89)	1.57 (1.14-2.16)	1.43 (1.18-1.74)	1.41 (1.16-1.71)	1.59 (1.31-1.93)	1.51 (1.26-1.82)
Excess drinking	1.73 (1.47-2.03)	1.88 (1.66-2.12)	1.57 (1.38-1.78)	1.49 (1.17-1.91)	1.61 (1.32-1.95)	1.53 (1.28-1.83)	1.53 (1.32-1.77)	1.40 (1.20-1.64)
Nonuse of seat belts	1.05 (0.91-1.21)	1.36 (1.16-1.59)	1.07 (0.94-1.22)	0.95 (0.76-1.20)	1.03 (0.87-1.20)	1.09 (0.95-1.24)	1.14 (0.99-1.32)	1.45 (1.24-1.69)
Perpetrator of bullying	1.17 (1.00-1.38)	1.69 (1.46-1.96)	1.29 (0.95-1.76)	1.10 (0.85-1.43)	1.38 (1.12-1.69)	1.59 (1.32-1.92)	1.37 (1.20-1.58)	1.53 (1.25-1.87)
Excess time spent with friends	1.22 (0.98-1.52)	1.29 (1.15-1.46)	1.25 (1.11-1.42)	1.22 (0.97-1.54)	1.25 (0.95-1.65)	1.29 (1.09-1.53)	1.68 (1.37-2.07)	1.41 (1.17-1.69)
Alienation								
At home	1.16 (0.98-1.37)	1.10 (0.97-1.25)	1.10 (0.93-1.30)	1.04 (0.81-1.33)	1.22 (0.97-1.54)	1.09 (0.91-1.29)	1.08 (0.91-1.28)	1.19 (0.98-1.44)
At school	1.26 (1.08-1.46)	1.19 (1.04-1.37)	1.35 (1.15-1.59)	1.55 (1.13-2.14)	1.14 (0.94-1.40)	1.13 (0.94-1.36)	1.10 (0.93-1.32)	1.43 (1.17-1.74)
Unhealthy diet	1.30 (1.00-1.70)	1.41 (1.17-1.70)	1.18 (1.05-1.33)	1.38 (0.98-1.95)	1.22 (0.98-1.52)	1.33 (1.14-1.55)	1.24 (0.99-1.55)	1.36 (1.15-1.62)
Truancy	1.59 (1.07-2.35)	1.70 (1.50-1.93)	1.34 (1.12-1.61)	1.98 (1.46-2.68)	1.55 (1.21-2.00)	1.03 (0.89-1.20)	1.56 (1.36-1.80)	1.64 (1.37-1.96)

*Data are given as adjusted odds ratio (95% confidence interval). The odds ratios were simultaneously adjusted for age, sex, socioeconomic status, and physical activity.
†Weighted sample.
‡Data not available.
§Definition of truancy varies.

Table 3. Adjusted Logistic Regression Analysis for Health Behaviors and Youth Injury*

No. of Health Risk Behaviors	Belgium (Flemish Sample) (n = 4361)	Canada (n = 6110)	England (n = 5288)	Estonia (n = 1624)	Hungary (n = 3238)	Israel (n = 3736)†	Lithuania (n = 3965)	Poland (n = 4606)
0§	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	1.38 (1.12-1.69)	1.35 (1.16-1.56)	1.17 (0.99-1.38)	1.15 (0.86-1.55)	1.14 (0.95-1.36)	1.21 (0.98-1.49)	1.31 (1.07-1.62)	1.34 (1.11-1.63)
2	1.42 (1.15-1.77)	1.58 (1.34-1.85)	1.47 (1.23-1.75)	1.02 (0.74-1.42)	1.38 (1.12-1.71)	1.50 (1.21-1.86)	1.68 (1.36-2.07)	1.68 (1.36-2.08)
3	1.78 (1.40-2.26)	2.04 (1.69-2.46)	1.68 (1.38-2.06)	1.32 (0.92-1.89)	1.42 (1.09-1.85)	1.49 (1.18-1.88)	2.21 (1.75-2.78)	1.92 (1.50-2.46)
4	1.75 (1.31-2.34)	2.18 (1.76-2.71)	2.03 (1.61-2.54)	1.82 (1.20-2.76)	1.80 (1.28-2.53)	1.80 (1.36-2.38)	2.38 (1.81-3.11)	2.21 (1.65-2.96)
≥5	2.38 (1.76-3.21)	2.93 (2.36-3.65)	2.14 (1.67-2.76)	2.46 (1.54-3.93)	1.93 (1.34-2.80)	2.07 (1.55-2.77)	2.55 (1.92-3.39)	2.81 (2.11-3.74)

*Data are given as adjusted odds ratio (95% confidence interval). The odds ratios were simultaneously adjusted for age, sex, socioeconomic status, and physical activity. $P<.001$ for trend for all countries.
†Weighted sample.
‡Index based on the results of 8 health risk behaviors.
§Reference.

adjusted for the influence of some confounders, although it was limited to those that were measured and the self-reported manner in which they were assessed. It is possible that the results were enhanced because of the simultaneous conscientious overreporting of risk behavior and injuries by some adolescents, a form of recall bias. Yet, the associations were strong and consistent multinationally, despite the fact that countries varied in social and cultural factors that might influence reporting inaccuracies. A further limitation is the focus on only 1 of possible multiple injuries reported by youth in the previous 12 months. This is most likely to bias the ORs and gradients toward unity,[29] meaning that the results presented are conservative.

