Work and health in the coir industry in Sri Lanka: a descriptive study with a specific focus on risk factors for injuries and incidence of injuries at these workplaces

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Abstract

Introduction

The coir industry processes fibres from coconuts. This industry plays an important role in sustaining the livelihood of a large number of people in Sri Lanka. Coir-related exports account for 6% of agricultural exports, 1% of total exports, and 0.35 percent of GDP in Sri Lanka. Even though this industry employs many people, we know relatively little about the potential health risks of these workers. Very few studies have been done in this industry showing the actual working conditions and possible injuries affecting the workers' health. More knowledge from the industry could be useful in plans for prevention of occupational injuries in the coir industry. Therefore, this project will study occupational injuries among coir workers and the risk factors associated with them, to be able to suggest preventive issues at these workplaces, if needed.

Objectives

The objective of this study is to obtain information about work, risk factors, and occupational injuries among coir workers. The study describes risk factors associated with injuries and the incidence of workplace injuries among workers of both genders in the coir industry.

Methods

This was a cross-sectional study of 128 coir workers in six medium-scaled coir industries, conducted in North-Western and Western provinces of Sri Lanka. An observational checklist was developed for collecting data of risk factors for injuries outdoors and indoors in the coir industries, registering uneven or slippery flat surfaces, moving transports and machines, parts of machines, lighting, and noise. The project group also designed an interview guide for managers, which included relevant questions for the coir industry visited; starting year of the factory, the number of workers, injury statistics, and the type of machines used in those coir industries. Also, an interview guide was used for obtaining information from the workers, collecting data on background of the worker (sex, age, education, years at work, and type of work), any experienced injury in the past three months.

The data were analysed using descriptive statistics. Chi-square tests were used to compare differences in injuries last three months among the two genders, and independent T-tests were used to compare the age, work year, years of school, years of work in the coir industry, and

hours of working per day in the two groups. The annual incidence rate of injuries per 1000 workers was calculated.

Results

In this study, the annual incidence rate of injuries was calculated to 1063 injuries per 1000 workers per year. The female workers had a higher incidence rate (1556) than the male workers (638). Operating machines was significantly more common among the female workers, and this work was associated with workplace injuries.

Slipped, tripped, and fall (64%) were the most common events of injury seen among all the injured workers. Also, cuts and bruises were common types of injuries. Fractures (12.5%) were also described in the study. Several risk factors were identified in the workplace environment, such as uneven floors, dusty floors, high noise levels, unmarked transport routes, not using of PPE and handling of dangerous machines in both indoors and outdoors.

Discussion /conclusion

The annual incidence rate of injuries in the coir industry was higher than reported from many other types of industries, and highest among the female coir workers. Workers in the present study were exposed to a variety of injury risks. Specifically, many of the female workers used machinery with potentially hazardous moving parts while wearing no personal protective equipment (PPE), and this might be the reason for their high incidence injury rate. This raises concerns and highlights the need for preventative measures in this industry to minimize the injury risks and hazards. Further study is required to learn more about the occupational injuries in this industry.

Table of Contents

List of Tables

List of Figures

Abbreviations

GDP	Gross domestic product
MT	Metric Tons
ICC	International Coconut Community
ILO	International Labour Organisation
WHO	World Health Organisation
OSH	Occupational Safety and Health
PPE	Personal Protective Equipment
SPSS	Statistical Package for Social Sciences
NIOSH	National Institute for Occupational Health and Safety
dB(A)	A-weighted decibels
EDB	Export Development Board
IDB	Industrial Development Board

Terms and Definitions

Coir

The coconut fibres, also known as coir, are 100% fibres extracted from the outer part, the husk of coconuts (Uragoda, 1975).

Occupational injury

Any personal injury caused by work is considered an occupational injury in the present study. Occupational injuries are defined differently in different countries. In the present study, the workers were asked for injuries they had experiences at the workplace, during workhours and during their work; this was considered as a self-reported occupational injury (ILO, 2012).

Occupational accident

An occupational accident is an unexpected, unplanned, and unwanted event at the workplace. The injuries may fatal or non-fatal (ILO, 2012).

Occupational hazards

Any activity, method, or material related to work (in the coir industry in the present study) that has the potential to cause an injury or severely affect the health of those who undertake this task (WebMD, 2021).

Risk

refers the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard (Canadian Occupational health and Safety, 2021).

Risk factors

A risk factor, also known as a hazard, is a factor linked to an increased risk of disease or infection (National Cancer Institute, USA, 2021).

Industry

Industry is a term that defines a set of businesses and companies that generate or deliver goods, services, or income (Encyclopaedia Britannica, 2021).

Medium-scale industries

A medium-scale industry is in this study defined as one that employs 50 - 250 people (European Commission, 2021).

Small-scale industries

A small-scale industry in this study is defined as one that employs fewer than 50 people (European Commission, 2021).

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Chapter One

Introduction to coir

1.1 Background regarding coir

Coconut fibres, also known as coir, are fibres extracted from the outer part, the husk of coconuts. Coir is the fibrous material that makes up the coconut fruit's thick mesocarp (middle layer) (Cocos nucifera) (Raviv & Lieth, 2008). It has a very hard, thick brown shell (endocarp) and hard, white flesh (Figure 1) (Uragoda, 1975).

Figure 1: A bisection of ripe fruit from the coconut palm (Cocos nucifera). The left shows the exterior of the coconut view. The right shows the interior view of the coconut: The coconut palm is consisting of exocarp, mesocarp, and endocarp is followed by the endosperm. Source (Schmier et al., 2016).

The husk of the coconut contains roughly 75% fibre and 25% fine material, known as 'coir pith' (Raviv & Lieth, 2008). Coir is made up of two kinds of fibres: Brown and white. Brown coir is made from mature, ripe coconuts and is stronger than white coir, although less flexible (Figure 2). White fibres come from the not ripe coconuts (Figure 3) (Espiritu, 2021).

Figure 2: Brown coir fibre. Source (Milun Exports, 2021).

Figure 3: White coir fibre. Source (Milun Exports, 2021).

The coir fibre has a wide variety of uses, depending on the colour, length, and thickness of the fibres (Figure 4). The brown coir is, for instance, used for upholstery padding (car-seats), sacking, and horticulture. On the other hand, white coir is used to manufacture fine brushes, strings, ropes, and fishing nets, among other items.

Figure 4: Products are made from coir fibre*. Source (Export Development Board, Sri Lanka, 2021).*

Other products from coir are:

-Coco peat, also known as coir fibre pith, coir dust, or coir, is used for horticultural and agricultural purposes and is also an industrial absorbent.

-Geotextiles are used as mesh, netting, and blanket sheets for slope stabilization and erosion control.

-Coir pots, nursery bags, coir chips (or coco chips or husk chips), coir poles, and grow bags are used for farming purposes.

-Coir yarn is used today in numerous industries due to its quality and strength (Cocomats International, 2021).

1.1.1 Coir industry in the world

The coir industry plays an important role in many coconut-producing countries as a major source of income. The global annual production of coir fibres is about 350,000 metric tons (Coir Board, 2014b).Around the world, 93 countries grow coconuts. India and Sri Lanka produce around 90% of the total global coir fibres (Table 1). The coastal region of India produces approximately 60% of the entire world supply of white coir fibres, whereas Sri Lanka has around 36% of the total world brown fibres (Prabhu & Thomas, 2002).

Other countries in South Asia include the Philippines, Thailand, Malaysia, and Vietnam, are also involved in the production and export of coir products, but only on a smaller scale (Persistence market research, 2019). In addition, India and Sri Lanka are the main countries where coir is extracted by traditional methods for the commercial production of various products, including brushes, brooms, ropes, yarns for nets, bags, mats, and padding for mattresses.

