Risk factors for upper limb fractures due to unintentional injuries among adolescents: a case control study from Sri Lanka

Hemali Jayasekera (hemalisenatilleke@gmail.com)
Ministry of Health
Samitha Siritunga
Ministry of Health
Upul Senarath
University of Colombo
Paramjit Gill
University of Warwick

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Abstract

Background

Injuries are the number one cause for morbidity and mortality among adolescents. Adolescent fractures are a hidden public health problem in Sri Lanka. Upper limb fractures are common in adolescents due to various risk factors. Many injuries are predictable and can be prevented by identifying the risk factors. The aim of the study was to determine the risk factors for upper limb fractures among adolescents in Sri Lanka.

Methods

A case control study was undertaken with 450 cases and 450 controls. Cases were recruited consecutively from six major hospitals from the adolescent victims who had admitted with newly diagnosed upper limb fractures and controls were apparently healthy adolescents from the same district and excluded previous upper limb fractures. Risk factors for upper limb fractures were assessed by odds ratio (OR) with 95% confidence interval (CI) and adjusted for possible confounding by performing logistic regression analysis.

Results

The mean age of the cases was 13.62 years with a Standard Deviation (SD) of 2.8 and controls was 12.75 years (SD = 2.7) respectively. Having a high standard of living index (OR = 3.52; 95%CI: 2.3–5.2), being in a high social class category (social class I & II) (OR = 2.58, 95%CI: 1.7–3.92), engage in physical or sports activity (OR = 9.36; 95%CI: 3.31–26.47), watching television (OR = 1.95; 95%CI: 1.18–3.22), playing video or computer games (OR = 2.35; 95%CI: 1.7–3.24), and attending extra classes (OR = 1.82; 95%CI: 1.2–2.7) were risk factors for having a upper limb fracture.

Trial registration: N/A

Background

Injuries are the number one cause of morbidity and mortality among adolescents. Fractures have been identified as a major consequence of injuries and fractures of the limbs significantly limit their functional capacity. It can lead to reduced productivity and quality of life of adolescents. They belong to economically productive age group in a country as such prevention of injuries among adolescents will be an investment for a developing country [1]. Adolescents have to live in a world with potential hahzards as adults design and produce products for their own use [2].

Fractures are common public health problems among children and adolescents all over the world [3]. According to the WHO, the overall fracture rate was 32.4% of the unintentional injuries among children under 15 years of age [1].

Upper limb fractures caused by injuries account for 80% of all fractures. This has been contributed to a significant level of morbidity and mortality [4]. “Types of fractures depend on the magnitude and direction of the force” [5]. At different ages during the growth period, the type of fracture varies due to changes in bone composition [6].

There is an increase in the tendency to sustain a fracture in children and adolescents under the age of 19, although most of these patients are generally healthy [3]. Stark et al. [7] revealed that the poor socio-economic status associated with adolescent fractures. Goulding stated that genetic factors, lack of exercise, obesity, poor nutritional status, and exposure to trauma were the main risk factors involved in sustaining a fracture in this age group [8]. He also pointed out that fracture rates were gradually increasing among adolescents due to environmental changes which was a result of urbanization in the recent past.

A cross sectional study design was carried out **in out patient clinics of** the **Department of Orthopedics and Traumtology** in a **children’s hospital** situated in the southern region of **Italy revealed that** adolescent **males were** more prone to fractures than adolescent females **($p < 0.001$)** [3]. cohort study design was carried out in Australia among hospitalized patients revealed that the risk of having a fracture increased gradually from the age of 12 to the age of 19 in males and vice versa in females [9]. This study also revealed that the cumulative risk of having at least one fracture following an injury was 11.8% in males and 6.3% in females. Further, in a study carried out in Emergency Departments of United States revealed that unintentional injuries were high among males, in people with low socioeconomic status, and among 15 to 19 years age group [10]. An epidemiologic review stated that the rate of disability among children and adolescents following unintentional injuries was three times higher in low- and middle-income countries compared to that of high-income countries [11].

