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Fall injury patterns and injury severity at Colombo South Teaching Hospital, Sri Lanka

Degree Project in Medicine

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Abstract

Background: Almost 650,000 people die every year because of falls, a number increasing worldwide. Over 80% occur in low and middle-income countries. In Sri Lanka about 3% of all deaths due to traumatic injuries are caused by falls.

Purpose: The aim of this study was to explore the panorama of fall injuries in patients attending the Accident Service Unit of Colombo South Teaching Hospital, including patient demographics and injury patterns in order to suggest preventive measures.

Method: This was a cross-sectional observational study performed at the Accident Service Unit of Colombo South Teaching Hospital September – October 2018. 342 patients were interviewed with a questionnaire. Data was collected on demographics, trauma mechanism and injury patterns. Abbreviated Injury Scale (AIS) and New Injury Severity Score (NISS) were used to evaluate and summarize the patients' injuries.

Results: 479 injuries were recorded, 63% minor injuries with AIS 1. All injuries, but two, were graded AIS 1-3. The most common injuries were superficial/bruise/abrasion and fracture. There were differences between the genders and trauma mechanism, males have more than two times higher risk of falling from height than females. The majority of fall from height among males, were work-related. In general, the severity of the injuries among the patients were mild measured with NISS. Males aged 18-64 years had more severe injuries after fallen from high levels. Patients >85 years achieved significantly more severe injuries than younger patients.

Conclusions: Working men 18-64 years have a higher risk of falling from height and sustain severe injuries. Also, elderly people of both genders with ground level falls present with more advanced injuries. Many of these injuries could be prevented by appropriate information to the public and preventive measures of the risk groups.

Keywords: Fall injuries, fall from height, ground level fall, injury severity, Colombo, Sri Lanka.

Abbreviations

CSTH = Colombo South Teaching Hospital

ASU = Accident Service Unit

LMIC = Low- and middle-income country

AIS = Abbreviated Injury Scale

ISS = Injury Severity Score

NISS = New Injury Severity Score

WHO = World Health Organization

Background

Injuries

Every year over 5 million people die from injuries all over the world[1], and almost 10% of all deaths worldwide are due to injuries. It is estimated that injuries cause more deaths than HIV, tuberculosis and malaria together[2]. In 2013 one billion people suffered from different injuries that needed attention[3]. Injuries are in the top rank of causes of death for both men and women in all age groups regardless of which socioeconomic group they belong to. However, men are more often overrepresented in fatal injuries[1]. Low- and middle-income countries (LMIC) tend to have a greater amount of injuries and also fatal injuries. Only 10 % of all injury-related deaths occur in high in-come countries. In LMIC there are big differences in people's predisposition to suffer from injuries depending on their economic status. A low- and middle-income population is more expected to not recover entirely after an injury and will end up with a remaining disability[1].

Fall injuries globally

A fall is defined, according to World Health Organization (WHO), as an incident where a person without intention comes to rest on the ground or another lower level than they were before. A fall from height means therefore a fall from a higher level to a lower level[4]. Falls are often ranked high on leading causes of injuries[5-7]. WHO estimate that almost 650,000 people die every year because of falls. This makes fall come at second place on list of causes of death by unintentional injuries[8]. 14% of all deaths as a result of injuries worldwide is because of falls[2]. Over 80% of all deaths because of falls occur in LMIC, with 60% occurring in the Western Pacific and South East Asia[8]. Fall was one of the few injuries were the number of deaths increased between the year of 2005 and 2015 worldwide, an increase with 21%; this was the largest increase among all injuries[9]. Fall injuries are

predicted to continue to increase the next fifteen years [2] and are expected to be doubled by the year 2030. One explanation to why is because the population around the world is getting older[10].

Risk factors for fall injuries

There are many risk factors for fall injuries; they could be divided into four groups; biological (age, sex), behavioral (risky behavior, intake of multiple medications, intake of alcohol, sedentary behavior), environmental (slippery floors/stairs, uneven sidewalks, poor lightning) and socioeconomic (income, education, employment)[10].

Age is often an obvious risk factor as the human body loses strength as it gets older[10]. There are two groups in the society where fall injuries are more common, the elderly population (>65 years) and the young (<15years)[2, 5, 10]. Studies show that the majority of all injuries in the elderly is because of falls. The risk of suffering from a fall injury increases with age and is highest over the age of 85 years[5]. Not many epidemiological studies about fall injuries have been done in low- or middle income countries, but a new epidemiological study from Bangladesh, a lower middle-income country in South-East Asia, showed that the majority of all fall injuries occurred in the elderly[11]. Fall is the most common cause of death in fatal injuries in older people but also the dominant reason for disability[10]. In young people falls stand for the most common reason for morbidity[4]. A previous fall is considered to be a major risk factor to have another fall[12]. Older patients who had experienced a fall after the age of 50 years prior to their current fall, had twice the risk of undergoing another fall[13] and many patients have recurrent falls[12, 14, 15]. One study of elderly patients in Sri Lanka showed that as much as 50% of the patients had a tendency to fall[16]. Home

environment is also associated with increased risk of falling, which also has been shown in several studies where the majority of fall injuries occurred in the home[5-7, 11, 14].

Injury patterns and type of fall

The injury pattern for falls differs depending on different demographics. Studies have found varied results. One study found that children and young adults tend to have more head, face and limb injuries unlike the elderly where injuries to the waist is more common[11]. This is similar to another study where elderly patients >80 years often received more hip and thigh injuries[17]. Another study showed that elderly people frequently have more injuries to head/neck, thorax and extremities/pelvis while younger people have more abdominal and external/skin/soft tissue injuries[18]. Head injury is commonly obtained in falls in all ages and regardless of fall height[15, 19-21]. One study however showed that older patients >65 years had a three times greater risk of obtaining a head injury than younger patients[22]. Head injury was the most common cause of death in fall from height in a study exploring falls down stairs[19].

Falls can be divided into ground level falls and falls from height. Among older people ground level falls are more common than falls from heights. Ground level falls often results in more severe injuries in patients over 65 years old than in younger people. Especially neck/head and extremities/pelvis injuries are more severe in an older population[18]. Likewise spine injuries are frequently more severe[23]. One study discovered that the mortality after a ground level fall differed when comparing younger patients <60 years and older patients, from 0,1% (<60 years) and 5,4% (>90 years), respectively[24]. Furthermore, older patients with falls from height obtain more severe injuries and often with multiple injuries in all body regions when compared to younger patients[23]. Many studies have found it more common for younger

people, 20-50 years, to fall from heights, than on ground level. The majority of the patients with falls from height were men[20, 21, 25]. Patients fallen from height often present themselves with multiple injuries[19, 21, 25].

Healthcare in Sri Lanka

Sri Lanka is an island in the Indian Ocean, located southeast of India, with its biggest city Colombo facing west[26]. The island has almost 21 million citizens. Sri Lanka is considered a lower middle in-come country and is a fast-growing economy[27]. The island has been exposed to several natural disasters over the past decade and also gone through a thirty-year long civil war. Many actions have thereafter been made for recovery. In recent years Sri Lanka has undergone a change. The demographic and epidemiological situation of different diseases have changed and improved, which partly can be seen as a result of the major development of the country's healthcare. The Sri Lankan government highly prioritizes healthcare with focus on the public health and free healthcare. The public healthcare covers the whole country and is greatly assisted by the private sector[26].

Fall injuries in Sri Lanka and the threat of an aging population

In Sri Lanka, traumatic injuries are the main cause for hospitalization; in 2008 about 850,000 admissions were because of injuries. About 3% of all deaths due to traumatic injuries are caused by falls, which makes it one of the greatest causes of death among traumatic injuries[26]. A challenge the country faces in the near future is the fast aging of the population. In 2012 the elderly population (>60 years old) accounted for 12.2% of the total population and by 2031 they are expected to account for 18.6% of the total population, which means an addition of 1,5 million people[28]. This will likely increase the fall incidence as an

aging population seems to trigger an increase in fall injuries as older people generally have a higher risk of falling[10].

Purpose

The aim of this study was to explore the panorama of fall injuries in patients attending the Accident Service Unit (ASU) of Colombo South Teaching Hospital (CSTH), including patient demographics, circumstances, trauma mechanism and injury patterns to identify possible risk groups in order to suggest preventive measures.