Table 1: World exports of coir and coir-based products (in metric tons, MT) 2014-2018 (Coconut Development Authority, 2018b)

Country	**2014**	**2015**	**2016**	**2017**	**2018**
Total international coconut production	295,122	229,357	238,877	269,642	256,563
India	81,738	74,225	84,255	84,510	87,438
Coir Yarn	4,187	4,013	4,611	3,406	3,393
Coir Mattings	2,270	1,550	1,389	1,307	1,114
Coir Mats	69,132	62,471	71,103	72,530	73,560
Coir rope	632	525	392	541	493
Rugs & Carpets	114	363	184	250	187
Rubberized coir	993	955	616	1208	1003
Others	4,410	4,348	5,960	6,268	7,688
Indonesia	31,972	36,171	28,525	31,136	36,449
Malaysia	11,877	2,399	2,802	1,038	-
Philippines	27,834	12,287	15,769	46,837	48,568
Sri Lanka	137,854	101,012	105,028	105,046	84,059
Mattress Fibre	36,320	18,090	18,647	18,836	31,050
Bristle Fibre	16,409	11,612	15,525	24,068	2,025
Coir Yarn	2,205	2,617	1,169	1,729	1,404
Twisted Fibre	74,698	62,733	62,338	53,933	41,051
Coir Twine	8,222	5,960	7,349	8,480	8,529
Thailand	3,847	3,263	2,498	75	49
Other countries	196	196	196	196	196

Source: Coconut Statistical Yearbook 2018, ICC

Some African countries like Tanzania and Zanzibar also produce coir-based products like coir pith, thatches, brooms, firewood, and ropes for worldwide export (Muyengi *et al.*, 2015). Still, the size of this production is much smaller than for the countries in Table 1. These African products are exported to China, the USA, European countries, Australia, and Japan.

1.1.2 Processing of coir fibres extraction

The coir fibre extraction is processed through four significant steps: harvesting and husking, retting, defibring, and finishing (Figure 5).

a) Harvesting and husking

The coconuts are harvested by workers who climb up in the trees and cut them down or they are picked up from the ground when the coconuts have fallen from the trees. The green (unripe) coconuts are harvested on the palm after about 6 to 12 months and contain white fibres. Brown fibres are produced by harvesting fully mature coconuts after the nutritious layer of the seed has been processed into copra and desiccated coconut. The fruit's fibrous layer is then manually separated from the hard shell by driving the fruit down onto a spike to separate it (dehusking) (Coir Board, 2014a).

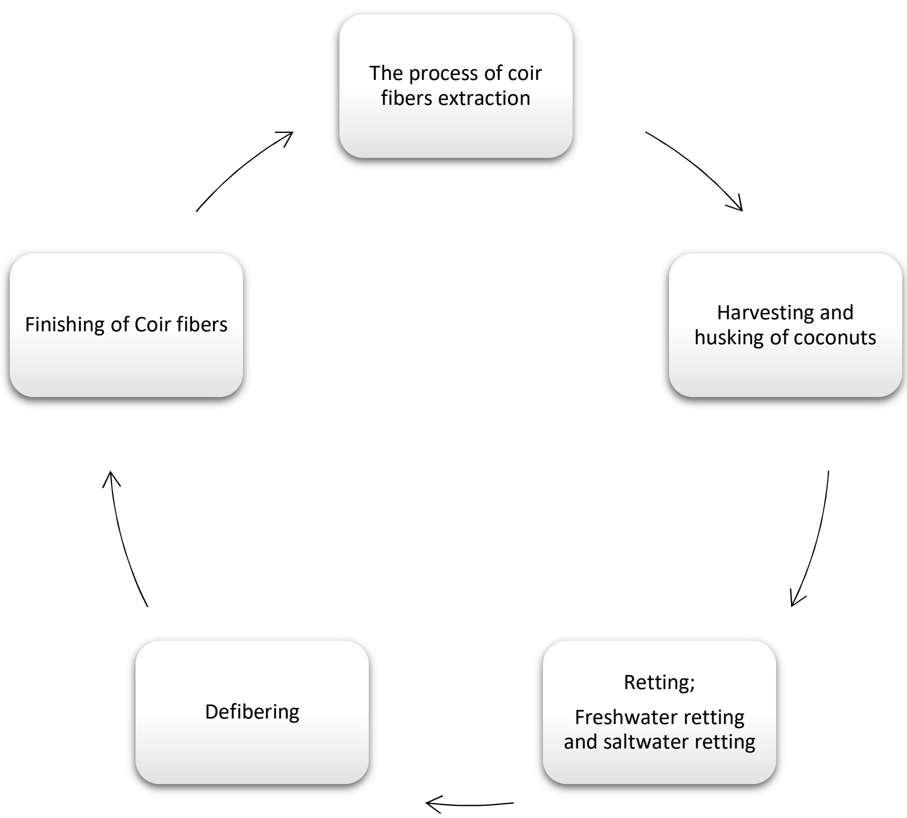

Figure 5: The process of coir fibre *extraction.*

b) Retting

Retting is a curing process that involves keeping the husks in an environment that encourages naturally occurring microbes, typically a water basin. The pulp of the husk is partly decomposed, allowing it to be divided into coir fibres and a residue known as coir pith.

Freshwater retting (Figure 6) is used for fully ripe coconut husks, and saltwater retting is used for green husks (MadeHow, 2021).

Figure 6: Coir husks are soaked into large ponds for 3-6 months. Around 1 million coconuts can be soaked into a pond like this photo, where the pond is filled with coconut husks. Afterward, the workers collect the husks and transfer them to other places for further processing. This is called freshwater retting.

c) Defibring

The coconut fibres are removed from the shells by steel combs in a process known as defibering. Workers may use manual wooden rollers to beat on the pulp extracted after retting to defiber the pith and fibre. Another method is using modern machines with steel drums and beater arms to separate the pith and fibre. Pith and fiber are collected separately by using rotating steel drums. Often machines like traditional ceylon drums are used to wash and tumble the fibres (Dinesh MJ, 2021).

d) Finishing

In the finishing stage, the coir fibres are gathered and dried. After that, the fibres are pressed into bricks, discs, and coir pots. Often, machines are used for this part of the process, for instance, to press the fibres together. In this dried, processed state, the coir is ready to be sold and used. However, this part of the process may include decolorization/ bleaching or dying of the fibres using chemicals (using sulphur dioxide, chlorine, or dyes); some factories also weave the fibres into mats. Most employees working in this process are male (Coir Board, 2014a).

Mechanical process

Recently, mechanical techniques have been developed to speed up or eliminate the retting process. Ripe husks can be processed in crushing machines after being retted in water for around seven to ten days. Immature husks can be dry milled without any retting. These green husks also need to be dampened with water or soaked one to two days after passing through the crushing machine before proceeding to the defibring steps (MadeHow, 2021).

1.1.3 Coir industry in Sri Lanka

The best climate for coconut plantations has ensured that Sri Lanka is the fourth-largest exporter of coconut products globally. Every year, Sri Lanka harvests between 2500 and 3000 million nuts. The government aims to enhance the annual coconut crop to 3600 million nuts per year, increasing the industry (Export Development Board, Sri Lanka, 2021). Coconut coir and coir-based product manufacturers have been a widespread group of industries in Sri Lanka for centuries. Coir-related exports account for 6% of agricultural exports, 1% of total exports, and 0.35 percent of GDP in Sri Lanka (Oxfam International, 2006).

In Sri Lanka, there are around 1040 coconut-based industries listed, with 342 coir fibre mills (Coconut Developmental Authority, Sri Lanka, 2018a).

Around 75% of the coir workers are female who works part-time in this industry (Oxfam International, 2006). These industries employ almost 500,000 workers, and most of the workers work for their family business or are self-employed. On the other hand, working conditions and productivity are often low (Coir Board, 2014b).

The coir industry is predominantly located in Southern, Western, and North-Western provinces in Sri Lanka (Oxfam International, 2006). The fibres fall into brown and white fibres, contributing to 80% and 20% of the world's coir fibre demand.

The coir industry in Sri Lanka involves two main types of workplaces: Factory and domestic work.

a) Factory work

The factory work in the coir industry is modernized, mechanized, and export-oriented. Particularly the brown-fibre production in the North-Western Province produces coir in factories (Oxfam International, 2006). These small and medium scale industries still extensively use the traditional drum system for producing fibre.

Traditional Ceylon drum and Petti Kuttama are Sri Lanka's most traditional machinery used in the coir industry (Figure 8). These machines are used for fibre extractions. The workers put husks manually into the machines and take them out after crushing the coir into fibres (Sunday Observer, 2011).