The relationship between socioeconomic status and adolescent fractures were highly significant in a study carried in Scotland. The study was carried out with weighted linear regression analysis and fracture incidence in adolescent males ($p = 0.1$) and adolescent females ($p < 0.001$) [12]. Jeddi et al. [13] determined risk factors among adolescents in Iran with a cross sectional population-based study. By logistic regression analysis, the study revealed that sex was a significant risk factor ($p = 0.003$). Further, male to female ratio of fracture was 1.89 and one third of adolescents were in 13 to 15 years age group.

A population-based case control study with multivariate analysis done in Southern Tasmania showed that participation in light physical activity decreased the risk of fractures (OR = 0.8, 95%CI: 0.7-1.0) among adolescents [14]. Clark had revealed that children in the United Kingdom engaging in daily vigorous physical activity had double the risk (OR, 2.06; 95% CI:1.21–1.76) of sustaining a fracture [15]. Further, the study carried out in Tasmania also revealed that time spent on television, computer, and watching videos in both sexes was significant, and there was a 1.6-fold risk of succumbing to wrist and forearm fractures in both sexes (OR = 1.6; 95%CI; 1.1–2.2) [14].

A study done on patients who were treated at orthopedic post-surgical clinics in a tertiary care hospital in Sri Lanka revealed that the commonest cause of sustaining a fracture was a fall. The study had revealed

that 35.8% of patients with fractures following injuries were children and adolescents. Upper limb fractures were the commonest type of fractures (83.2%) seen among adolescents in Sri Lanka [16]. Since published data was not available in the local context to identify the risk factors and the burden of upper limb fractures among adolescents, the current study filled this gap in the body of knowledge. Prioritization of strategies with regard to primary prevention will ease the economic burden since Sri Lanka is still a developing country.

Main objective of the present study was to determine the risk factors for upper limb fractures due to non-road traffic injuries among adolescents aged 10 to 19 years attending selected government hospitals in the district of Colombo, Sri Lanka.

Methods

A case control study was performed to determine the risk factors for adolescent's upper limb fractures with cases recruited consecutively from hospitals and a control group recruited purposively from the community by matching the socio-economic background as cases. The study was conducted in the district of Colombo, in Sri Lanka among adolescents attending Accident Services Units (ASU) or Primary Care Units (PCU) of six major hospitals in the above district during 2018 to 2019.

Selection of cases

Cases were adolescents aged 10 to 19 years who resided in the district of Colombo for the last one year, and who had been admitted to a tertiary or secondary care hospital in the same district with a newly diagnosed upper limb fracture based following an unintentional injury. Adolescents who were in intensive care unit with severe trauma at the time of data collection, adolescents with pathological fractures and adolescents who had existing functional disabilities were excluded from the study. Cases were identified from the admission registers of the ASU or PCU of the hospitals with the assistance of the clinical specialists. However, adolescents with upper limb fractures due to road traffic accidents were excluded from the study since they had different set of risk factors as found in previous litrature [17].

Selection of controls

Apparently healthy adolescents who did not have any documentary evidence of an upper limb fracture in the past and resided in the same district more than one year period was defined as controls. A control was selected to match a case with their sociodemographic background with the assistance of public health staff in a Medical Officer of Health (MOH) area from an updated eligible family register [7, 8]. Public Health Midwife (PHM) who was a grass root level health care officer in Sri Lanka assisted data collectors to select a control to match a case. Adolescents who were critically ill and adolescents found to have had an upper limb fracture in the past were excluded.

Sample size calculation

The sample size for cases (n = 450) and controls (n = 450) for univariate analysis was calculated by ratio of one control per case with 5% significance level, beta error of 0.2 and adding 5% for non-response rate to detect the smallest risk (odds ratio of 1.5 for participation of sports on upper limb fracture [14] and 29% incidence rate of the risk factor among the community controls in a study carried out in Tasmania. The authors could not find any published literature from Sri Lanka to match for the local setting.