Material and Methods

Study population and data collection

This cross-sectional observational study was performed at the ASU at Colombo South Teaching Hospital, Kalubowila, Colombo, Sri Lanka. Data was collected on weekdays from September 19 to October 31, between 9 am – 5 pm. Inclusion criteria were an age above 18 years, a clear history of a fall, and that the patient could communicate in English, Sinhala or Tamil. Only adults were included in this study because of the fact that many children are taken to a nearby Children's hospital instead of CSTH. Patients with fall injuries due to a road traffic accident were excluded. Patients who met the inclusion criteria and visited the ASU during the time the researcher was working were interviewed with a data collection form. If the patients visited the ASU and were treated and discharged when the researcher was not there, they were excluded. Accordingly, patients could not be included and were missed if they visited the ASU outside of working hours (9 am – 5 pm), with exception of the patients still being admitted during these hours. The admission-books in the wards were searched every day in order to find patients who had been admitted during evenings/nights and

weekends when the researcher was not at the ASU. A flowchart of the research and inclusion process is seen in Figure 1.

The questioning was, if needed, performed with the help of a research assistant or medical staff who could interpret non-English speaking patients. If the patient had difficulty communicating or giving the information required, the patients' family, relatives or treating medical staff were questioned. Every patients' medical records and, if available, x-rays were thereafter reviewed in order to evaluate the injuries.

The data collection form used in this study was made using the WHO injury surveillance guidelines[1]. Information collected about the patient in the data collection form was: demographics (age, sex, education, occupation and income), circumstances regarding the fall (time, weather, location of the fall and area, activity when the fall happened, height or ground level, which height, fall from certain object, intent, experienced a fall before), the injuries (localization, type of injury, severity and if the patient was admitted to hospital) and risk-factor for fall (under the influence of alcohol at the time of the fall) (Appendix A). The severity of the injuries obtained by the patients was evaluated using the Abbreviated Injury Scale (AIS) (Appendix C)[29]. The injuries were classified by body region (head/neck/spine, face, thorax, abdomen, extremities/pelvis, external) and type of injury (no injury, superficial injury/bruise/abrasion, cut/laceration/open wound, strain/sprain/dislocation, fracture, internal injury/organ injury, other injuries) and were scored a number between 0-6 according to severity. Number 1 was a minor injury and 6 was a non-survivable injury. Number 0 counted as no injury. The AIS score was later used in the New Injury Severity Score (NISS) to summarize the patient's injuries into a single score. The NISS was obtained by squaring the AIS scores from the patients' three most severe injuries and adding them. This gives you a

number between 1-75[30]. An AIS score of 6 (e.g. a non-survivable injury) gives the patient the maximum NISS score of 75 automatically, regardless of the patient's other injuries[29]. The NISS is used as a mortality and survival prediction, where a high score in NISS indicates more severe injuries and a higher risk of dying[30].

Statistical methods

The data was collected anonymously and compiled in Microsoft Excel before analysed in IBM Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics were used to study the demographics and circumstances of the falls in the study population. To find statistically significant differences between gender and various age groups crosstabs and chi-square tests were used, specifically Fisher's exact test because of small sample sizes. To further investigate various age groups involvement in falls an ANOVA test was performed. Two independent-sample T-test and T-test for several independent samples were used when comparing injury severity and different groups. In order to identify risks and comparing risks among different age groups and gender a logistic regression was done.

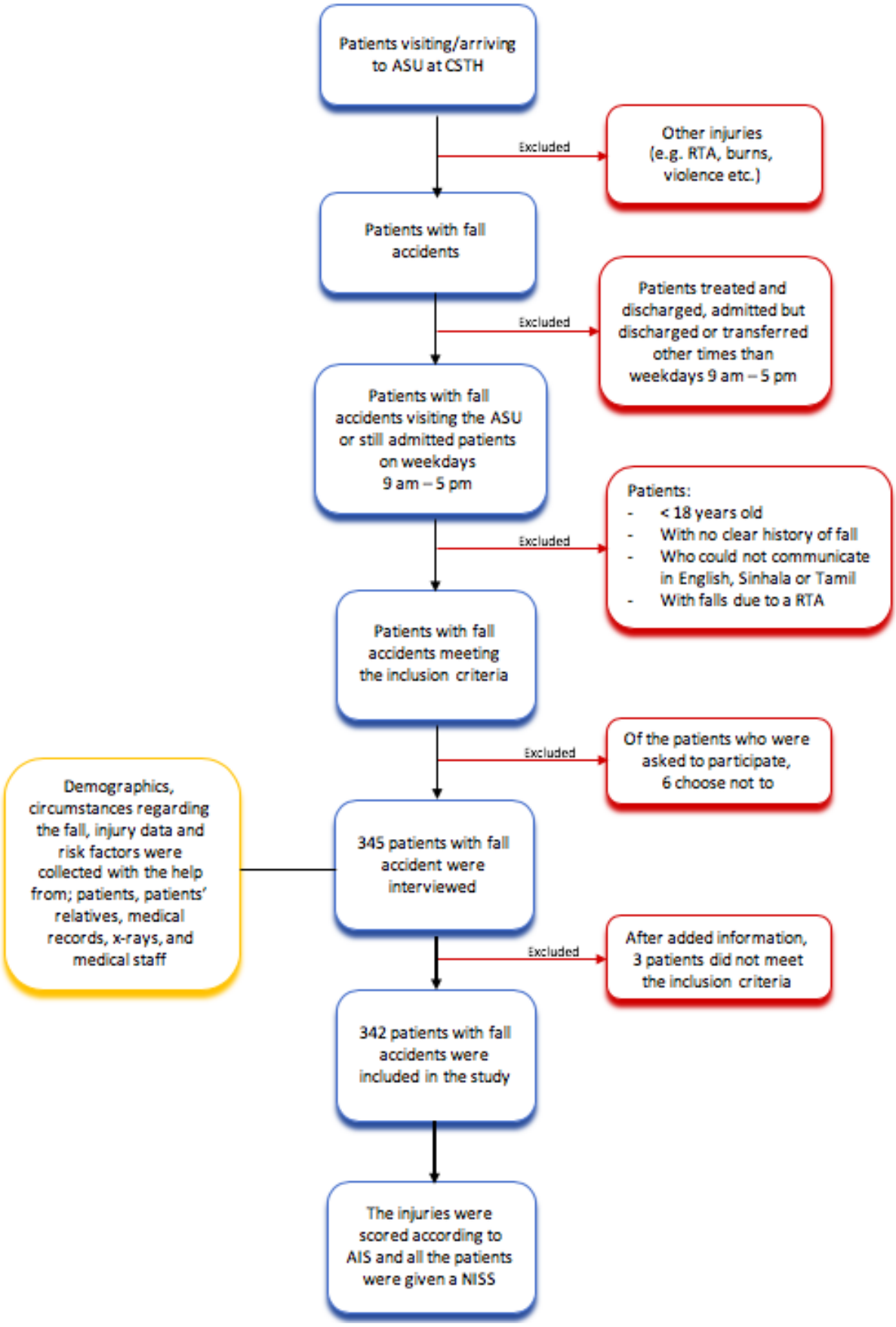

Figure 1. *Flowchart of research and inclusion process. ASU=Accident Service Unit, CSTH=Colombo South Teaching Hospital, RTA=Road traffic accident*.

Ethics

This study was approved by the Ethics Review Committee at the Faculty of Medical Sciences, University of Sri Jayewardenepura (Appendix B). It has aligned to the principles of the Helsinki declaration. The patients were given information about the study when they were asked to participate. All participation in this study was completely voluntary and consent were given by all the included patients both verbally and written before the start of the questioning. The consent forms existed in English, Sinhala and Tamil and were created with guidance from WHO's templates for consent form[31]. The data collection form existed in both English and Sinhala. If the signing of the consent form could not be done by the patients, for example due to the injuries obtained, the help from the patients' relatives were used. All data collected was kept confidential. The researcher has not interfered or purposely delayed the care or treatment of the patient.

Results

Population

345 patients were interviewed during the study period. After added information 3 patients were excluded since they did not meet the inclusion criteria. Eventually 342 patients were included in the study. The mean age of the participants was 53 years, with ages ranged between 18-101 years. The median age of the participants was 54 years. Out of the included 342 patients 46% (n=157) were males (mean age 48 years, median 47 years) and 54% (n=185) were females (mean age 58 years, median 61 years). Two thirds of the patients were < 65 years old (67%). 95.6% of the patients had an education while 4.4% had no education. 57.6% of the patients reported a monthly income above 24000 LKR and 42.4% had a monthly income less than that.

Fall accidents and type of fall

In this study a fall from height was considered a fall from all heights above ground level, i.e., above 30 cm. Of the 342 fall accidents included in this study the majority of them had falls from ground level (Fig. 2). 234 patients had fallen from ground level and 108 patients had fallen from height. There was a difference between the genders, with the number of patients who had a ground level fall or fall from height. This difference was found statistically significant ($p<0.001$) (Table.1). Males have a higher risk of falling from height than females with an Odds Ratio of 2.42, 95% Confidence Interval 1.48-3.96 ($p<0.001$).