The machines are considered very dangerous and unsafe for the workers. Hand crushing is a common injury by this machine, and without proper treatment, the hands of the injured worker can become deformed.

Figure 7: Traditional decortictor; It has a belt, drums, and motor using electricity.

Decorticator machine:

The decorticator is a machine that is used to dry processing of coir (Figure 7). The husks are inserted into the machine and beaten against a cylindrical cage mechanically (Drewe, 2012).

D-1 machine

D-1 machine is the modified decorticator. The D-1 machine was created in Sri Lanka and is a mixture between a needle drum and a defibering machine. Green husks, retted husks, and wetted husks can all be used, and the machine produces mixed fibers that are superior to those derived from the decorticator alone (Drewe, 2012).

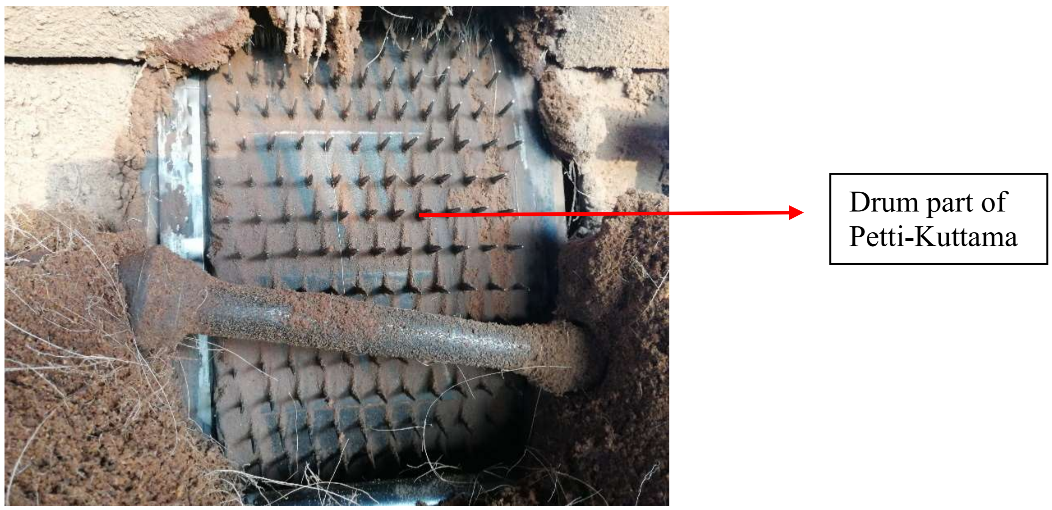

Figure 8: The drum part of Petti-Kuttama, which *separates coir dust from coir* fibre.

b) Domestic work

Domestic coir work is mainly performed by women in the Western and Southern regions of Sri Lanka and is a traditional, labour-intensive white-fibre industry (Oxfam International, 2006). This work involves the same coir process with the four steps described above for factory work, but the process is manually performed. The coconuts are picked and cut by men. Then the work includes soaking coconut husk for weeks in water. The coconut husks are soaked in pools dug for 10-12 months of anaerobic (bacterial) fermentation (FAO, 2002). The retted husks are then manually crushed and beaten into fibres. After hackling, washing, and sun drying, the fibres are loosened manually and cleaned. Then they are spun into ropes. Some of the women in the villages spin the coir by hand. Some use equipment like a spinning wheel called "rads" for spinning fibres into ropes (Panicker *et al.*, 2010).

Introduction to occupational injuries

1.2 Occupational injuries

Any personal injury or death caused by paid work may be considered an occupational injury. Occupational injuries result from a work-related accident or occupational accident. The definitions can differ in many countries due to different national regulations regarding compensations given for this type of injury (ILO, 2012).

An occupational accident is an unexpected, unplanned, and unwanted event at the workplace (ILO, 2012).

In the present study, the definition used is an injury developed after an accident has occurred at the workplace, during work and during work hours.

1.2.1 Occupational injuries in the world

Every day, people die because of occupational injuries or work-related diseases in the world.

According to the recent reports of the International Labour Organization (ILO), there are more than 2.78 million deaths per year worldwide. In addition, 374 million nonfatal work-related injuries occur each year, resulting in more than four days of missed work. Also,poor occupational safety and health practices are estimated to cost the global economy 3.94 percent of GDP each year. (ILO, 2019).

These injuries not only cause great pain, suffering, and death to victims but also to their dependents (Takala *et al.*, 2014). In most countries, vast numbers of workplace injuries are not even reported or recorded to ILO. Global figures are, therefore, most likely underestimated. ILO reports that most work-related deaths and non-fatal occupational injuries occur in low and middle-income countries in South-East Asia and the Western Pacific region. These countries have the highest proportion of the world's working population and have a high proportion of workers in risky jobs (ILO, 2021).

1.2.2 Occupational injuries in Sri Lanka

Occupational injuries in Sri Lanka include death and any personal damage or disease that occurs as a result of a workplace accident. Accidents may lead to damage of machines or equipment at the workplace, but that is a problem separate from human suffering. Working conditions have a substantial impact on worker performance and productivity, therefore improving them for better health and safety has far-reaching ramifications for individuals, industries, and economies worldwide.

About 1,300 work-related accidents are reported in Sri Lanka annually, and about 80 are fatal accidents. However, these statistics probably do not reflect the accurate picture as reporting of occupational accidents is poor in Sri Lanka (Dissanayake, 2016).

In 2019, 18 non-fatal occupational injuries and one fatal occupational injury per 100000 workers were reported from Sri Lanka (ILOSTAT, 2019).

A recent study including 25 formal industries in Sri Lanka reported that over 50% of large machinery, and 33% of medium-scale machineries were not adequately guarded (Arnold *et al.*, 2019). Nearly 41% of the machineries were difficult to operate, and of them, 36.2% had controls in positions that were difficult to reach. Only 34.8 % of the safety measures implemented had proper demarcation of areas, with 28.9 % displaying safety signs. Housekeeping was poor in 59.4 %, and less than 40% had safe storage of raw materials and end products. All these factors give a risk of accidents/injuries. Also, this report tells that a high percentage of other physical hazards are present in these workplaces; Excessive noise (78.3%), poor light (58%), increased temperature (65.2%), and poor ventilation (68.1%) (Arnold *et al.*, 2019).

1.2.3 Prevention of occupational injuries

One of the most major global health challenges in the twenty-first century is reducing the worldwide burden of injuries, especially since injuries are preventable and numerous viable measures exist to minimize current injury rates.

To be effective, interventions to prevent occupational injury should be multi-dimensional. To reduce the number of injuries incidence and underlying occupational morbidity, various actions, including workplace visits, risk assessment activities, and development initiatives addressing specific risks, must be performed and the knowledge integrated for prevention planning.

Every country should implement the ILO's Occupational and Health Safety Program principles (ILO, 2018), including:

- All workers in the official and informal sectors have the right to work in safe and healthy conditions.
- Collaboration and coordination at the workplace, national, regional, and all levels since Occupational Safety and Health is multidisciplinary in nature.

- Workers who are vulnerable (in terms of age, sex/gender, race/ethnicity, and general health status) must be protected against the workplace's specific stresses and risks (ILO, 2018).
- Continuous training and specialized education should enhance the national expertise of professionals in various domains of Occupational Safety and Health (ILO, 2018).

Different actions can prevent occupational injuries:

- Governments must prevent workers from health and safety risks by enacting OSH legislation, enforcing regulations, and conducting workplace inspections.
- Hazard identification and control, safe work practices to reduce risk, the use of personal protective equipment, and safety and health information are all topics covered in worker and management training.
- Technical measures could help eliminate injury risks among workers.
- Personal protective equipment (PPE) can be employed by exposed personnel as a last option for preventing exposure to risks when no other technique is available or when the level of safety attained by other options is deemed unsatisfactory.

1.2.4 Health and safety laws in Sri Lanka

The National Institute of Occupational Safety and Health Act was passed by Parliament on July 23, 2009 for the establishment of the Occupational Safety and Health in Sri Lanka, for the development of an occupational safety and health policy; for the establishment of an environment that leads to occupational safety and health in all workplaces in order to protect both employers and employees; and for related matters, there with or incidental there to (Government, Sri Lanka, 2009).