The additive risk score used herein is admittedly at an early stage of development. The score itself and our approach to analysis were developed using conventional epidemiological methods and the rationale espoused by an existing behavioral model.[26] Formal factor analyses were not used during its construction, and the measures of reliability conducted suggest that there is room for improvement. Correlation between types of behavior contained in the score also might not be sufficiently high to fulfill criteria for reliability when com-

Republic of Ireland (n = 3914)	Sweden (n = 3329)	Switzerland (n = 4707)	United States (n = 4583)
1.90 (1.61-2.26)	2.01 (1.62-2.50)	1.60 (1.36-1.88)	1.58 (1.35-1.84)
1.89 (1.61-2.22)	2.01 (1.66-2.4)	1.88 (1.60-2.21)	1.55 (1.35-1.79)
1.20 (1.04-1.38)	1.45 (1.15-1.82)	‡	1.07 (0.93-1.24)
1.99 (1.50-2.64)	2.09 (1.46-3.01)	1.31 (1.14-1.50)	1.43 (1.21-1.69)
1.37 1.19-1.59)	1.55 (1.27-1.89)	1.28 (0.98-1.67)	1.11 (0.95-1.29)
1.28 (1.09-1.49)	1.16 (0.93-1.43)	1.05 (0.91-1.22)	1.07 (0.93-1.24)
1.28 (1.07-1.52)	1.74 (1.38-2.19)	1.08 (0.94-1.24)	1.30 (1.13-1.49)
1.37 (1.20-1.57)	2.47 (1.68-3.61)	1.16 (0.92-1.46)	1.05 (0.91-1.22)
1.83 (1.53-2.20)	2.77 (2.20-3.48)	1.50 (1.27-1.77)§	1.19 (1.03-1.37)

Republic of Ireland (n = 3914)	Sweden (n = 3329)	Switzerland (n = 4707)‡	United States (n = 4583)
1.00	1.00	1.00	1.00
1.39 (1.12-1.71)	1.47 (1.23-1.77)	0.92 (0.79-1.06)	1.19 (1.00-1.42)
1.63 (1.31-2.02)	1.68 (1.31-2.15)	1.42 (1.19-1.69)	1.31 (1.09-1.57)
1.71 (1.35-2.17)	2.36 (1.76-3.17)	1.70 (1.36-2.12)	1.51 (1.23-1.86)
2.69 (2.04-3.55)	3.49 (2.43-5.01)	1.62 (1.23-2.14)	1.47 (1.16-1.85)
3.84 (2.92-5.04)	4.42 (2.95-6.63)	2.12 (1.53-2.93)	2.10 (1.65-2.68)

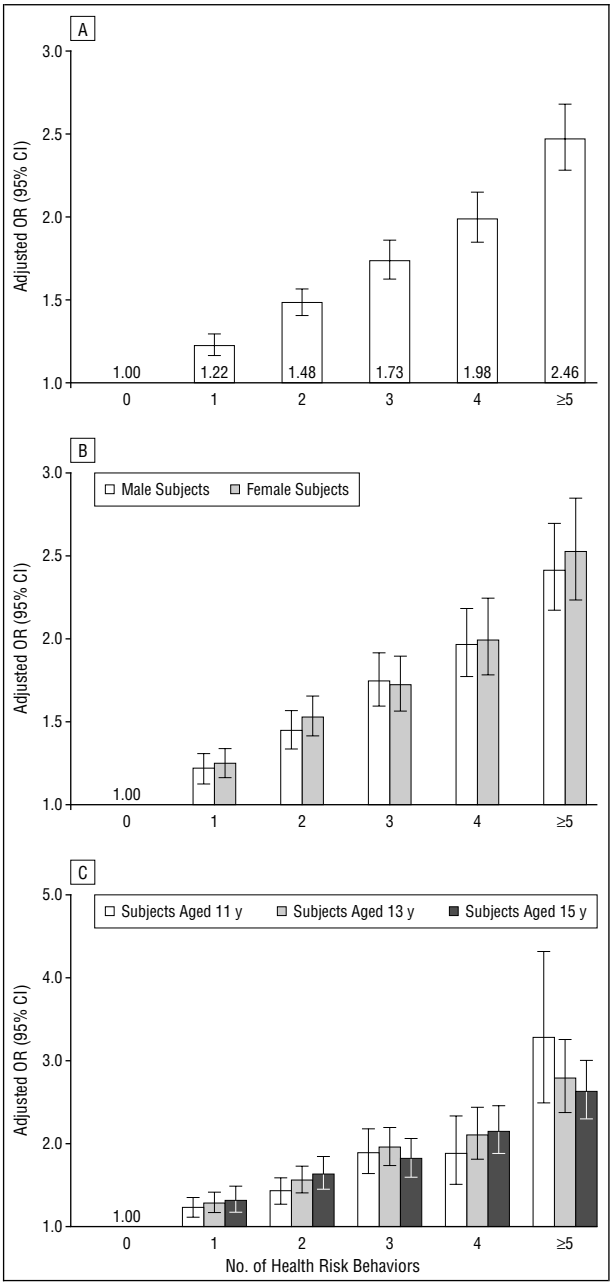

Figure 1. Associations between numbers of health risk behaviors and youth injury: combined 12-country analyses. A, Overall. B, By sex. C, By age. The ORs are simultaneously adjusted for age, sex, socioeconomic status, physical activity, and country. OR indicates odds ratio; CI, confidence interval.