Distribution of the mechanism of fall between age groups, defined as 18-44 years, 45-64 years, 65-84 years and 85+ years, and gender can be seen in Figure 3. When dividing the patients into these four subgroups there was a significant difference between the groups whether they had a ground level fall or fall from height ($p<0.001$). After comparing the two

middle groups (44-64 years and 65-84 years) with the oldest group (85+ years) they both showed a marginally higher risk of falling from height, but this result was not significant (p=0.356, p=0.743). When comparing the youngest patients (18-44 years) with the oldest patients (85+ years) they showed a three times higher risk of falling from height, however not significant (p=0.055). Viewing the difference of the number of patients with ground level fall or fall from height, divided into older or younger than 65 years old, 80% of the patients over 65 years old had a ground level fall compared with 20% who had a fall from height. About one third of the patients (32.8%) had experienced a fall previously. In the older age group, 85+ years, the majority of the patients had experienced a fall earlier, while in the younger age groups a smaller proportion of the patients had previous falls. In the youngest group (18-44 years) less than 20% of the patients had fallen before. Slightly more than half (52.7%) of the patients who had experienced a fall earlier had fallen within the last year.

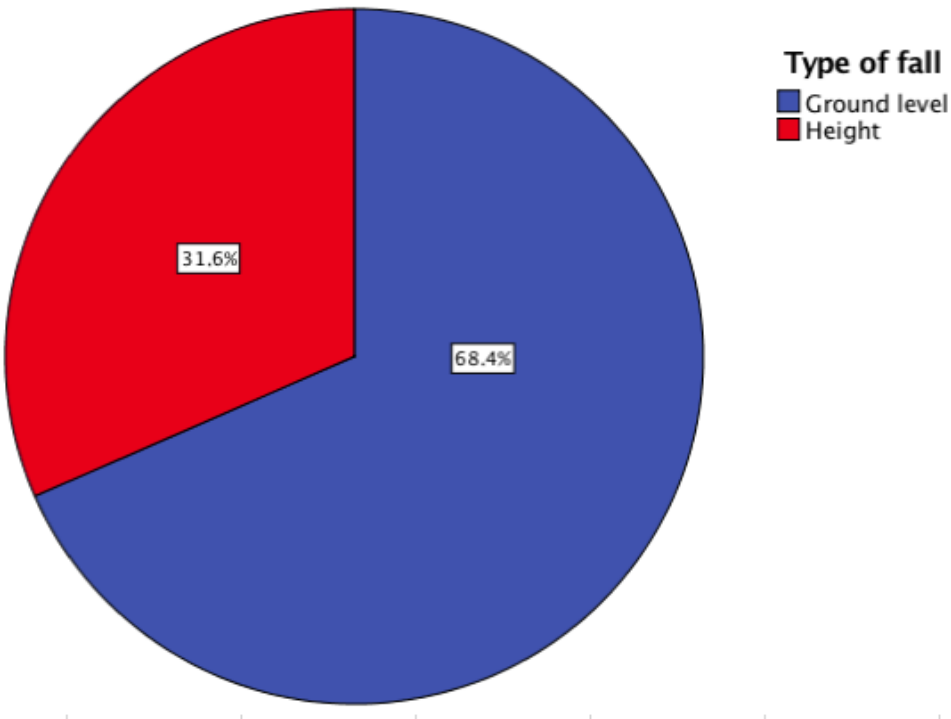

Figure 2. *Distribution of ground level falls and falls from height among the patients at ASU, CSTH.*

Table 1. *Male and female patients divided in to type of fall; ground level fall or fall from height.*

Type of fall * Gender Crosstabulation

			Gender		
			Male	Female	Total
Type of fall	Ground level	Count	88	146	234
		% within Type of fall	37.6%	62.4%	100.0%
	Height	Count	69	39	108
		% within Type of fall	63.9%	36.1%	100.0%
Total			157	185	342

Fisher's Exact Test, p<0.001

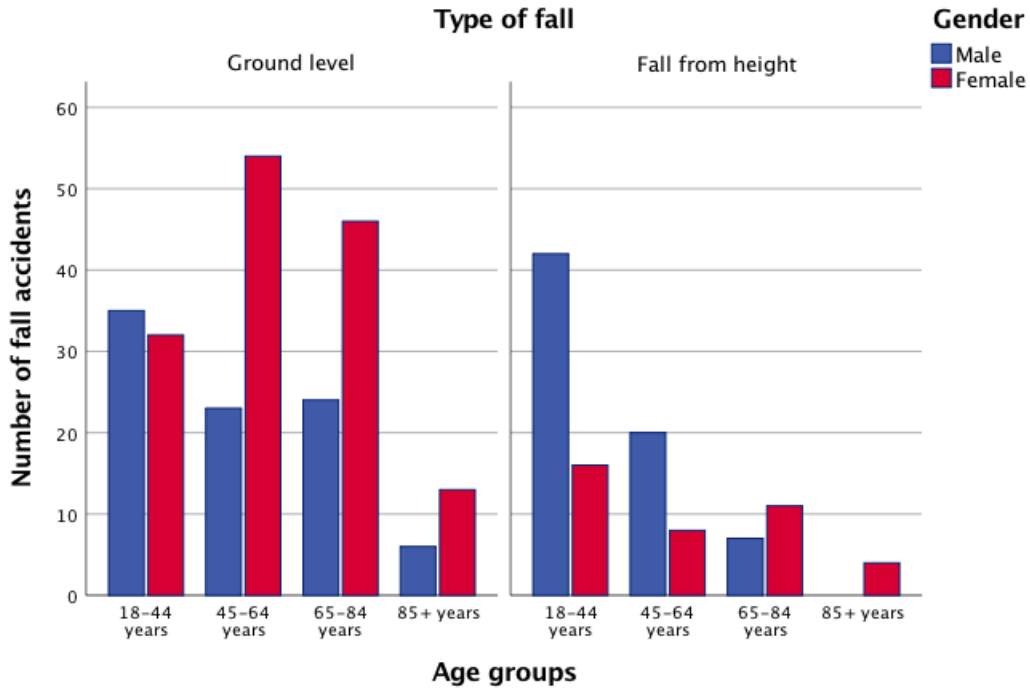

Figure 3. *Number of fall accidents that occurred among female and male patients divided into age groups in ground level fall and fall from height.*

Circumstances of fall

The most common location of the falls was at home (60.5%), followed by at work (23.4%), street (10.2%), other (4.4%) and school (1.5%). Regarding the mechanisms of the fall, the distribution of location differed slightly between ground level fall and fall from height (Fig.

4). There was also a difference in location between male and female, where over 75% of all falls among females happened at home compared with 43% among males. Among females with ground level fall or fall from height and males with ground level falls home was the most common location of the fall. However, among males fallen from height the most common location of the fall was at work (59.4%).

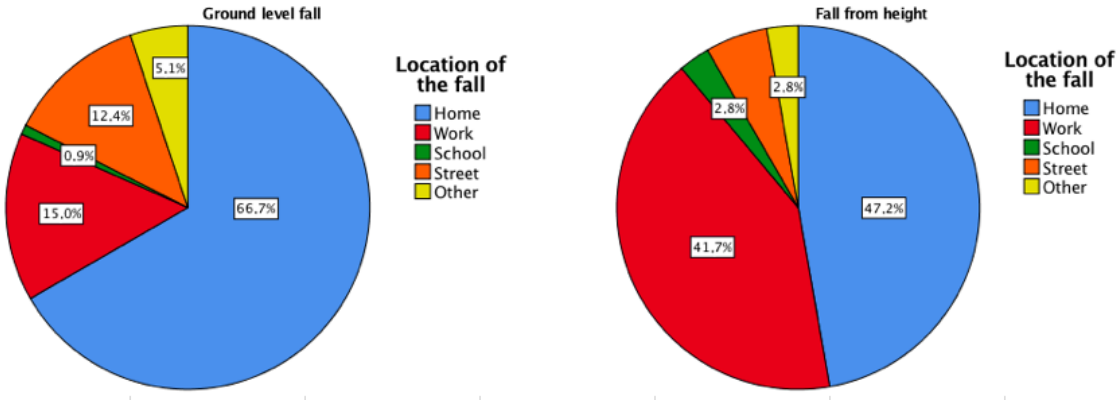

Figure 4. *Location of the falls divided in to ground level falls and falls from height.*

64% of the fall accidents occurred when the patients had leisure time, 24.3% happened when they were working or studying and 11.7% occurred when they were participating in other activities. There was a difference in activity when falling between ground level falls (68.8% leisure time, 16.2% working/studying and 15.0% other activities) and falls from height (53.7% leisure time, 41.7% working/studying and 4.6% other activities). Of those falling from height while working 89% were male (40 patients out of 45 total). Comparing males and females, 74.1% of all falls amongst females where during leisure time in contrast to 52.2% among males. Females with ground level falls or falls from height and males with ground level falls had the majority of their falls during leisure time. Unlike males fallen from height, where it was more common to be working at the time of the fall (58%).