Study variables and validated questionnaires used in the study

The principal investigator (PI) developed a conceptual framework using previous literature to identify potential risk factors during the design stage [18–20]. An interviewer administered questionnaire was formed with the assistance of expert group to collect data on sociodemographic characteristics and potential risk factors of upper limb fractures from both cases and control groups. These included factors related to personal (age, sex, ethnicity, level of education, whether living with a parent or caregiver), socio economic status, lifestyle and leisure time related activities, social habits including smoking and alcohol consumption, engagement in sports, athletics, physical activities and exercise, predisposing factors including episodes of fasting and previous epilepsy [8] and consumption of food including milk. Father's or caregiver's occupation was used as a tool to assess the social class of the family using previously validated instrument [21] and it was used to assess the social class of the participant using a scoring system. Standard of living index was assessed using a separate instrument which was developed and validated for the local set up [21]. Each response was given a score on a previously decided weighted scoring system and the participants were categorized under high, or low standard of living accordingly.

A Global School Based Student's Health Survey for adolescents was conducted in 2016 in Sri Lanka [18]. The instrument used for that survey was validated and culturally adopted. The lifestyle related factors and violence related activities were assessed by using GSHS instrument. A guideline developed by the Ministry of Sports in Sri Lanka was used by authors to assess the risk factors associated with sports or athletics, physical activities, and exercise related activities in this study. It had been developed to assess the sports related activities or physical activities and sedentary behavior specifically for adolescents to suit for the local context [22].

The instrument used in the study to determine the risk factors for adolescent's upper limb fracture was a pre coded interviewer administered questionnaire. The judgmental validity was assessed by an expert panel including Orthopedic Surgeons, Pediatric Surgeons, Consultant Community Physicians and General Surgeons. The instrument was piloted in a different setting prior to the main study.

Following the appraisal of validity, a team of pre intern medical graduates were trained by the principal investigator to collect data from the cases and controls separately. Informed written consent was obtained from the eligible participants and their parents or caregivers before recruiting as study participants. All the measures were taken to improve the quality of data.

Operational definitions used for each variable in the study are given in Table 1.

Table 1
List of variables and operational definitions.

Term	Definition used in the study
Social class	Social class was determined by father's occupation according to the following categorization [23]: Social class 1 - Leading professions (Professional and Managerial) Social class 11 - Lesser professions and businessmen (Teacher) Social class 111 - Skilled workers and non-manual workers (Armed forces, Police, Clerks, Shop keepers) Social class 1V- Partly skilled workers (Farmer, Estate worker, Skilled laborer Social class V – Unskilled workers - Elementary occupation High social class - Combination of social class I and II Low social class – Combination of social class III, IV and V
Permanent resident	Adolescent residing for one year period in the same Grama Niladhari division in the district of Colombo
Adolescent	Age 10–19 years old children
Newly diagnosed	A person who is diagnosed for the first time with documentary evidence and radiological investigation to have upper limb fracture within one week following an injury
Care giver	A person who provides ongoing care and assistance without any payment for a family member or a friend who needs support due to physical, cognitive or mental health condition
Unintentional injury	The events caused without the intention of any person / party/ group or community and those are not inflicted by deliberate means
Transport accidents	Any accident occurred due to involvement of a vehicle during any mode of transportation involving land transport accidents such as avenues, streets, roads, highways, express way, air transport accidents, and water transport accidents. The victim may either be the vehicle occupant or others exposed to accident
Physical activity	Any bodily movement produced by skeletal muscles that requires energy expenditure [22]
Physical exercise	Physical exercise is a subcategory of physical activity that is planned, structured, repetitive and purposeful in the sense that the improvement or maintenance of one or more components of physical fitness is the objective. Physical activity includes exercise as well as other activities which involve bodily movement and are done as part of playing, working, active transportation, house chores and recreational activities [22]
Sport	An activity involving physical exertion, skill and/or hand-eye coordination as the primary focus of the activity with elements of competition where rules and patterns of behavior governing the activity exist formally through organizations