Sri Lanka became the first South Asian country to launch the Labour Inspection System Application, which appears to comply with the provisions of C081. By registering factories and conducting routine inspections, the Industrial Safety Division works under the Department of Labour to guarantee workers' safety, health, and welfare at work (Health and Safety, Sri Lanka, 2020).

According to the Factory Laws, the employer must ensure workers' health, safety, and welfare in the workplace. The quality of the premises, cleanliness, overcrowding, maintaining a proper temperature, ventilation, lighting, floor drainage, and sanitary convenience should all be checked. The safety of the workers must be ensured by appropriately installing and maintaining the machinery, mechanisms, transmission apparatus, tools, equipment, and machines.Also, in order to ensure worker safety, tools, equipment, machines, and products must be properly organized. safety (Health and Safety, Sri Lanka, 2020).

In addition, Numerous articles of the Factories Ordinance of 1942 demand the employer to offer free safety equipment (breathing apparatus, eye protection eyewear, and exhaust appliances) to employees whose jobs require exposure to wet or hazardous substances (Health and Safety, Sri Lanka, 2020).

1.2.5 Gender differences and occupational injuries

Gender consideration is essential for understanding gender differences and reinforcing knowledge on occupational health concerns in all industries (Messing & Silverstein, 2009). Male and females have different roles in the occupation sector, and as a result, their work-related exposures and health consequences are varied (Quinn & Smith, 2018). However, some studies have found clear gender differences in occupational morbidity, with men experiencing higher rates of work-related injuries, cancer, hearing disorders, and vibration-related diseases, while women are more likely to experience upper musculoskeletal pain, work environment bullying, and sexual harassment (Eng *et al.*, 2011).

Compared to men's occupation, women's work has traditionally been regarded as safer and less injurious to their health. Women are less likely to report occupational injuries and stress at the workplace. As a result, there is a scarcity of information about occupational hazards for women. There are more women than men working in the coir industry in Sri Lanka. Some studies suggest that they are forced to work long hours for no additional pay, and most work directly beneath the hot sun, in unsanitary and dictatorial working conditions (Krishnakumar & Nalini). Therefore, the working conditions for these women are of interest, and comparisons between men and women in the coir production should be performed.

Introduction to literature about the coir industry

1.3 Coir industry, injuries, and health (Literature review)

The knowledge about work and health in the coir industry is minor, and few publications exist on this topic. A review of the literature on coir-related injuries and health was conducted in the medical database PubMed in 2021; only 12 studies were found (Table 2).

Regarding injuries in the coir industry, there were no studies of adults. Some studies exist related to coconut picking and coconuts falling down on people (Rehan *et al.*, 2016), but this is not very relevant for the coir industry's working conditions itself. There has been a study on how to improve the cutting process of the coconuts, quite promising in the attempt to reduce injuries from this type of work (Yuliati *et al.*, 2019). However, this study is focused on the technical challenges and not the health of the workers.

Some studies concern respiratory health, probably since the coir industry creates a dusty environment. An old study from Sri Lanka published in 1975 interviewed 779 workers and examined them by lung x-rays (Uragoda, 1975). However, no sign of respiratory diseases was found. The workers had a low prevalence of respiratory symptoms (2-6%), and the findings on the x-ray examination were like those found in a control group.

Later, an Indian study of coir workers from Alappuzha in Kerala, India, showed the presence of naso-bronchial allergy and pulmonary function abnormalities among coir workers, but this study did not have any control group (Panicker *et al.*, 2010). Therefore, the findings are difficult to interpret.

In a small study from India, sixty-two coir workers with asthma showed high IgE levels, indicating that their asthma might be immunological in origin (Panicker & Sulaiman, 2018). However, it is uncertain if the coir work was the cause of asthma. No dust exposure studies have been performed in the coir industry.

A study from Brazil showed that coir workers had a high prevalence of fungal infections, and the fungus could be isolated from the coconut fibres (Nascimento, Leitão, Silva, Maciel, Muniz Filho*, et al.*, 2014). This publication referred to another study (Silva *et al.*, 1995), indicating that fungus exposure is related to human fungal infections among workers. However, these studies are in Portuguese, and only the abstract has been published in English.

A study from India recently showed that persons who had more than ten years of coir work showed electrophysiological changes in the peroneal nerves. Still, it is uncertain if this has any relation to their work (Chandra *et al.*, 2017).

Also, some survey studies reported occupational health hazards and symptoms among the coir workers, especially women in coastal regions of India (Sahu *et al.*, 2019). A Study in coir Spinning Units in Tamil Nadu revealed that the workers are affected by ailments such as headache, back pain, respiratory problems, skin diseases, and infections in the eyes (Saranya, 2016). Furthermore, air sampling showed the presence of spores and pollens inside coir industries in Kerala, India (Nayar *et al.*, 2007).

A high prevalence of women workers (90 %) involved in the coir retting process in Rathgama, India suffered from skin disease (7%), Eye diseases (10.5%), headache (26%), back pain (24.5%), and respiratory diseases (8.8%) (Kumara *et al.*, 2016). Similarly, the same symptoms were found among coir women workers in Kerala, where had 28.7% respiratory problems, 20.6% skin problems, and 65.0% allergic problems (Krishnakumar & Nalini).

In summary, there are few publications about coir workers and their health, and new studies are warranted, especially among adult workers in this industry. No published studies on injuries among adult workers in the coir industry have been found.

Table 2: Overview on the literature of injuries and health in coir industries.

Health outcome	Country of study	Study /design and population	Methods	Results	Reference
Respiratory health (and allergy)	Sri-Lanka	Cross-sectional 779 workers from coir;591 in control group	Interview. Chest x-ray	Prevalence of respiratory symptoms (2-6%), Findings on the x-rays were similar to a control group.	(Uragoda, 1975)
	Kerala, India	Survey	Fungal spore concentration	Coir workers are at risk of catching respiratory/allergic diseases due to airborne spores and pollens in the factory.	(Nayar *et al.*, 2007)
	Alappuzha, Kerala, India	Descriptive cross-sectional study; 624 coir workers	Interview, Blood tests, Chest x-ray, pulmonary function test	Naso-bronchial allergy and pulmonary function abnormalities might be induced by coir work.	(Panicker *et al.*, 2010)
	Tamil Nadu	Survey; 125 participants from 25 spinning units	Interviews	Workers were affected by headaches, back pain, respiratory problems, skin diseases, and ailments in the eyes.	(Saranya, 2016)
	Sri-Lanka	Field Survey of female coir workers	Interviews	Around 90 % suffered from skin disease, blindness, headache, backbone pains, and respiratory diseases.	(Kumara *et al.*, 2016)
	Alappuzha. Kerala, India	Descriptive study; All coir workers who attended outpatient clinic	Semi-Structured interview, Serum IgE level, Spirometry	Asthma might be immunological in origin.	(Panicker & Sulaiman, 2018)
	Kerala, India	Descriptive study; 40 coir workers	Interviews	28.7% had respiratory troubles; 20.6% suffered from skin problems & 65% had allergic problems.	(Krishnakumar & Nalini)