Among the patients fallen from height, 40 (37.7%) patients had fallen from building/ladder, 38 (35.8%) from staircase, 26 (24.5%) from other and 2 (1.9%) from a tree. Data shows that 72.5% of those who fell from a building or a ladder were working or studying. All but two of the patients fallen from a building/ladder were males and the two patients fallen from a tree were males. The falls in a staircase or from other objects were more evenly distributed between males and females.

The height of the falls varied between 30 cm to 18 meters, mean fall height 2.5 meters. Data of fall height was missing in two cases. The majority of the falls were from under 3 meters (79.2%). Of the 22 falls above 3 meters recorded, all but one were males. Nearly all of the fall accidents happened during weekdays (92.4%). The most common time for fall accidents was in the morning, 5 am – 11 am (41.1%). 58.9% of the falls occurred during sunny weather, 22% during rain and 12.8% when it was dark. Alcohol intake prior to the fall accident was admitted or suspected in 5 cases (1.5%), all of them male. Two of the falls were due to intentional falls, whereof one was fall from height and one a ground level fall.

Fall injuries and injury severity

During this study 479 injuries were recorded among 342 patients. In two of the patients, injury information was missing. Amongst the patients it was most common (73%) to obtain one injury and more uncommon with two or more injuries. The most common injury was external superficial injury, bruise or abrasion 38% (n=182), thereafter fracture in extremities 27.8% (n=133) and external cut, laceration or open wound 11.5% (n=55) (Table 2). The distribution of the grade of severity among the 479 injuries recorded were 63.0% (n=302) minor injuries, 18.0% (n=86) moderate, 18.6% (n=89) serious, 0.2% (n=1) severe and 0.2% (1=) critical (Table 3). No maximum/non-survivable injury was recorded in this study.

Table 2. *Distribution of injuries according to type of injury and severity of the injuries in patients with fall accidents.*

	Injuries	% of injuries	Minimal AIS	Maximal AIS	Mean AIS
External - Superficial injury/bruise/abrasion	182	38.0%	1	1	1.00
Extremities - Fracture	133	27.8%	1	3	2.46
External - Cut/laceration/open wound	55	11.5%	1	2	1.09
Head, neck and spine - Strain/sprain/dislocation	34	7.1%	1	2	1.03
Extremities - Strain/sprain/dislocation	25	5.2%	1	3	1.32
Head, neck and spine - Internal injury/organ injury	24	5.0%	1	5	2.50
Head, neck and spine - Fracture	12	2.5%	2	3	2.33
Thorax - Fracture	5	1.0%	1	4	2.00
Face - Superficial injury/bruise/abrasion	2	0.4%	1	1	1.00
Face - Cut/laceration/open wound	2	0.4%	1	1	1.00
Face - Fracture	2	0.4%	1	2	1.50
Abdomen - Internal injury/organ injury	2	0.4%	2	3	2.50
Thorax - Internal injury/organ injury	1	0.2%	3	3	3.00

AIS=Abbreviated Injury Scale.

Table 3. *Distribution of injuries according to AIS in patients with fall accidents.*

AIS	Number of injuries	% of injuries
1	302	63%
2	86	18%
3	89	18.6%
4	1	0.2%
5	1	0.2%
6	0	0%

AIS=Abbreviated Injury Scale.

92% of all patients in this study had a NISS equal to or under 9. NISS mean for the population was 4.2. The NISS scored for men ranged between 1 to 27 and for women between 1 to 13. Mean NISS for male patients was 4.1 and for female patients 4.3. This difference was not

significant (p=0.524). The mean NISS varied between different age groups, with mean NISS of 3.3, 3.5, 5.4 and 8.3 for the four age groups 18-44 years, 45-64 years, 65-84 years and 85+ years, respectively (Fig. 5). When comparing them, the patients in the two older age groups, 65-84 years and 85+ years have a significantly higher NISS than the younger patients in the two younger age groups (p=0.004, p<0.001). The oldest patients (85+ years) have a significantly higher NISS when compared to all of the younger age groups (p<0.001, p<0.001, p=0.005). There was however no significant difference when comparing mean NISS between the two younger age groups (p=0.974).

When also considering gender and type of fall a few groups stands out with more severe injuries (mean NISS) (Fig. 6). Besides the elderly 85+ years with ground level falls, also the young men ages 18-44 years and 45-64 years fallen from height. Males aged 45-64 years showed a statistically significant difference with more severe injuries than the corresponding group of males with ground level falls (mean NISS 5.9 vs 2.5, p=0.032) and females with falls from height in the same age (mean NISS 5.9 vs 1.9, p=0.034). This trend could also be seen when comparing males aged 18-44 years to the corresponding males with ground level falls (mean NISS 4.3 vs 2.9) and females with falls from height in the same age (mean NISS 4.3 vs 2.4). This difference was however not statistically significant, p=0.424 and p=0.062 respectively. Among admitted patients the mean NISS was 6.1 and for patients who were treated and discharged 1.8, this was a significant difference (p<0.001). There was no significant difference (p=0.481) in injury severity between the patients fallen from height (mean NISS 4.3) and patients with ground level falls (mean NISS 4.2).