Data analysis

The Statistical Package for Social Sciences (SPSS) version 20.0 was used for data analysis. A probability value less than 0.05 was taken as the level of significance. An unadjusted odds ratio (OR) with a 95% confidence interval was calculated to assess the strength of each variable acting as a risk factor. To carry out the analysis of the case control study, logistic regression (LR) analysis was used. The independent variables were selected at the 0.05 significance level. Variables at the 0.1 significance level were removed. The dependent variable in the LR model was presence or absence of upper limb fracture. The model with the best “goodness of fit” was selected as the final model. Goodness of fit of the model was assessed by the overall percentage of the prediction of having a fracture, the Chi squared test, Hosmer and Lameshow test, Omnibus test, Cox and Snell Square test and Negelkerke R^2 tests. The model showed a significant goodness of fit statistic (Hosmer and Lemeshow $\chi^2 = 18.10$; df = 8; p = 0.02).

Results

The study sample consisted of 450 cases and 450 controls. The response rate of the sample was 99.6%. The mean age of the cases was 13.62 years (SD = 2.8) and the mean age of control was 12.75 years (SD = 2.7). The standardized skewness for age in the study was 0.58 and the standardized Kurtosis was 0.67. Other basic characteristics of the cases and controls are shown in Table 2

Table 2
Distribution of demographic and socio-economic characteristics of cases and controls

Characteristic	Disease condition			
	Cases (N = 450)		Controls (N = 450)	
	No:	%	No:	%
Sex				
Male	371	82.4	246	54.7
Female	79	17.6	204	45.3
Age				
10–13	299	66.4	233	51.8
14–15	78	17.4	88	19.6
16–19	73	16.2	129	28.6
Ethnicity				
Sinhalese	330	73.3	398	88.4
Muslim	80	17.8	30	6.7
Tamil	39	8.7	20	4.5
Burger	1	0.2	2	0.4
Religion				
Buddhist	286	63.5	375	83.3
Catholic/ Christianity	64	14.2	45	10
Hindu	21	4.7	12	2.7
Islam	79	17.6	18	4
Monthly income				
Rs 10,000–15,000	32	7.1	92	20.4
Rs 15,001- Rs 30,000	127	28.2	163	36.2
Rs 30,001- Rs 45,000	151	33.6	114	25.3
Rs 45,001- Rs 60,000	83	18.4	42	9.3

[a]Classification based on father's occupation

[b]Classification based on validated instrument

Characteristic	Disease condition			
>Rs 60,000	53	11.8	28	6.2
Not known	4	0.9	11	2.4
Social class[a]				
Class1	38	8.2	17	3.8
Class2	44	9.5	19	4.2
Class3	202	43.5	98	21.8
Class4	130	28.0	241	53.6
Class 5	36	10.8	75	16.6
Standard of Living[b]				
High	139	30.0	110	24.4
Medium	280	60.3	247	54.9
Low	31	6.7	93	20.7
[a]Classification based on father's occupation				
[b]Classification based on validated instrument				

The univariate analysis revealed that the age difference among adolescents was significant, indicating a two-fold risk of having an upper limb fracture among ages between 10 to 14 years (OR = 2.02; 95% CI = 1.5,2.7; $p < 0.001$). The sex difference of the participants was also significant with male sex having a higher risk for upper limb fracture (OR = 3.89; 95% CI = 2.87, 5.29; $p < 0.001$). There was a twofold risk of having upper limb fracture (OR = 2.58, 95% CI = 1.7;3.92, $p < 0.001$) among participants who belonged to high social class status (social class I and II) (Table 3).

Table 3
Risk of upper limb fractures associated with demographic and socioeconomic characteristics of adolescents