	India	Survey; Coir workers	Interview; Noise & dust level measurement	Recurrent prolonged cough (30%), phlegm (25%), wheeze (8%), dyspnoea (21%), bronchitis (13%), sinusitis (27%), shortness of breath (8%), and bronchial asthma (6%) in all working units of coir industries.	(Sahu *et al.*, 2019)
Injuries	Soloman islands	Medical record review	Hospital records review	Total 3.4% of all injuries presented to the surgical department of Central Referral Hospital were related to the coconut palm.	(Mulford *et al.*, 2001)
	Kirakira, Solomon Islands	Retrospective clinical audit;3455 admission records	Hospital admission records	142 (55%) of the trauma admissions involved were children, most of which were due to coconut tree trauma.	(Rehan *et al.*, 2016a)
	Alappuzha, Kerala, India	Cross-sectional study;71 individuals	Neurological examinations	142 upper limbs and lower limbs in patients engaged in more than ten years of coir work showed electrophysiological changes in the peroneal nerves.	(Chandra *et al.*, 2017)
	Brazil	Survey; 80 patients	Conjunctival, Nails, cutaneous & sub-cutaneous skin samples	Coir workers may have fungal infections in conjunctiva, nails, and surface & subcutaneous injuries of female coconut breakers.	(Nascimento, Leitão, Silva, Maciel, Muniz, *et al.*, 2014)
Skin	Brazil	Survey; 80 patients	Conjunctival, Nails, cutaneous & sub-cutaneous skin samples	Coir workers may have fungal infections in conjunctiva, nails, and surface & subcutaneous injuries of female coconut breakers.	(Nascimento, Leitão, Silva, Maciel, Muniz, *et al.*, 2014)
	Tamil Nadu	Survey; 125 participants from 25 spinning units	Interviews	Workers were affected by headaches, back pain, respiratory problems, skin diseases, and ailments in the eyes.	(Saranya, 2016)

	Kerala, India	Descriptive study; 40 coir workers	Interviews	28.7% had respiratory troubles; 20.6% suffered from skin problems & 65% had allergic problems.	(Krishnakumar & Nalini)
	Sri-Lanka	Field Survey	Interviews	Around 90 % suffered from skin disease, blindness, headache, backbone pains, and respiratory diseases in coir women workers.	(Kumara *et al.*, 2016)

1.4 Rationale for the study

This study was performed in Sri Lanka, as the coir industry plays an important role in sustaining the livelihood of a large number of people in the Western, Southern and North-Western provinces of this country. Although many people are involved in this industry, we have very little knowledge about possible adverse health effects from this work. Research in the area is minor. Some studies on respiratory symptoms are published, but none on injuries, even though the coir industry uses hazardous machines in their production line. However, we know that similar industry types (e.g.: sisal, jute) cause many and serious injuries among the workers (El Ghawabi, 1978; Kayumba *et al.*, 2008), and it is likely that accidents and injuries constitute a problem also in the coir industry. There are several possibilities for preventive measures to prevent occupational injuries. Therefore, we decided to study injuries among the coir workers to see if, how, and to what degree this industry has occupational injuries.

The Ministry of Health, Sri Lanka, has expressed a wish to obtain more information about the coir industry because of the potential health risks. This was of interest to evaluate, as there might be a need for improving the working conditions for the coir workers. The health authorities acknowledge the need to study this industry in Sri Lanka as many workers were engaged at these workplaces. It is beneficial to have a good work environment in this important industry for Sri Lanka.

The primary purpose of this study was to investigate into potential health risks and possible ways the workers in the coir industry are exposed to those hazards, with a special focus on the risk of injuries among the workers. Injuries related to work can be prevented. The results from this study might give information that can improve the current working conditions of the workers.

Chapter Two

Objectives and research questions

2.1 Main objective

The main objective is to obtain information about work, risk factors, and occupational injuries among coir workers.

2.2 Specific objectives

1. To describe risk factors for injuries at the workplace of coir workers.
2. To describe the incidence of workplace injuries among employees of both genders in the coir industry.

2.3 Research questions

1. What kind of risk factors related to injuries are seen at the working site of coir workers in Sri Lanka's small and medium-scale coir industries?
2. What types of injuries do the coir workers suffer during the work?
3. Is there a difference in occupational injuries when comparing male and female workers?

Chapter Three

Methodology

3.1 Study design

This was a descriptive study using a cross-sectional design. This method was feasible as the fieldwork was performed during a COVID-19 pandemic, and it was difficult to perform large studies and follow workers over time. Also, Sri Lanka did not have a register over occupational injuries, and gathering original data was necessary to fulfill the objectives. The fieldwork was performed in a period of 4 weeks in February 2021, and six industries were visited two days each.

3.2 Organization of the study project

The project was planned by a master's student, two supervisors at the University of Bergen in Norway, and a physician from The Ministry of Health, Sri Lanka. The physician was in Bergen during his Post-doctoral fellowship and returned to Sri Lanka before the study started. He communicated on behalf of the Ministry of health in Sri Lanka that they were interested in such a study, since they knew little about this working population and worried that these workers were at risk for developing occupational injuries and diseases. This physician was the main contact with the industry in Sri Lanka.

Originally, the master student planned to carry out the fieldwork by visiting the industrial sites and collect the data herself. However, due to the coronavirus pandemic outbreak, this was not possible. Traveling from Norway to Sri Lanka was difficult as the airports were closed for long periods and only a few people were allowed to enter Sri Lanka. Also, the project plan included a pre-visit in the industry for the supervisors in Bergen, but as the supervisors could not travel, this visit was performed by the physician we had as a contact in Sri Lanka. During this pre-visit, photos and short videos were taken and sent to Norway, and the final planning of the study was done by online meetings.

Two Sri Lankan research assistants were hired to collect data on behalf of the principal investigator and the master student. The research assistants had a Bachelor of Medicine and Bachelor of Surgery (MBBS) and were doing internships during the period when the fieldwork was performed. They were selected based on previous experience in health and injuries.

The research assistants were trained by the master student through internet communication from Bergen, Norway. Four meetings were held.

The training consisted of:

-Information about the project

-Training in how to carry out the workplace surveillance using an observation checklist

-Training on the questionnaires to workers and management

The assistants performed the interviews of workers and the management of the industry as well as observations at the workplaces. During the data collection period, weekly feedback was given by them to the researcher in Norway. In Sri Lanka, some coir industries were closed due to the pandemic, while in the running industries, the manpower was not more than half in number than before the corona pandemic.

3.3 Study sites

The study was performed in Sri Lanka, as this country has a large coir industry. Sri Lanka is a country in southern Asia located off the coast of India, with a total land area of 65,610 km2 (25,330 sq mi) and a population of 22,072,000. It is divided into nine provinces and twenty-five districts for administrative purposes (Encyclopaedia Britannica, 2016).

Most of the coir industries (85%) are situated in the North-Western Province and Western provinces of Sri Lanka (IDB, Sri Lanka, 2007). Small and medium-scaled industries are described differently in each country. Six medium-scaled industries, each with 15-40 employees, were randomly selected from a list of industries in the Western (Gampaha district) and North-Western province of Sri Lanka (Puttalam and Kurunegala district) (Figure 9).