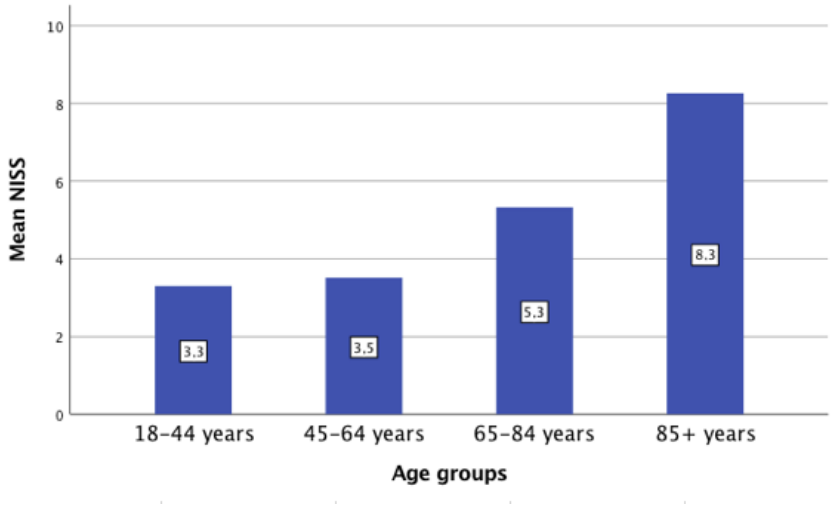

Figure 5. *Mean NISS for different age groups. NISS=New Injury Severity Score.*

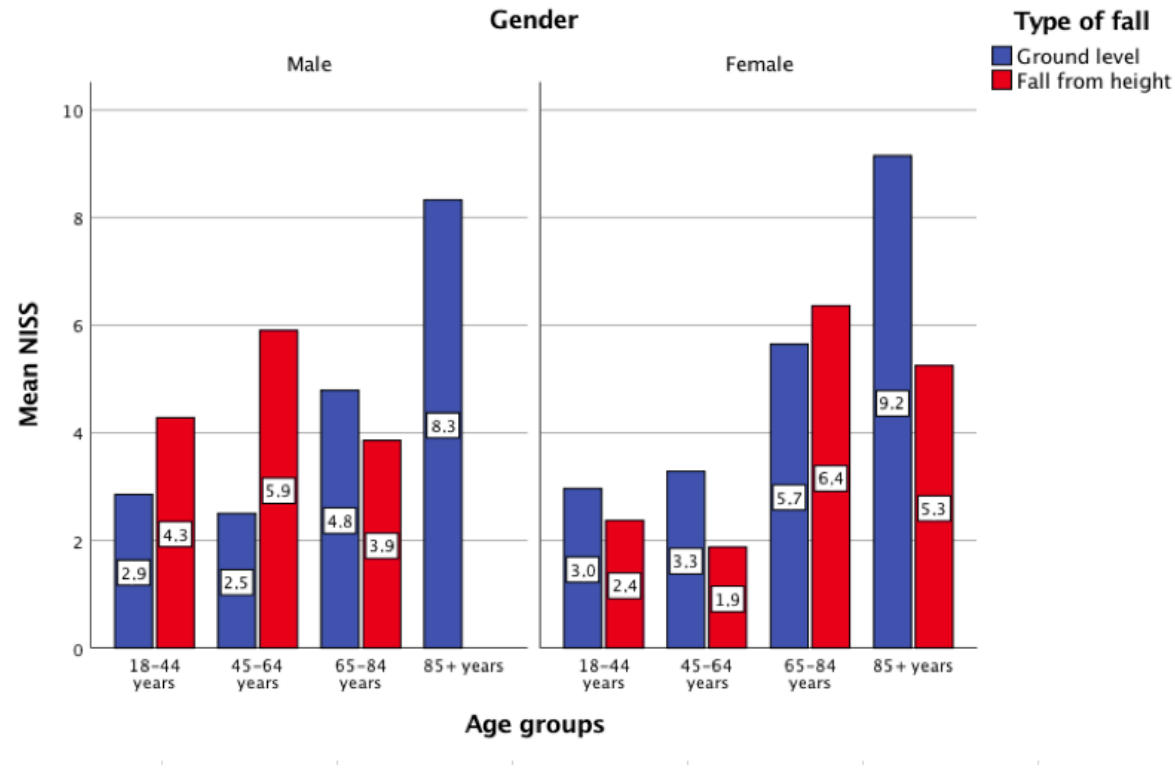

Figure 6*. Mean NISS for all age groups and genders in different types of fall. NISS=New Injury Severity Score.*

Discussion

This was a questionnaire-based study conducted at the ASU at CSTH. 342 patients were interviewed with the purpose to study fall accident; what kind of injuries you obtain and see who is affected in order to find groups where fall prevention should be focused.

The population in this study was young with two thirds of the subjects being younger than 65 years, which is similar to what is reported by Wadhwanyia et al.[11]. Other studies on fall accidents and fall injuries in Sri Lanka have however focused on older people[12, 13] which makes this study a suitable complement to previous studies as it focus on the entire panorama of fall injuries and with its result covering a younger population, especially the group of young men.

This study showed that males have a more than two times higher risk of falling from height than females. Earlier studies that have looked at falls from heights report that the majority of the subjects are men[20, 21, 25], which may suggest that men are at a higher risk of falling from height. In an attempt to try to find an explanation to this result you could consider factors such as type of work sector. The male population may tend to take on more risky and dangerous occupations than females, for example building and construction sector, which expose them to a more dangerous work environment (e.g. heights). This study also found that there was a clear difference between the genders regarding the location of the fall and the activity at the time of the fall. Especially fall from height showed this difference with the majority of males being at work working at the time of the accident. This is consistent with another study looking at the pattern of injury in falls from height which also saw this tendency, with a great part of the falls from height being work-related. Further, not one single female with work-related fall from height was reported in that study[25]. An explanation to

the differences in circumstances surrounding falls may be found looking at employment of the population. When viewing employment of the population as a whole, in the Sri Lankan society a larger part of the female population (compared to many high-income countries) is unemployed and staying at home as housewives, which could explain why the majority of fall accidents among females occur at home. Besides males fallen from height the most common location of the falls for the population was at home, which align with numerous studies on fall accidents[5-7, 11, 14].

As working young men are the ones falling from height it is imaginable that this have a big impact on the individual but also in a larger context. A fall accident could cause the individual a great amount of suffering and also cause disability. Younger people are seen to have higher morbidity because of falls[4]. However, in Sri Lanka this result could also have a big consequence as the majority of the male population provide for their family and sometimes are the only one with an income. Therefore, in case of a fall injury they could leave their entire family with economy problems, because of absence of work and for example expenses such as medical supplies etc. Not only the individuals are affected but also the community, such as productivity loss and medical cost. The above mentioned reasons are numerous reasons why it would be profitable to focus on preventive measures considering this group.

The number of work-related falls among males fallen from heights was high. Another study of work-related accidents showed that nearly 1 million people get injured at work each day[32], which makes it a global problem. To think that these accidents are preventable is most likely, in the terms of safety and safety precautions. This is also suggested in studies which shows that the majority of the accidents is caused by behavioral factors[33, 34], thus being preventable.

In this study a fall from height was considered a fall from a higher level to a lower, hence including falls from 30 cm up to 18 meters. A trend was found that males 18-64 years as a group showed more severe injuries, with higher mean NISS, when fallen from height than females fallen from height or males with ground level falls in the same ages. One reason for this could be as mentioned above that males in these ages have more falls from height. For example, all falls but one above 3 meters were males, which show that even though there was a group of females falling from height the height was lower than the height among the male falls. This would in that case be in line with findings in previous studies[15, 25].

Another group that showed significantly more severe injuries and a higher mean NISS was the older patients over the age of 85 years, regardless of gender and type of fall. Considering the number of patients in this group being few (n=23) any conclusions have to be made with great care. However, these findings are likewise shown in other studies examining fall injuries[17, 22, 23]. This seems reasonable since the human body loses strength as it gets older as well as speed of reflexes that protect against injuries with the result of more severe injuries. Moreover, older people tend to limit their exposure to heights. As mentioned above there are much to gain by preventing falls. Many of the falls in the elderly are preventable, thus ease any suffering from fall injuries. Similar to falls in younger people the cost (e.g. suffering and economical) of a fall injury is high, with medical costs and the indirect cost when family members stay home to care for their relatives.

External superficial injury, bruise or abrasion was the most common injury followed by fractures in extremities and external cut, laceration or open wound. This is not surprising considering the population being rather young with two thirds of the patients younger than 65

years old and also with the majority of the falls being ground level falls. This is furthermore shown in the distribution of severity of the injuries, with the majority of the injuries being minor. Additionally, both Arbes et al.[15] and Sterling et al.[18] reported a high amount of external injuries. Still, many earlier studies on injury pattern of falls have either focused on fatal injuries[15, 19, 21], on specific age groups[18] or specific type of fall[22] Thus, the number of studies found on non-fatal injuries within the same age range and with merged fall types is limited. The strength of this study is its focus on blended age groups, falls from ground and high level, as well as different injuries following fall accidents.

Methodological considerations

Another strength with this study is the number of cases (n=342) collected that covered all ages and not only focused on one age group or type of fall. This presented a good picture of the fall panorama in south Colombo and surrounding areas.

Since the data collection only occurred during daytime on weekdays patients arriving to the ASU outside working hours were not included in the study (e.g. nights and weekends). Furthermore, patients who were admitted and discharged or transferred outside working hours were missed. A few patients were also overlooked when the researcher was at the hospital. The reason for this was both that there was only one person to cover the ASU and the wards at the same time. This also happened because of misunderstanding between the researcher and hospital staff or the patient.

Further, the unknown number of patients who was overlooked because of language difficulties has to be mentioned. There were individuals who had trouble understanding English and written Sinhala, which made their participation impossible when no help with

interpretation was available. Additionally, patients who were admitted and could not communicate due to medical conditions or other reasons or did not have relatives to speak on their behalf, could not participate. Consequently, patients severely injured, with no relatives present could not be heard, thus possibly affecting the result of the injury pattern. Nevertheless, an observation made was that most of these patients tended to be older patients having a poor general condition affecting their ability to communicate.

One limitation was the assessment of the injuries according to AIS. Even though estimation tools were used, as the Abbreviated Injury Scale scoring chart (Appendix C)[29], it can be difficult to make the correct assessment of the injuries as a clinically unpractised researcher but also as a researcher with inexperience of using the scale. If all the injuries were assessed by someone who is trained of utilizing AIS, this limitation could be avoided. Nevertheless, in this study all the assessments were made by one researcher, which would prevent any bias that may emerge when different people make assessments.

Another limitation was that most of the severe head traumas and spinal cord injuries were taken to other hospitals specialized in these conditions, since CSTH does not offer neurosurgery. Additionally, the hospital does not offer thorax surgery. This could have affected the injury pattern and several severe injuries would not have been included. Considering head injuries being a common injury following a fall this could be an important limitation[15, 19-21].

Future studies

This was a small study conducted for a limited time at only one big government hospital. To make the results of this study more demonstrative and become more representative for larger

populations, future studies should include a bigger population from different hospitals, both public and private. They should also be carried out during a longer time to be able to engage as many fall accidents as possible. Preferably with researchers, speaking the local language as this would avoid the language barrier and some misunderstandings and make the data collection more time efficient and more reliable. It is also desirable with numerous researchers who can cover the ASU at all hours to avoid missing cases. It would be interesting to explore the reasons for the falls. The majority of the falls happens at home but to be able to be more specific in the kind of prevention actions that should be made this must be investigated further. Additional investigation among working men falling from height is welcomed to further understand how extensive this problem could be.