pared with the psychometric theory and associated standards. The associations identified using our score were, however, consistent and robust. We would argue that the basic concept (if not the scale) has considerable potential for etiological research.

CONCLUSIONS

The associations between risk behavior and injury are intriguing, although it would be premature to suggest that they are causal. The observed associations were strong and statistically significant, followed a gradational pattern of risk, and were consistent with human theory that attests to their plausibility. The fact that the similar associations were found across countries and cultures provides evidence in support of a common etiology to these injuries. Furthermore, the strong and consistent nature of these associations suggests that the additive risk score model of risk behavior, while admittedly at an early stage of development, has promise. Based on these findings, we conclude that the issue of multiple risk behavior, as assessed via an additive score, merits attention as an etiological construct. The latter may be useful in future injury control research and

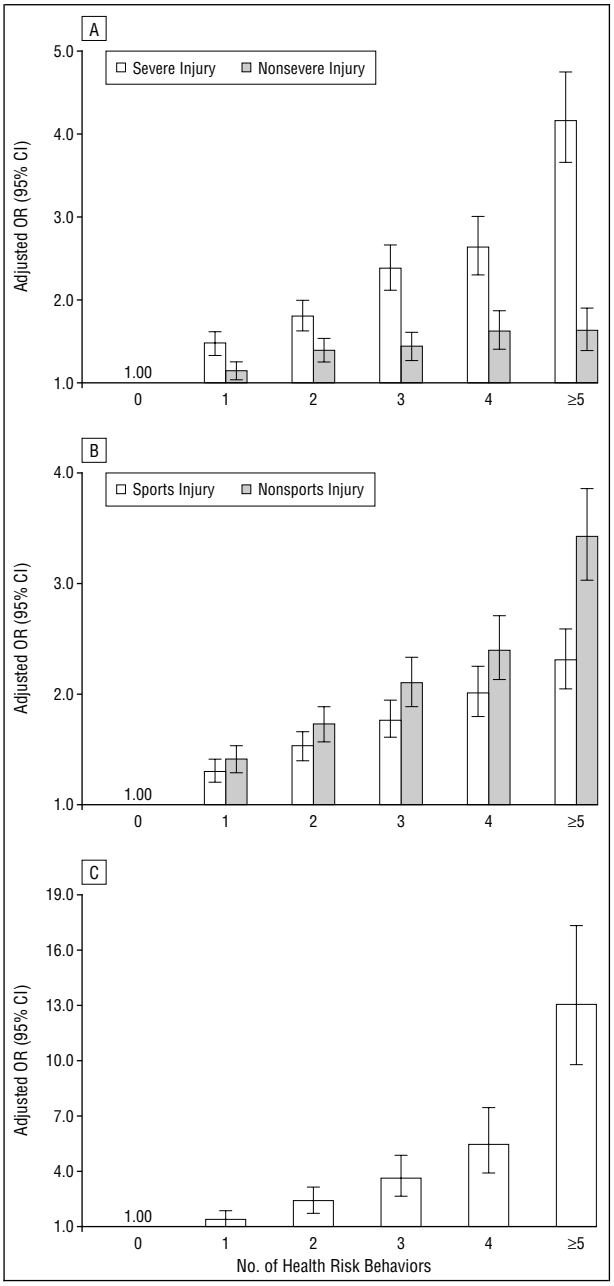

Figure 2. Associations between numbers of health risk behaviors and youth injury: analyses restricted to specific injury types. A, By injury severity. Data not available for 4 countries. B, By sports involvement. Data not available for 2 countries. C, Fighting-related injuries. Data not available for 3 countries. The ORs are simultaneously adjusted for age, sex, socioeconomic status, physical activity, and country. OR indicates odds ratio; CI, confidence interval.

prevention efforts conducted among populations of young people.

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What This Study Adds

Increases in adolescent risk-taking behavior have been reported internationally. The immediate health consequences associated with these behaviors are poorly understood, although there is some suggestion that they lead to elevated risks for injury. Whether this is a universal phenomenon is unclear.

The present study examined associations between adolescent risk-taking behavior and risks for injury among 49 461 youth in 12 countries. Strong gradients in injury risk were observed in association with the number of risk-taking behaviors reported. This was true in all 12 countries and for all demographic subgroups and injury types examined. Based on these findings, we conclude that the issue of multiple risk behavior, as assessed via an additive score, merits attention as an etiological construct.

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