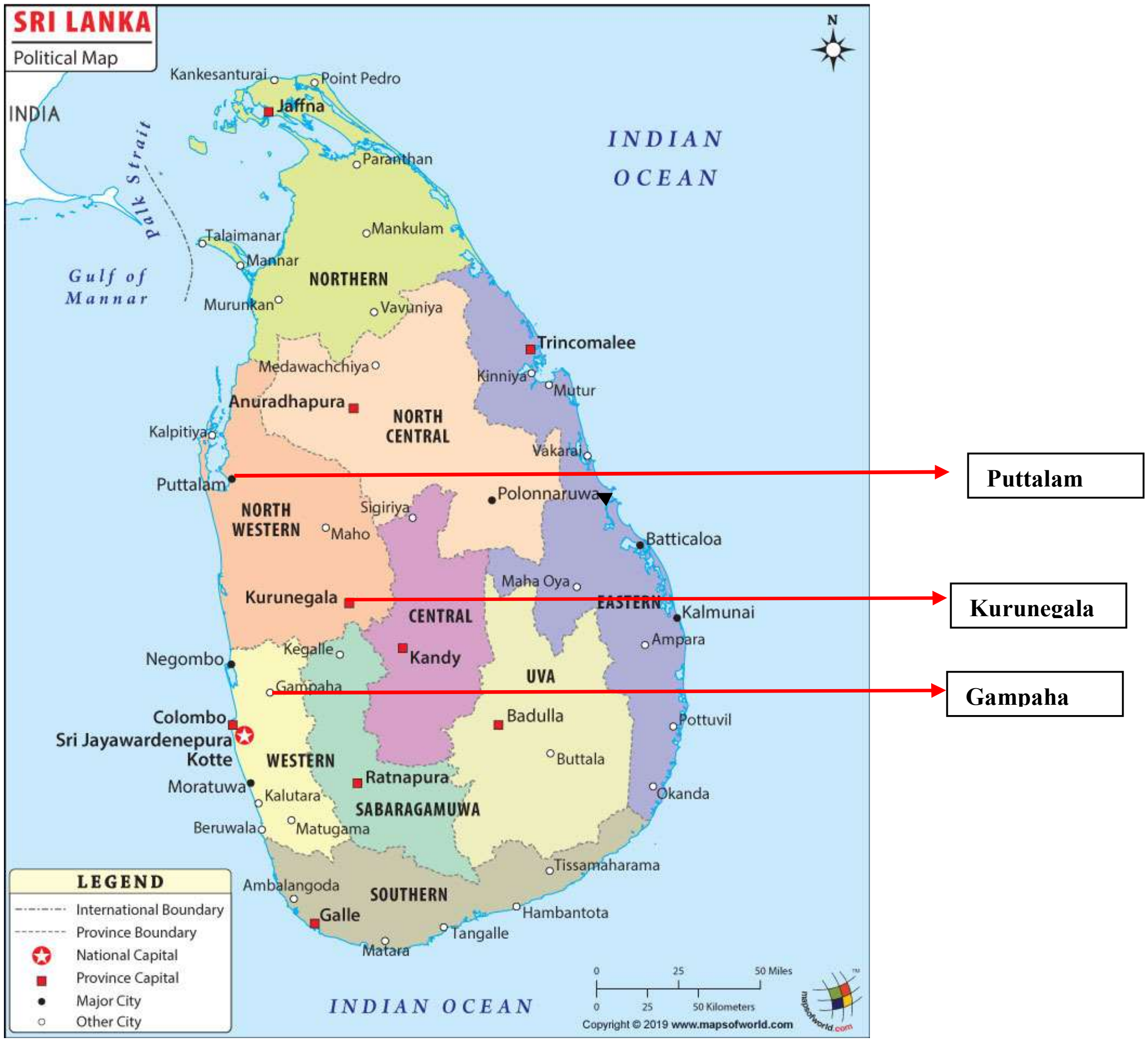

Figure 9: Most of the coir industries are situated in North- western (Puttalam and Kurunegala district) and Western provinces (Gampaha) of Sri Lanka

3.4 Study population (including inclusion and exclusion criteria)

The study's participants were coir workers from Sri Lanka. Workers from six industries selected from North-western (Puttalam and Kurunegala district) and Western (Gampaha) were included in the study. Workers present at work on the chosen days for researchers visiting the industries and who were given consent were included in the study.

3.5 Sample size calculation

Sample size calculation for statistical power estimation was difficult to perform in this situation, as we had no figures from Sri Lanka about occupational injuries. However, using figures from Ethiopia, also a low-income country, with a prevalence of 38% of occupational injuries in a population of building site workers and an expected prevalence of 25% of occupational injuries in the general population, the statistical power was 90 for a number of 134 participants (significance level 0.05) (Tadesse & Israel, 2016).

$$N = \frac{p_0 q_0 \left\{ z_{1-\alpha/2} + z_{1-\beta} \sqrt{\frac{p_1 q_1}{p_0 q_0}} \right\}^2}{(p_1 - p_0)^2}$$

q0=1−p0

q1=1−p1

$$N = \frac{0.38 * 0.62 \left\{ 1.96 + 1.28 \sqrt{\frac{0.25*0.75}{0.38*0.62}} \right\}^2}{(0.25 - 0.38)^2}$$

N=134

Where,

p_0 = proportion(incidence)of population

p_1 = proportion (incidence) of the study group

N = sample size for the study group

α = probability of type I error (usually 0.05)

β = probability of type II error (usually 0.2)

z = critical Z value for a given α or β

3.6 Approaching the industries and the workers

The principal investigator in Sri Lanka approached the owner of these industries by phone and asked for permission to perform the study. We asked for a meeting with the owner to inform and explain how the study would be performed. Industries that agreed to participate were contacted for detailed planning through a meeting with the leadership and employees. We asked for a contact person who could organize contact with the workers. If we did not get any permission, we would not perform the study at that industrial site. We also asked the owner for signed permission to take photographs in the industry in a way that workers were not recognized (Appendix 1). The photographs have been used to illustrate the different work tasks in the coir industry in this master's thesis and can also be used in publications from the study and in teaching material for students at the University of Bergen (Figure 10).

In agreement with the owner, the workers were gathered for oral information about the project, either in the morning or at the lunch break. The information was given by the research assistants, and the workers were asked to participate by approaching them one by one after the information had been given to them. The day after the information or on the same day, each of the workers was addressed during working hours for a short interview at the worksite. They signed a written consent before the interview (Appendix 2).

On the day of information and/or interview of the workers, the researchers performed the walkthrough survey and interviewed the manager (Appendix 3 and 4).

3.7 Data collection

a) Workplace observation and interview with management

In all the industries, the principal investigator/research assistants collected information about factors of possible relevance for occupational injuries by using an observational checklist. The checklist was based on a "Risk assessment tool" developed by the European Agency for Safety and Health at Work (EU OSHA, 2007). The list included checkpoints rated as yes/no from the following lists of the Risk assessment tool; Uneven or slippery flat surfaces, moving transports and machines, parts of machines, lighting, and noise (Appendix 3). The workplace observations lasted between 15 and 40 minutes and included both the indoors and outdoors environments. Also, during the walkthrough, the workers were observed regarding clothing and personal protection (Appendix 3).

The management was interviewed regarding the industry, starting year of the factory, the number of workers, injury statistics, and the type of machines used (Appendix 4).

b) Interviews with the workers about injuries

The interview of each worker was performed by the data assistants in a quiet part of the industry site with no employer present. The interviewer asked questions about the background of the worker (sex, age, education, years at work, and type of work) and for any personal experienced injury in the past three months (Figure 10). The workers who had experienced an injury was asked to describe what happened, what part of the body was hurt, and what kind of consequences the injury had (Appendix 5). There were no suitable interview guides published on this topic. Thus, the project group developed relevant questions for the coir industry. This interview guide was developed in English but later translated to the local language by two native speakers. The procedure was to translate the interview back again to English by two other people. Afterward, the interview was adjusted to function optimally.

The interviews were performed with the help of the data assistants in cooperation with the principal investigator who all spoke the local language. Unfortunately, the data assistants did not understand how to obtain information about the location of the injury, so this information was not gathered.

Figure 10: Interview of a worker by a data assistant in one of the coir industries.

3.8 Data handling

The interviews were performed without registration of the name of the workers. The participants were registered by a number in the registration forms to keep them apart from each other. Each worker had to sign a written consent before the interview started. The information was read to some workers who were unable to read or write, and they signed their consent with a 'x'.

The registration forms were kept confidential by the researchers and locked down after each working day. All the data sheets were scanned and emailed from Sri Lanka to Norway as a zip file.

When all data had been collected, the information from the forms was entered into a database and analysed statistically. The registration forms will be kept locked down until the end of 2021, when the project period is over. Afterward, the forms will be destroyed.

3.9 Statistical analysis

Data were analysed by IBM SPSS Statistics for Windows (version 25). Descriptive statistics were used to analyse data from the workplace surveys and interviews of the management and the workers.

The basic features of the participants were described using descriptive statistics, such as minimum, maximum, and mean age, work year, years of school, years of work in the coir industry, hours of working per and permanent jobs in the industry (Table 8).

A Chi-square test was used to assess the gender differences of injuries last three months. The independent T-test had been used to compare the age, work year, years of school, years of work in the coir industry, and hours of working per day between the genders. In all quantitative analysis, a significance cut-off points of $p \leq 0.05$ was used to determine significance.

A risk scale was developed for each factory based on the items observed during the indoor and outdoor workplace observations. When a risk item was present, it was given a score of 1, and when it was not, it was given 0. For each factory, the risk factor scores were summed together to create a final sum: indoors (17 items), outdoors (14 items), and total (31 items).

The annual injury incidence rate can be calculated by a variety of methods. In this study, the annual injury incidence rate was calculated by multiplying the number of injuries with 1000 and dividing by the number of interviewed workers (Michelo *et al.*, 2009).