Conclusions

A ground level fall was the most common type of fall among the patients. The most common location of the falls was at a home environment. This pattern was shown in all ages, gender and fall types, except among men fallen from height where the workplace was the most common location. Almost all falls from height in men were revealed to be work-related.

This study showed that men have more than two times as high risk of falling from height than women, which also is in line with previous studies.

Compared to other trials this study showed a younger population sustaining fall injuries, with two thirds of the participants under the age of 65 years. This could indicate that Sri Lanka, as a LMIC, have another distribution of fall injuries.

The majority of the fall injuries in this study was shown to be minor, with superficial injuries and fractures being the most common injuries. Although the majority of the injuries were mild, they can still cause unnecessary suffering.

Working men 18-64 years were shown to be an exposed group, with a higher risk of falling from height and also sustain more severe injuries. Also, elderly people of both sexes with ground level falls present themselves with more severe injuries. Consequently, these groups are more disposed to suffering and disability, which can be avoided as many fall accidents are preventable.

Seeing that work-related fall injuries among men and falls in older people cause unnecessary suffering and disability and are not only affecting the individual it can be of importance to focus prevention on these groups. One example could be to look over security precautions on workplaces, especially work at heights but additional studies in this area is required to further understand the problem and see what kind of preventive measures that are needed.

Populärvetenskaplig sammanfattning

Fallolyckor och allvarlighetsgraden av uppkomna skador på Colombo South Teaching Hospital, Sri Lanka

Varje år dör nästan 650 000 människor världen över i fall och fallolyckor. Antalet fall och fallolyckor ökar globalt och lika så dödsolyckor. Man har sett att majoriteten av alla dödsolyckor sker i låg- och medelinkomstländer, dit Sri Lanka räknas. På Sri Lanka är den näst vanligaste traumatiska dödsorsaken fallolyckor.

Syftet med den här studien var att undersöka fallskador hos patienter som besökte akutmottagningen på Colombo South Teaching Hospital. Detta för att bättre förstå vilka som drabbas och vilka skador de får i fallen för att kunna se vart förebyggande åtgärder behövs. Studien genomfördes mellan september och oktober 2018 och sammanlagt samlades det in information från 342 vuxna patienter. Patienterna intervjuades med hjälp av en enkät med frågor om ålder, kön, ekonomisk status, typ av fall, fallhöjd och skador m.m. Journalerna tittades även igenom för att kunna bedöma skadorna patienterna fått.

I den här studien inhämtades information om totalt 479 skador. Av dessa skador var majoriteten milda. De vanligaste skadorna efter ett fall var ytliga skador, så som blåmärken och skrapsår och de näst vanligaste var frakturer i armar och ben. Deltagarna i studien var ganska unga med två tredjedelar under 65 års ålder. Denna studien visade att män har en dubbelt så hög risk att falla från hög höjd än kvinnor. Den visade även att de flesta fall från hög höjd hos män var arbetsrelaterade. En förklaring till dessa resultat skulle kunna vara att fler män har arbeten som utsätter dem för höga höjder.

Generellt var allvarlighetsgraden på skadorna hos patienterna låg. Två utsatta grupper som oftare får allvarligare skador visade sig vara män 18–64 år som faller från hög höjd och patienter över 85 års ålder som faller från markplan.

Många fallolyckor kan förhindras och de orsakar mycket onödigt lidande. De identifierade grupperna i denna studien kan vara grupper där förebyggande åtgärder kan vara av betydelse.

Acknowledgement

First and foremost, I would like to thank the amazing doctors, nurses and other staff at Colombo South Teaching Hospital and especially at the Accident Service Unit for their friendliness and help in this study. All their contributions were invaluable. I also would like to thank my two supervisors, Prof. Göran Kurlberg and Dr. Bawantha Gamage for their support and guidance. A special thanks to Ms. Amali Ranasinghe for all her invaluable help with interpretation at the hospital and administrative help in applying for the ethical approval. Finally, I would like to say thank you to The Swedish International Development Cooperation Agency (SIDA) and Landénska Donation Fund for their economical contribution and making this study possible.

Appendices

Appendix A - Data collection form

Data collection form

No: _____

Age: _____ Sex: ☐ Male ☐ Female

Highest education: ☐ No Education ☐ Primary ☐ Secondary ☐ University/College

Occupation: _____

Monthly Income: ☐ > 24000 LKR ☐ < 24000 LKR

Time of day: _____

Weather: _____

Location of the fall: ☐ Home ☐ Work ☐ School ☐ Street ☐ Other

Area: _____

What did you do at the time of the fall? ☐ At work/school ☐ Leisure ☐ Other

Fall: ☐ Ground level ☐ Height

Height (in meters): ☐ Tree ☐ Building/ladder ☐ Cliff/rock ☐ Staircase ☐ Other

Experienced a fall earlier: ☐ Yes ☐ No

If yes, how long ago (in weeks/months): _____

Intentional: ☐ Yes ☐ No

Use of alcohol before fall (confirmed/suspected): ☐ Yes ☐ No

Admitted to hospital: ☐ Yes ☐ No

Body region/ Type of injury	Head/Neck/ Spine	Face	Thorax	Abdomen	Extremities/ Pelvis	External
No injury						
Superficial injury/bruise/ abrasions						
Cut/laceration/open wound						
Strain/sprain/dislocation						
Fracture						
Internal injury/organ injury						
Other injuries						

Injuries

Type of injury:	Injury description:	AIS(0-6):

ISS: _____

NISS: _____

Appendix B - Ethical approval

Ethics Review Committee

A SIDCER *(Strategic Initiative for Developing Capacity in Ethical Review) recognized ERC*

Faculty of Medical Sciences, University of Sri Jayewardenepura
Gangodawila, Nugegoda, Sri Lanka

Date: 18. 09. 2018 Our ref: 38/18

ERC meeting date: 23rd August 2018

Dr. Bawantha Gamage,
Department of Surgery,
Faculty of Medical Sciences,
University of Sri Jayewardenepura.

Dear Dr. Gamage,

Application Number: 38/18

Title: Descriptive study on injuries following falls, among patients attending to Accident and Emergency department of Colombo South Teaching Hospital, Sri Lanka.

Principal Investigator: Alfredsson Miranda
Co-investigators/ Supervisors: Dr. Bawantha Gamage, Dr. Göran Kurlberg

I am pleased to inform you that the FMS/USJP ERC at its meeting held on the above mentioned date has granted ethical approval for your project as per details given below.

Document	Version No	Date of submission
Project proposal	02	14.08.2018
Study instrument - English	02	14.08.2018
Participant consent forms - English	02	14.08.2018
Participant consent forms - Sinhala	02	14.08.2018
Participant consent forms - Tamil	02	14.08.2018

The ethical approval for your project is effective from the above mentioned ERC meeting date.
We affirm that none of the proposed study team members were present during the decision making process of the ERC. The quorum requirements were met.

The **approval is valid until one year from the date of sanction**. You may make a written request for renewal / extension of the validity, along with the submission of annual status report. **Please note that ethical approval would be revoked if any alteration is made to the project without obtaining prior written consent from the ethics review committee.**

Address all correspondence to: Secretary, Ethics Review Committee,
Faculty of Medical Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.
Tel.94-11-2758588, Fax 94-11-2811480, erc.fms.usjp@gmail.com

Ethics Review Committee

A SIDCER *(Strategic Initiative for Developing Capacity in Ethical Review) recognized ERC*

Faculty of Medical Sciences, University of Sri Jayewardenepura
Gangodawila, Nugegoda, Sri Lanka

As the Principal Investigator, you are expected to ensure that procedures performed under the project will be conducted in accordance with all relevant national and international policies and regulations that govern research involving human participants.

Please note that this approval is subjected to the following condition:

- An ERC approved stamped ICFs are attached herewith. Please ensure that the stamped ICF are provided to the participants.
- Progress reports to be submitted at six monthly intervals.
- All serious adverse events (SAEs) that may occur in Sri Lanka should be reported within 14 calendar days of their occurrence to the ERC, FMS USJ
- Any serious adverse event, which has arisen during the clinical trial or which has come to your knowledge from reports other participating trial sites should be informed in writing to ERC FMS, USJ within 30 working days.
- The adverse events should be reported in the format of the attached adverse events reporting form.
- The final report to be submitted at the completion of the study.
- In the event of any complaints from the participants, these should be reported to the Secretary, ERC FMS USJ.
- In the events of any protocol amendments, ERC must be informed and the amendments should be highlighted in clear terms as follows:
  a. The exact alteration/amendment should be specified and indicated where the amendment occurred in the original project. (Page no. etc.)
  b. If the amendments require a change in the consent form, the copy of revised Consent Form should be submitted to Ethics Committee for approval

Thank you.