Characteristic	Disease status				OR	95% CI	Significance
	Cases (N = 450)		Controls (N = 450)				
	No.	%	No.	%			
Age							
10 to 14 years	351	78.2	284	64.0	2.02	1.50–2.71	$\chi^2 = 21.94$
> 14 to 19 years	98	21.8	166	36.0	1.0		p < 0.001
Sex							
Males	371	82.4	246	54.7	3.89	2.87–5.29	$\chi^2 = 80.54$
Females	79	17.6	204	45.3	1.0		P < 0.001
Ethnicity							
Sinhalese	330	73.3	398	88.4	2.78	1.95–3.98	$\chi^2 = 33.2$
Non -Sinhalese	120	26.7	52	11.6	1.0		P < 0.001
Religion							
Buddhists	286	63.6	375	83.3	2.8	2.09–3.92	$\chi^2 = 45.13$
Non-Buddhists	164	36.4	75	16.7	1.0		P < 0.001
Parents employed							
Employed	432	96.0	442	98.7	3.1	1.21–7.82	$\chi^2 = 6.14$
Not employed	18	4.0	6	1.3	1.0		p = 0.021
No: of siblings							
One sibling	187	41.6	143	31.8	0.66	0.49–0.86	$\chi^2 = 9.26$
More than one	263	58.4	307	68.2	1.0		p = 0.003
Social class							
High (Social class I &II	86	18.4	36	8.0	2.58	1.70–3.92	$\chi^2 = 21.01$
Low (Social class III, IV & V)	364	81.6	414	92.0	1.0		p < 0.001

[a]Sri Lankan Rupees

Characteristic	Disease status				OR	95% CI	Significance
	Cases (N = 450)		Controls (N = 450)				
	No.	%	No.	%			
Monthly family income							
LKR[a] 30,000 or less	3	0.7	24	5.5	0.12	0.35–0.39	$\chi^2 = 1.05^{a}$
More than LKR[a] 30,000	447	99.3	426	94.5	1.0		$p < 0.001$
Standard of living							
High	419	93.1	357	79.3	3.52	2.29–5.41	$\chi^2 = 35.95$
Low	31	6.9	93	20.7	1.0		$p < 0.001$
[a]Sri Lankan Rupees							

The difference in engaged with sports or physical exercise was significant in cases and controls which showed a nine-fold risk of having upper limb fracture who had engaged with heavy intensity sports or physical exercise (OR = 9.36; 95% CI; 3.31, 26.47, $p < 0.001$). According to the study, there was a risk of having upper limb fracture among participants who were watching television on weekdays (OR = 1.95; 95% CI; 1.18, 3.22, $p = .009$) and playing video games or computer games on weekends (OR = 2.35; 95% CI; 1.7, 3.24, $p < 0.001$) Other variables that have significant OR are given in Table 4.

Table 4
Risk of upper limb fractures associated with lifestyle related factors

Characteristic	Disease status				OR	95% CI	Significance
	Cases (N = 450)		Controls (N = 450)				
	No.	%	No.	%			
Sports/Physical exercise[a] (Mild/Moderate)							
Yes	226	47.4	194	57.1	1.48	1.11–1.96	$\chi^2 = 7.19$
No	229	52.6	146	42.9	1.0		p = 0.007
Sports/Physical exercise[a] (Heavy)							
Yes	44	1.0	38	8.4	9.36	3.31–26.47	$\chi^2 = 25.76$
No	406	99.0	412	91.6	1.0		p < 0.001
Sports related activity[a]							
Yes	257	73.4	215	91.5	3.89	2.28–6.65	$\chi^2 = 27.48$
No	193	26.6	20	8.5	1.0		P < 0.001
Leisure activities							
Yes	316	87.8	290	95.7	3.1	1.64–5.88	$\chi^2 = 13.17$
No	44	12.2	13	4.3	1.0		p < 0.001
Tuition/extra classes							
Yes	201	56.9	221	67.2	1.82	1.18–2.78	$\chi^2 = 7.56$
No	152	43.1	108	32.8	1.0		p = 0.007
Watch television							
Yes	385	87.5	328	93.2	1.95	1.18–3.22	$\chi^2 = 7.03$
No	55	12.5	24	6.8	1.0		p = 0.009

[a]Classification based on guideline developed by Ministry of Sports, Sri Lanka

Characteristic	Disease status				OR	95% CI	Significance
	Cases (N = 450)		Controls (N = 450)				
	No.	%	No.	%			
Play video/ computer games							
Yes	93	21.4	124	39.0	2.35	1.7–3.24	$\chi^2 = 27.78$
No	342	78.6	194	61.0	1.0		$p < 0.001$
[a]Classification based on guideline developed by Ministry of Sports, Sri Lanka							

According to these results, the risk of having upper limb fractures among adolescents in Sri Lanka are age between 10 to 14 years, being a male adolescent, being a Sinhalese, being a Buddhist, Parent is employed, having a high standard of living index, belong to high social class category, mild to moderate intensity physical or sports activity, heavy intensity physical or sports activity, watching television, playing video or computer games and attending extra classes or tuition classes after school hours. Bivariate analysis was carried out with logistic regression analysis and adjusted Odds Ratios (aOR) to identify individual risk for upper limb fractures adjusted for all confounders.