Since we collected information on workers who had been injured only in the last three months, we calculated the number of people expected to be injured in a year by multiplying the numbers of injured people by 4.

The type of injury events was grouped into four categories for the data analysis: Slipped, tripped, and fall; Cut by sharp object or machine; Pressure damage by machine and Trapped by the assembly line. Also, the type of injury was grouped into five categories: Cut only; Bruises only; fracture only; Cut and bruises, and cut, bruises, and fracture. The type of help needed for each injury was also grouped into eight categories: Medication; Bandages; Medication and rest, Bandages, and rest; Medication, Bandages, and rest; Medication and bandages; Medication, rest and visit to the health clinic and Stopping work, Med, Bandages, and rest.

3.10 Ethical consideration

In 2020, the study protocol was sent to the Regional Committee for Medical and Health Research Ethics, Western Norway. The study received no objections from the committee but found that an ethical clearance was not needed according to the Norwegian Health Care Act, as we did not register names or other types of the identification of the participants, and only information about experienced injuries and no other health parameters (Ref 124455/REC North). The study protocol was also sent to the Sri Lankan Committee, Faculty of Medicine, University of Kelaniya, Ragama, Sri Lanka, and was evaluated and accepted there in 2021 (Ref no. P/03/01/2021).

The main purpose of the study was informed to the study participants, and the information they gave would be kept confidential. They were also being informed of the possibility of withdrawing from any part of the study. Written consent from each of the study participants and the industry management was ensured before data collection. No names were used on the information gathered during the interviews.

If any specific health problems had been presented to the data collectors by the workers during the fieldwork, they should be referred to the health institution nearby. This situation did not occur.

Chapter four

Results

4.1 Interviews with management

The managers at each of the six selected coir industries were interviewed about facts concerning the industries (Table 3). The oldest industry was established in 1923, while the newest started in 2016. The number of workers in the industries varied from 15 to 100. In most industries, half of the workers were male and half of them female, but in one industry, more females were employed. In 2020, the production in the industries varied from 10 to 50 tons of coir husk. All industries had production machines both indoors and outdoors, and they had a routine for maintenance of the machines, such as oiling. Only one of the six industries had a register of recorded injuries.

When the data assistants did not note the information about any item during the industry visit, the items were marked out as missing in Table 3.

Table 3: Information from the management of the industry about the six coir factories.

Key Information	**Industry**					
	1st	**2nd**	**3rd**	**4th**	**5th**	**6th**
Factory established (year)	m	1998	1923	2016	2014	1987
Total number of workers	15	100	31	20	28	20
No of female workers	5	60	20	10	25	06
Size of production in 2020 (Tons of coir)	m	10	50	10	18	20
Register of injuries	m	m	no	yes	no	no
Machines indoors	m	yes	m	yes	yes	yes
Machines outdoors	yes	yes	yes	yes	yes	yes
Routine for maintenance of machines (oiling)	m	yes	yes	yes	yes	yes

**m= Missing information because the data assistants did not note the information during the industry visit*

4.2 Risk scale of workplace observation

Workplace observations were carried out both indoors and outdoors in the six industries using the observational checklist (Table 4 and Table 5).

Most industries had uneven floors or grounds covered in dust (Figure 11). Indoors, the transport routes were not marked while it was marked outdoors in most industries. Insufficient lighting was present in only one out of the six industries indoors. Other characteristics like loose cables on the floors, obstructions like loose objects in work areas, and assembly lines were also observed in all the industries, both indoors and outdoors.

In addition, machinery with dangerous moving parts like brushing machines and drums were present in four out of six industries indoors, while two industries had this type of machines outdoors (Figure 12). Most of these machines had safeguards that not preventing workers' hands, arms, eyes, or other parts of the body from contact with the hazardous parts, and these safeguards were secured firmly in one out of six industries indoors. It was possible to remove safeguards in four industries indoors, making the machine less safe for the worker.

Figure 11: The floor was covered with dust as seen indoors one of the coir industries.

Noise levels so high that one must raise the voice to be heard were noted in four out of six industries indoors and two out of six factories outdoors.

Like told in the methods, a risk scale was calculated for each industry, based on the items identified during the workplace observation, both indoors and outdoors. Each risk item was scored as 1 for a risk item present and 0 when it was not present. The scores for the risk factors were added to a final sum for each industry; indoors (17 items), outdoors (14 items), and total (31 items).

Table 4 and Table 5 lists the score for the 17 risk items observed indoors (17 registered risks= 100%) and the 14 risk items observed outdoors (14 registered risks=100%), respectively. The mean risk score percentage for the six industries was 43% (range 23%-76%) indoors (Table 4) and 23% (0%-64%) outdoors (Table 5). When combining the indoor and outdoor risk scores, the mean risk score percentage was 34% (16%-71%) (Table 6).

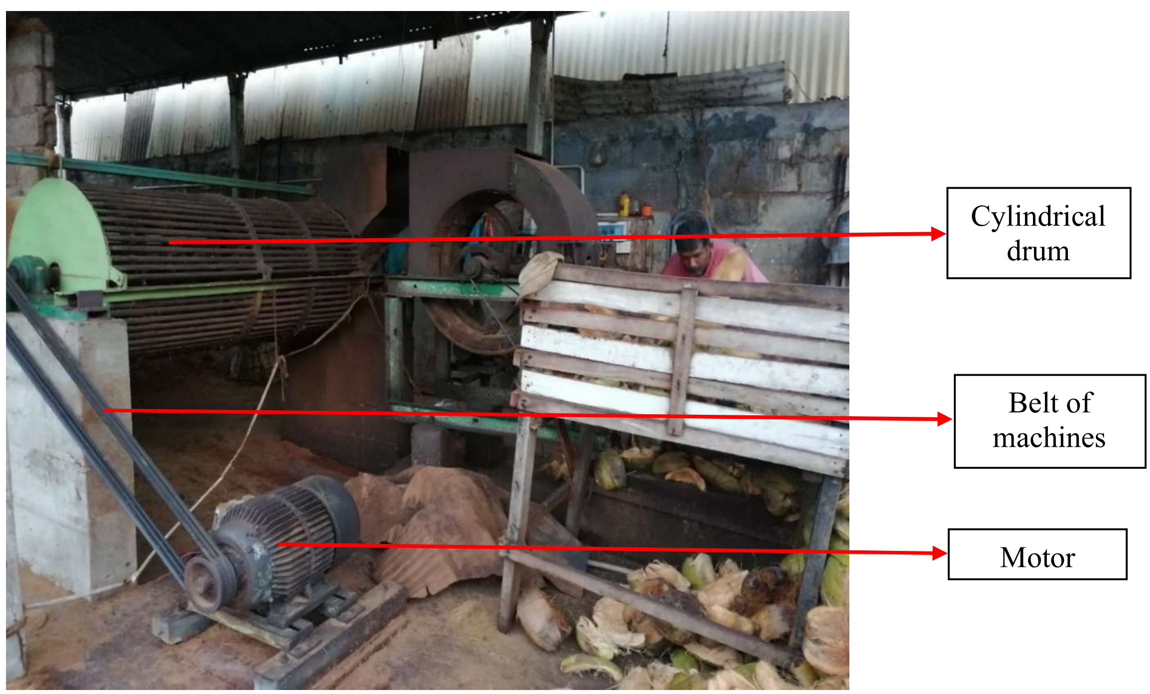

Figure 12: Machinery with dangerous moving parts like brushing machines and drums (Petti-Kuttama).