Yours Sincerely,

Prof. Renu Wickremasinghe
Chairperson

Dr. Manjula Weerasekera
Secretary

Address all correspondence to: Secretary, Ethics Review Committee,
Faculty of Medical Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.
Tel.94-11-2758588, Fax 94-11-2811480, erc.fms.usjp@gmail.com

TABLE I

TRAUMA CHART

INJURY SEVERITY SCALE *(GUIDELINES)*

LORNE GREENSPAN M.D.†
BARRY MCLELLAN M.D.x
HELEN GREIG*
Emergency Department
Toronto General Hospital
Toronto, Ontario, Canada

A.I.S. SCORE	1 MINOR	2 MODERATE	3 SEVERE, NOT LIFE-THREATENING	4 SEVERE LIFE-THREATENING	5 CRITICAL, SURVIVAL UNCERTAIN
EXTERNAL	**Abrasion / contusion** · superficial or unspecified / ≤ 25cm² on face or 50 cm² on body **Superficial or unspecified laceration** i) not into subcutaneous tissue regardless of length ii) into subcutaneous tissue but ≤ 5 cm on face or ≤ 10 cm on body **1° burn up to 100%** **2° or 3° burn < 6% total body**	**Major abrasion / contusion** **>25 cm² on face** **>50 cm² on body** **Deep laceration (into subcutaneous tissue) and >10 cm on body or > 5 cm on face** **2° or 3° burn to 6-15% total body**	**2° or 3° burn to 16-35% total body**	**2° or 3° burn to 26-35% total body**	**2° or 3° burn to 36-90% total body**
HEAD (includes FACE (F))	**Awake on admission or initial observation** · no prior unconsciousness but may have headache / dizziness 2° to head trauma **Ear canal injury** **Eyes (F)** · conjunctiva abrasion / contusion / laceration · corneal abrasion / contusion · lid abrasion / contusion / laceration · vitreous / retina / canaliculis (tear duct) laceration · choroid rupture · uvea injury **Gingiva (F)** (gum) contusion / laceration **Lip (F)** contusion / laceration (no matter how extensive) **Mandible (F)** · fracture unspecified · ramus fracture **Nose (F)** fracture **Teeth (F)** avulsion / dislocation (loosened) / fracture **Superficial tongue (F)** laceration	**Awake on admission or initial observation** · prior unconsciousness but length of time unspecified · amnesia (no recollection of crash) · unconsciousness < 15 min **Lethargic, suporous, obtunded on admission or initial observation (can be aroused by verbal stimuli)** · no prior unconsciousness · unconsciousness < 15 min **When level of consciousness on admission or initial observation is unkown** · unconsciousness < 15 min **Medical diagnosis listed as concussion with no other description** **Fracture of vault** (frontal, occipital, parietal sphenoid, temporal or unspecified) closed, undisplaced, diastatic, linear, simple, unspecified **Ear** · inner / middle ear injury · ossicular bone dislocation · tympanic membrane rupture · avulsion of pinna (outer ear) **Eye (F)** · cornea laceration · sclera laceration / rupture **Alveolar ridge (bone) (F)** fracture with or without tooth injury **Avulsion gingiva / lid / lip (F)** **Mandibular fracture (F)** · ramus if open / displaced / comminuted · body with or without ramus involvement · subcondylar **Maxilla fracture (F)** closed / unspecified / Le Fort 1 / zygomatic fracture **Tongue (F)** deep + /or extensive laceration **Nose (F)** fracture open / displaced / comminuted	**Awake on admission or initial observation** · prior unconsciousness but length unspecified / amnesia · unconsciousness 15 mins with neurological deficit · unconsciousness 15-59 mins **Lethargic, stuporous, obtunded on admission or initial observation (can be aroused by verbal stimuli)** · no prior unconsciousness / unconsciousness < 15 min with neurological deficit · unconsciousness 15-59 min · prior unconsciousness / loss of consciousness unspecified **Unconsciousness on admission or initial observation (unresponsive to verbal commands)** · length of unconsciousness unspecified · unconsciousness < 1 hr **When level of consciousness on admission or initial observation is unknown** · unconsciousness 15-59 min · unconsciousness < 15 mins with neurological deficit **Fracture of base** (basilar ethmoid, orbital rool, sphenoid, temporal) without CSF leak **Comminuted compound, depressed or displaced fracture of vault** **Cerebellum or cerebrum** · contusion · injury involving any of the following but no further anatomic description (subarachnoid hemorrhage, edema, brain swelling, subpial hemorrhage, hygroma, ischemia, infarction) **Zygomatic fracture (F)** open / displaced / comminuted **Eye (F)** · avulsion · optic nerve avulsion / laceration · tear **Mandibular fracture (F)** · ramus involvement / mandible fracture · subcondylar / body with or without ramus involvement for any one displaced / comminuted **Orbit fracture open / displaced, comminuted (F)** **Le Fort II (F)**	Awake on admission or initial observation · unconscious 15-59 min with neurological deficit · lethargic, stuporous, obtunded on admission or initial observation (can be aroused by verbal stimuli) · unconsciousness 15-59 min / prior unconsciousness for unspecified length of time / unspecified loss of consciousness involving neurological deficit **Unconscious on admission or initial observation** (unresponsive to verbal commands) · 1-24 hr (includes 1 calender day when hrs cannot be estimated) · appropriate movements but only upon painful stimuli (no matter the length of unconsciousness) · length of unconsciousness unspecified / unconscious < 1 hr involving neurological deficit **When level of consciousness on admission or initial observation is unknown, but unconscious** for: · 1-24 hrs (includes 1 calender day when hrs cannot be estimated) · 15-59 min involving neurological deficit **Fracture of base** (basilar ethmoid, orbital roof, sphenoid, temporal) with CSF leak or pneumocephalus **Fracture of vault** (frontal occipital, parietal, sphenoid, temporal, unspecified) open, / dura torn, / CSF leak, / pneumocephalus or brain exposed **Cerebellum or cerebrum** · laceration · hematoma, epidural / subdural ≤ 100 cc, or unspecified · hematoma, intracerebral, intracerebellar (including petechial and subcortical hematoma) **Le Fort III (F)**	**Unconscious on admission or initial observation (unresponsive to verbal stimuli)** · inappropriate movements (decerebrate, decorticate, flaccid, no response to pain—no matter the length of unconsciousness). · 1-24 hr (includes 1 calender day when hours cannot be estimated) / appropriate movements but only upon painful stimuli (no matter the length of unconsciousness with neurological deficit **When level of consciousness on admission or** initial observation is unknown, but unconscious for: · 1-24 hrs (includes 1 calender day when hours cannot be estimated) with neurological deficit · >24 hrs **Brain stem** · compression / contusion / injury involving hemorrhage **Cerebellum or cerebrum** · hematoma, epidural / subdural > 100 cc · diffuse brain injury (white matter shearing injury)
NECK	**Pharynx** contusion / laceration / puncture / rupture **Throat (inner soft tissue)** abrasion / contusion / laceration (not involving major artery) **Tracheal** contusion	**Pharynx** contusion with hematoma / laceration with hemorrhage **Contusion** / esophagus / larynx / thyroid gland	**Trachea** crush **Thyroid gland** laceration	**Laceration** of trachea / carotid artery / subclavian artery **Larynx** crush / fracture / laceration	**Esophagus / larynx / trachea** avulsion / rupture
THORAX	**Rib** contusion / fracture	**Rib** fracture open / displaced / >2 adjacent ribs up to flail chest **Sternum...**fracture	**Lung / pericardium** contusion with or without unilateral hemothorax **Lung** laceration superficial or unspecified **Unilateral hemothorax / pneumothorax** with rib cage or thoracic cavity injury **Sternum fracture...**open / displaced / comminuted	**Chest wall (soft tissue)** perforation / puncture **Lung contusion** with hemomediastinum / pneumomediastinum / bilateral hemothorax or pneumothorax **Myocardium...**contusion **Pericardium...**contusion with hemomediastinum / pneumomediastinum or tamponade / perforation / puncture / rupture / laceration / bilateral hemothorax or pneumothorax **Bilateral hemothorax / pneumothorax** **Hemomediastinum / pneumomediastinum** **Flail chest ("sucking chest" wound)** **Lung laceration** superficial or unspecified with hemothorax / pneumothorax **Inhalation burn**	**Laceration...**aorta / bronchus / coronary artery / lung (deep + /or extensive) / myocardium (including multiple chambers) / pulmonary artery or vein / superior or inferior vena cava / pericardium if involving hemomediastinum / pneumomediastinum or tamponade **Puncture / rupture** of aorta / intracardiac valve or septum / myocardium (involving multiple chambers) / superior or inferior vena cava / pericardium if involving hemomediastinum / pneumomediastinum or tamponade **Perforation** of aorta / bronchus / myocardium / pericardium if involving hemomediastinum pneumomediastinum / tamponade **Rupture bronchus** **Inhalation burn** requiring mechanical respiratory support **Myocardium contusion** if severe or involving hemomediastinum or pneumomediastinum