Risk factors for upper limb fractures following adjusted for confounders were siblings in the family (OR = 11.62, 95% CI: 0.95, 41.29, p = 0.03) and attend extra classes after school hours (aOR = 2.51, 95%CI: 0.68–0.93, p = 0.04), high standard of living index (aOR = 0.03, 95% CI:0.002, 0.474, p = 0.01), being a Buddhist (aOR = 0.02, 95% CI: 0.00, 0.09, p < 0.001) play video or computer games (aOR = 0.19, 95% CI: 0.039–0.91, p = 0.04), and watch television (aOR = 0.06, 95%CI:0.009, 0.373, p = 0.02) were shown in Table 5.

Table 5
Adjusted Odds ratios for having risk factors for the variables with effect modification.

Predictor variable	Adjusted OR (aOR)	Significance (p value)	95% CI for Exp (β)	
			Lower	Upper
High Standard of living score	0.03	0.01	0.002	0.474
Religion (Being a Buddhist)	0.02	0.00	0.00	0.09
Siblings in the family	11.62	0.03	0.95	41.29
Attend tuition/extra classes	2.51	0.04	0.68	0.93
Play video/computer games	0.19	0.04	0.039	0.91
Watch television	0.057	0.02	0.009	0.373

The final LR model was able to classify the cases from controls with 93.8% accuracy, compared to 75% without any of the independent variables used in the model. The Cox and Snell R square and Nagelkerke R square test results, 66–88.3% of the variability in the dependent variable is explained by the independent variables in the model.

The results of Hosmer and Lemeshow Goodness of Fit test were Chi-square (x^2) test value = 18.1; df = 8: p = 0.02. The sensitivity of the model was 92.4% and the specificity was 87.6%. The positive predictive value was 92.9% while the negative predictive value of the model was 96.9%. Two significant effect modifications between being a Buddhist and low standard of living (p < .001) and having one sibling and attending extra classes (p = 0.01) were observed. Accordingly, being a Buddhist with low standard of living score had six-fold risk (OR = 6.35) of having an upper limb fracture than adolescent with high standard of living score. For an individual with one sibling with ever attended extra classes had two-fold risk (OR = 2.48) of having an upper limb fracture compared to those who did not attend extra classes.

Discussion

There was no single study available in Sri Lanka, which addressed the potential risk factors for upper limb fractures among the adolescent population. It was possible to conduct the study in this way, as many adolescents with upper limb fractures attended six major hospitals situated in the biggest commercial city of Sri Lanka [24]. The study aimed at assessing the community specific risk factors for upper limb fractures among adolescents in Sri Lanka to target preventive programmes at field level. The Non-Communicable Disease unit (NCD) for acute NCD has already taken steps for injury prevention such as awareness programmes, child safety programmes and prehospital care programmes to empower the community through health promotion. In addition, there is a National Injury Surveillance system at district level to take further action. The Ministry of Health in Sri Lanka has also identified a healthy school concept with a hazard free school environment for the future generation. A survey called Global School Health Survey (GSHS) also recommended the regular assessment of hazards and safety in the school environment [18]. The Ministry of Health can strengthen its home safety programmes by disseminating home safety checklists to implement safe home environments by increasing awareness regarding home safety in the community. Further, the child injury prevention booklets developed by the Ministry of Health, Sri Lanka can be utilized by public health staff to increase public awareness on child safety [24]. This will be a more cost-effective preventive method to deal with adolescent and child injuries by reducing falls and other mechanisms of injuries among children and adolescents. Educating the parents on the risk-taking behavior of their children is another important preventive measure.

Adolescents from low-income families have a higher risk of sustaining a fracture. The main risk of having a fracture was related to the socioeconomic background of these adolescents [25]. The findings of the current study showed that high standard of living is negatively associated with having an upper limb fracture (aOR = 0.03, 95% CI = 0.02,0.47, p = 0.01). The results portrayed the correct picture since the study carried out in a highly commercialized and the most populated district. The findings of a similar study carried out in Scotland described that low socioeconomic status was a significant risk factor for fractures

among adolescents. Further, the results of this study were obtained by performing regression analysis ($p < 0.001$) [12].

Children's Safety Net work explained that more males were affected, especially those in the 15 to 19 age group [25]. The current study further revealed that the age (OR = 2.02; 95% CI = 1.5,2.7; $p < 0.001$) and sex of the adolescent (OR = 3.89; 95% CI = 2.87, 5.29; $p < 0.001$) were significant risk factors for adolescent's upper limb fractures. The mean age of the cases in the present study was 13.62 years (SD = 2.8). These results were compatible with a study done in Australia. As mentioned previously a cohort study carried out in Australia revealed that the risk of having a fracture increased gradually from the age of 12 to the age of 19 in males and vice versa in females [9]. This study also revealed that the cumulative risk of having at least one fracture following an injury was 11.8% in males and 6.3% in females.

A GSHS survey conducted in 2016 in Sri Lanka revealed that one fifth of adolescents were not physically active for at least 60 minutes per day and 37.3% of the students were not engaged in any activity preferring to sit for three or more hours per day [18]. The present study found that two-fold risk of upper limb fractures associated with playing video games or computer games during weekends (OR = 2.35; 95% CI; 1.7, 3.24) and watching television during weekdays (OR = 1.95; 95% CI; 1.18, 3.22). These findings were supported by the findings of Deoiong & Graeme where the time spent on television, computer, and watching videos in both sexes had a significant relationship with a 1.6-fold risk of having wrist and forearm fractures (OR = 1.6; 95% CI; 1.1, 2.2) [14]. There is a vulnerability to have sedentary lifestyles among Sri Lankan adolescents since most of them attend extra classes after school hours. As such attending extra classes was a significant risk factor among adolescents in Sri Lanka (aOR = 2.51, 95% CI: 0.68, 0.93, $p = 0.04$). This is an important finding for the planners of preventive programmes in the country, where the sedentary lifestyle among adolescents must be discouraged to prevent from risk of having upper limb fractures as well as to prevent from other non-communicable diseases. Deoiong & Graeme further revealed that adolescents were disturbed behaviorally and psychosocially by watching television or playing computer and video games. Johnson et al. [26] also revealed that television viewing during early adolescent age was significantly associated with aggressive behavior (aOR = 1.46; CI; 1.05–2.60)

Findings of Deoing and Graeme were not compatible with those of the current study, where light physical activity decreased the risk of fractures (OR = 0.8; 95%CI: 0.7,1.0) among adolescent and the engagement of mild physical activity was a risk factor in the current study (OR = 1.48; 95% CI; 1.11, 1.96, $p = 0.007$) [14]. Deoing and Graeme conducted a population-based case control study in Tasmania while the current study was a hospital-based case control study. The difference in study design and the socio demographic differences in the two countries could have attributed to the incompatible results. Further, the present study found that there was a nine-fold risk of upper limb fracture in those who were engaged in heavy intensity sports or physical activities (OR = 9.36; 95% CI: 3.31, 26.47). The findings were compatible with a study done by Clerk et al. [15] where a two-fold risk of upper limb fracture was observed with vigorous physical activity in the United Kingdom (OR = 2.06; 95% CI: 1.21, 1.76).

The findings of this research were disseminated to policy makers to implement preventive strategies for adolescent injuries as Sri Lanka is still one of the developing countries.

Strengths and limitations

The current study was conducted in the highly commercialized and the most populated district in Sri Lanka and the authors are aware that the findings cannot be generalized to other districts. Although there is a possibility of the risk magnitude to be differ for each district in Sri Lanka, the risk factor profile can be generalized to the country.