TABLE 1

A.I.S. SCORE	MINOR	MODERATE	SEVERE, NOT LIFE-THREATENING	SEVERE LIFE-THREATENING	CRITICAL, SURVIVAL UNCERTAIN
ABDOMEN/ PELVIC CONTENTS (*includes all described in parenthesis)	**Superficial or unspecified laceration / perforation** of abdominal wall (no organ involvement) **Abrasion / contusion / superficial or unspecified Laceration or perforation** of scrotum / vagina / vulva / perineum **Penis...contusion** **Scrotum...rupture**	**Abdominal wall avulsion** **Deep + /or extensive laceration or perforation** of abdominal wall (no organ involvement) / scrotum **Stomach contusion** **Ureter** contusion / superficial or unspecified laceration	**Abdominal wall musculature rupture** **Contusion** of *biliary tract (Gall Bladder, hepatic, cystic, & common bile ducts) / colon / duodenum / jejunum / ileum / kidney (with or without hematuria) / liver / bladder / mesentery (omentum) / pancreas / peritoneum / rectum / spleen / urethra / uterus **Superficial or unspecified laceration / perforation** of bladder / penis / ureter / diaphragm **Deep + /or extensive laceration / perforation** of perineum / ureter / vagina / vulva **Avulsion** of scrotum / ureter **Retroperitoneum**...injury involving hemorrhage or hematoma	**Superficial or unspecified laceration / perforation** of biliary tract* / colon / duodenum / jejunum / ileum / kidney / liver / pancreas / peritoneum / rectum (superficial over entire rectal wall, extraperitoneal) **Deep + /or extensive laceration / perforation** of bladder / mesentery / penis / stomach / urethra / uterus **Avulsion** of bladder / mesentary / penis / spleen / stomach / testes / urethra / uterus (unpregnant or 1st trimester) / ovary **Rupture** of spleen / stomach / urethra / uterus (unpregnant or 1st trimester) / bladder (intraperitoneal) **Rupture / tear** ovarian / fallopian tube **Spleen laceration**	**Avulsion / deep + /or extensive laceration / perforation / rupture** of biliary tract* / colon / duodenum / jejunum / ileum / kidney / liver / pancreas (with or without duodenum involvement) **Deep + /or extensive laceration / rupture** of peritoneum / rectum **Intra-abdominal or intrapelvic major vessel laceration** **Uterus** (in 2nd or 3rd trimester) avulsion / rupture
SPINE	**Acute strain with no fracture or dislocation** cervical / thoracic / lumbar spine	**Dislocation (subluxation) + /or fracture** spinous or transverse process (or unspecified) of cervical, thoracic, lumbar spine **Minor compression fracture** T_{1-12} / L_{1-5}($\leq$ 20% loss in height of anterior vertebral body / unspecified)	**Cervical cord** contusion with transient neurological signs (muscle weakness, paralysis, loss of sensation) **Disc herniation (rupture) with nerve root damage** of cervical / thoracic / lumbar spine **Dislocation (subluxation) + /or fracture** of / lamina / body / facet / pedicle / odontoid of cervical / thoracic / lumbar spine **Nerve root / trunk brachial plexus / lumbar plexus / sacral plexus** avulsion / laceration / rupture, injury with unknown lesion **Compression fracture of more than one vertebrae + /or > 20% loss of height of anterior body** T_{1-12}/L_{1-5}	**Cervical cord lesion** incomplete with preservation of significant sensation + /or motor function	**Cervical cord** crush / laceration or total transection with or without fracture + /or dislocation C_4 or below **Complete cervical cord lesion** (quadriplegia or paraplegia) **Crush / laceration / total transection (paraplegia)** of cord / cauda equina
EXTREMITIES & BONY PELVIS	**Contusion / sprain** of acromioclavicular joint / elbow / shoulder (glenohumeral joint) / sternoclavicular joint / wrist (carpus) / ankle **Contusion** fibula / knee **Sprain** finger / foot / hip / toe **Fracture / dislocation** finger / toe	**Dislocation / laceration into joint** of acromioclavicular joint / elbow (dislocation of radial head) / hand (laceration involving flexor or extensor tendons) / sternoclavicular joint / wrist / heel (dislocation subtalar; laceration involving Achilles tendon) / patella (laceration or rupture patellar tendon) **Fracture** of clavicle / acromion / hand (cargal or metacarpal) / humerus / radius (including Colles) / scapula / ulna / fibula (head, neck, shaft, or lateral malleolus) / foot (metatarsal talar, tarsal or unspecified) / heel (calcaneous) patella / pelvis (closed or unspecified with or without dislocation of any of the combination of the ilium, ischium, coccyx, sacrum, pubic ramus) / tibia (shaft, malleolus, plateau, condyles) **Laceration into joint** of shoulder / ankle / knee **Muscle** avulsion or laceration of major muscle tendon of upper & lower (except patella & Achilles) extremities **Nerve laceration** of upper (median, radial, ulnar) or lower (femoral, tibial, sciatic or peroneal) extremity **Dislocation** of foot (subtalar, transtarsal, or transmetatarsal) **Laceration or rupture** of distal biceps tendon **Biceps** muscle rupture **Amputation / crush** of finger / toe **Acromioclavicular** separation **Contusion** of fibula with peroneal nerve injury ("footdrop") **Rupture** of collateral or cruciate ligaments of the knee	**Crush** of acromioclavicular joint / arm / forearm / elbow / hand / shoulder / sternoclavicular joint / wrist / ankle / foot / heel / knee / below knee **Amputation** upper extremity above or below elbow / hand / foot / heel / lower extremity below knee (traumatic; partial or complete) **Dislocation** of shoulder / wrist (radiocarpal, intercarpal, pericarpal) / ankle / knee / elbow (if involving olecranon) / hip (with or without fracture of acetabulum, femoral head, neck or intertrochanteric) **Fracture** of humerus / radius (including Colles) / ulna (with any one or combination of open, displaced, comminuted or involving radial nerve) / femur (condyle, head, neck, shaft with or without sciatic nerve involvement). **Fracture** of tibia / fibula / or pelvis (closed or unspecified with or without dislocation, of any one or combination of the following: ilium, ischium, coccyx, sacrum, pubic ramus) with any one or combination of open, displaced or comminuted **Sacroiliac** fracture + /or dislocation **Symphysis pubis** separation (fracture) **Knee**...rupture of collateral or cruciate ligaments **Ankle**...rupture of collateral ligaments + /or Achilles tendon **Laceration** of axillary / brachial femoral / popliteal artery **Nerve laceration** of upper (median, radial, ulnar) or lower (femoral, tibial, sciatic peroneal) extremity involving $\geq$ 2 nerves in same extremities **Muscle avulsion or laceration** of multiple major muscle tendons in upper and lower (except patella or Achilles) extremities **Complete patellar tendon** laceration or rupture	**Pelvis** ... crush **Above knee crush / amputation** (traumatic partial or complete)	

A.I.S.6 - *Maximum Injury* - *Automatically Assigned I.S.S.-75*	
EXTERNAL	- 2° or 3° burn including incineration $\geq$91% T.B.S.
HEAD	- crush or ring fracture crush/laceration brain stem (hypothalamus, medulla, midbrain, pons.)
NECK	- decapitation
THORAX	- total severence aorta chest massively crushed
ABD./PELVIC CONTENTS	- torso transection
SPINE	- cord crush/laceration or total transection with or without fracture C-3 or above

LD_{50}	
AGE (in years)	**I.S.S.**
15-44	40
45-64	29
over 65	20

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INJURY SEVERITY SCORE (I.S.S.)

I.S.S. BODY REGION	A.I.S. SCORE	SQUARED
HEAD/NECK	_____	_____
FACE	_____	_____
CHEST	_____	_____
ABD./PELVIC CONTENTS	_____	_____
EXTREMITIES/PELVIC GIRDLE	_____	_____
EXTERNAL	_____	_____

I.S.S. _____ (sum of squares of 3 most severe only) **LD_{50}** _____

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