The study was conducted in the district of Colombo, as it consisted of a population of diverse socio-economic conditions with a hazardous environment for adolescents. There were no previous studies done on adolescent fractures in the district of Colombo. The study setting was in Colombo as many adolescents with fractures following injuries were admitted to hospitals in the district of Colombo [27].

The cases and controls were not matched as the magnitude of the effect of potential risk factors such as age and sex had already been assessed as risk factors in the present study. The previous literature covering the local context reported results for unmatched case control studies for similar risk factors [22, 28]. However, confounders were controlled by performing logistic regression analysis. Recall bias and information bias were minimized in the current study by recruiting new cases within one week following an injury [29]. The ideal control group for this type of study is apparently healthy adolescents from the community who did not have previous upper limb fracture or presenting with a fracture. The current study fulfilled this requirement by recruiting apparently healthy adolescents from the community.

Conclusions

Of the potential modifiable risk factors, being limited to sedentary recreational activities such as watching television or playing computer or video games, attending extra classes and the adolescent's standard of living index were significant for upper limb fractures. The present study found that sedentary lifestyle may lead to musculoskeletal diseases even at a young age. Therefore, there is a need to strengthen the awareness programmes and preventive activities to combat the risk factors among adolescent population in Sri Lanka.

Future researchers need to address health issues among adolescents, especially those related to injuries, as this is still a neglected public health problem in Sri Lanka.

Abbreviations

WHO
World Health Organization
UNICEF
United Nations International Children's Emergency Fund
OR

Odds Ratio
CI
Confidence Interval
SD
Standard Deviation
BMD
Bone Mineral Density
ASU
Accident Service Unit
PCU
Primary Care Unit
PHM
Public Health Midwife
LR
Logistic Regression
GSHS
Global School Health Survey
SPSS
Statistical Package for the Social Science

Declarations

Ethics approval and consent to participate

Ethics clearance was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Colombo, Sri Lanka. Administrative clearance was obtained from the Directors and the relevant Specialists of the National Hospital of Sri Lanka, Lady Ridgway Children's' Hospital Colombo, Colombo South Teaching Hospital, Base Hospital Homagama, Base Hospital Awissawella and Base Hospital Mulleriyawa and Regional Director of Health Services (RDHS), Colombo, Sri Lanka. Written informed consent was obtained from all the eligible participants and their parents or caregivers of the study

Consent for publication[AFS1]

Not applicable.

Availability of data and materials

TheDatasets used during the current study are available from the corresponding author on

reasonable request.

Competing interests[AFS2]

The authors declare that they have no competing interests.

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Authors' contribution

HJ, SS, and US have contributed to the conception, design and interpretation of the data while PG has contributed for the interpretation of data and commented the drafted manuscript. HJ conducted the study and drafted the manuscript. HJ, SS, US and PG agree to be accountable for all aspects of the work for its accuracy or integrity and questions related to the accuracy and integrity were appropriately investigated and resolved. All authors have read and approved the final manuscript.

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Authors' information

HJ is a specialist in Community Medicine, has Masters Degree (MSc) and Doctorate of Medicine (MD) in Community Medicine and is attached to the National programme of non-communicable diseases, Ministry of Health, Sri Lanka and currently working as a Visiting Research Associate, Warwick Medical school, University of Warwick, United Kingdom.

SS is a Consultant Community Physician, has Masters Degree (MSc) and Doctorate of Medicine (MD) in Community Medicine, currently serving at the National programme for prevention and control of non-communicable diseases, Ministry of Health, Sri Lanka.

US is a Professor in Community Medicine and has Masters Degree and Doctorate of Medicine in Community Medicine, attached to the Department of Community Medicine, Faculty of Medicine, University of Colombo, Sri Lanka.

PG is a Professor in General Practice and Head of the Health Sciences, Warwick Medical school, University of Warwick, United Kingdom.

[AFS1]This heading has been added to adhere to the journal guidelines. Please confirm your intended meaning is maintained.
[AFS2]If you have no conflicts of interests to declare, please use the journal's suggested wording: "The authors declare that they have no competing interests."

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