Table 4: Risk scale of workplace observation in six different coir industries indoor

Risk for 17 items	Industry						
	1st	2nd	3rd	4th	5th	6th	All
Uneven floors	1	0	1	0	1	1	4
No slippery floors	0	0	0	0	0	0	0
Dusty floors	1	1	1	1	1	1	6
Thresholds or other changes on the floors	1	1	0	0	0	1	3
Loose cables on the floor	1	0	0	0	0	1	2
Obstructions from the loose objects	1	0	0	0	1	1	3
Transport routes not marked	1	1	1	1	1	1	6
Insufficient lighting	0	0	0	0	0	1	1
Assembly lines	0	0	1	0	0	0	1
Overloaded transport	0	0	1	0	0	1	2
Transport routes not free of obstructions	1	0	0	0	0	1	2
Loads on vehicles not secured	0	0	0	0	0	0	0
Dangerous moving parts (Brushing machine, drums)	1	m	1	1	0	1	4
Machine safeguards not preventing the worker's hands, arms, eyes, and other parts	0	0	0	0	0	1	1
Secured safeguards but easily removable	0	0	0	0	0	1	1
Possible to remove safeguards	1	1	0	1	1	0	4
High noise level	1	1	1	0	0	1	4
Total sums score indoors*; n (%)	**10 (59%)**	**5 (29%)**	**7 (41%)**	**4 (23%)**	**5 (29%)**	**13 (76%)**	**Mean score (43%)**

0=not present; 1=present; m=missing (missing information because the data assistants did not note the information during the industry visit).

**Total number and percentage of present risk factors in each factory. The percentage is calculated from the max. sum possible of the risk score – which is 17 for the indoor risk factors.*

Table 5: Risk scale of workplace observation in six different coir industries outdoor

Risk for 14 items	**Industry**						
	1st	**2nd**	**3rd**	**4th**	**5th**	**6th**	**All**
Uneven ground	1	0	1	1	1	1	5
Slippery ground	0	0	0	0	0	0	0
Loose cables on the ground	1	0	0	0	0	1	2
Obstructions from loose objects	1	0	m	0	0	1	2
Transport routes not marked	1	0	0	0	0	1	2
Assembly lines	0	0	m	0	0	m	0
Overloaded transport	0	0	1	0	0	1	2
Transport routes not free of obstructions	1	0	0	0	0	1	2
Loads on vehicles not secured	0	0	0	0	0	0	0
Dangerous moving parts (Brushing machine, drums)	0	m	0	1	0	1	2
Machine safeguards not preventing the worker's hands, arms, eyes, and other parts	0	0	0	0	0	0	0
Secured safeguards but easily removable	0	0	0	0	0	1	1
High noise level	0	0	1	0	0	1	2
Shed to protect	0	0	0	0	0	0	0
Total sums score outdoors*; n (%)	**5 (36%)**	**0 (0%)**	**3 (21%)**	**2 (14%)**	**1 (7%)**	**9 (64%)**	**Mean score (23%)**

0=not present; 1=present; m=missing (missing information because the data assistants did not note the information during the industry visit)

The percentage is calculated from the max.sum possible of the risk score which is 14 for the outdoor risk factors.

**Total number and percentage of present risk factors in each factory.*

Table 6: Total mean risk score (indoors and outdoors) in workplace observation in six different coir industries

	Industry						
	1st	**2nd**	**3rd**	**4th**	**5th**	**6th**	**All**
Sum of mean risk score*; n (%) **Indoors and outdoors**	**15 (48%)**	**5 (16%)**	**10(32%)**	**6 (19%)**	**6 (19%)**	**22 (71%)**	**Mean score (34%)**

**The maximum number of risk factors is 31, and the percentage is calculated from this number.*

On the risk scale, the sixth factory had the highest overall score of 71% (Table 6). The fourth and fifth factories had the same risk scores (19%) and second factory had lowest score with 16% only. In addition, the first and third factories got a total of 48% and 32% for workplace observation, respectively (Table 6).

4.2.1 Observation of workers

During the workplace observation, workers were also inspected for their clothing, shoes, gloves, and other protective equipment. Most of the workers wore causal T-Shirts and pants and no proper work clothing (Table 7). Protective gloves and shoes were not seen in five out of six factories (Figure 13).

Table 7: Information from observation of workers at six workplaces

	Observation of workers at six workplaces	
	No	**Percentages (%)**
Protective clothing not used	6	100
Barefooted workers observed	5	83.3
Protective Shoes not seen	5	83.3
Protective gloves not seen	5	83.3

Figure 13: Inside the coir industry, where most of the workers worked with machinery without any protective clothing, hand gloves or shoes.

4.3 Interviews with the workers

4.3.1 Socio-demographic characteristics

All workers present at the workplace were invited to participate in the study, and none of them refused. A total of 128 workers were interviewed, and among them, 53.9% were male and 42.2% were female. Information about gender was missing from 3.9% since the data assistants forgot to note the gender of the participant a few times. We had planned to visit a 7th coir industry in addition to the six ones already mentioned, but the coronavirus pandemic restrictions stopped the fieldwork activities completely and we could not visit the last industry. However, with the obtained number of participants, 128, statistical power was calculated to be 88 from six coir industries we visited.

Table 8 shows the socio-demographic characteristics of the participants by gender. The mean age of the workers was 45 years, and on average, they had worked for five years in this industry. There were no significant differences between males and females regarding age, work years, school years, and working hours.

About 65.6% had a permanent job in the industry while the rest (31.3%) was temporary workers. Information about the permanent job was missing from 3.1% (Table 8). The mean number of working hours per day was 8 hours, but it varied from 4 to 11 hours.

The education level, expressed as school years, varied from zero to a maximum of 12 years. The mean number of school years was seven years, and the females studied on average about eight school years while the males had only six school years.

Table 8: Socio-demographic characteristics of interviewed coir workers (n=128)

Variable		**All**	**Male**	**Female**	**p-value***
			AM (*SD*) range		
Age (years)		45 (11) 17-73	46 (10) 28-73	44 (11) 17-63	0.287
Work years		5 (6) 0.25-30	4 (5) 0.25-30	5 (6) 0.25-30	0.499
School years		7 (3) 0-12	6 (2) 0-12	8 (3) 0-12	0.10
Working hours (per day)		8 (1) 4-11	8 (1) 4-10	8 (1) 4-11	0.171
		N (%)			
Gender	Male	69 (53.9)			
	Female	54 (42.2)			
	Missing	5 (3.9)			
Permanent Job	Yes	84 (65.6)			
	No	40 (31.3)			
	Missing	4 (3.1)			

*AM: Arithmetic mean; SD: standard deviation; *independent T-test*

4.3.2 Type of work

The work task performed by most workers was packing of coir (39.4%). Other tasks done by many workers were operating machines (20.5%) and a combination of drying and packing of coir (17.2%) (Table 9). Among the male workers, 15.9% performed drying of coir, while no female workers were involved in this work task.

The males were most often involved in the packing of coir (43.5%) (Figure 14) and the combination of drying and packing of coir (30.5%) (Table 9). The highest proportion of female workers were machine operators (34.0%) and coir packers (34.0%). They also worked in the transportation (20.8%) and in maintenance (11.2%), where no males were engaged.

No statistical comparisons were performed for type of work, as many of the figures were small (or 0).

Table 9: Type of work performed in the industry among 127* of 128 interviewed workers

Type of work	**Total /Percent N (%)**	**Male N (%)**	**Female N (%)**
Drying of coir	11 (8.7%)	11 (15.9%)	0
Packing of coir	50 (39.4%)	30 (43.5%)	18 (34.0%)
Operating machines	26 (20.5%)	7 (10.1%)	18 (34.0%)
Transport	11 (8.7%)	0	11 (20.8%)
Maintenance	7 (5.5%)	0	6 (11.2%)
Drying and packing of coir	22 (17.2%)	21 (30.5%)	0
Total	127 (100%)	69 (100%)	53 (100%)

** Missing data (Total n=1; type of work n=1 and gender n=5) because the data assistants did not note the information during the industry visit*

Figure 14: Packing machine which is used for the packing of coir dust.

4.3.3 Injuries among the workers

From the total of 128 interviewed workers in the six factories, 34 had experienced at least one injury each during the past 3 months (Table 10). Unfortunately, the data assistants misunderstood one part of the interview. The plan was to register information about all workplace injuries the workers had experienced, but they only registered a maximum of one injury per worker. We, therefore, do not know if the workers had experienced more than one injury each. Also, as mentioned earlier in the methods, the assistants did not register the anatomic location of the injury.

The number of persons who had experienced at least one injury at work varied considerably among the six industries. The incidence of people with at least one injury at work during the last three months was 53.3% in the 1st industry, 33.3% in the 5th industry, 28.3% in the 2nd industry, 23.5% in the 4th industry, and 12.9% in the 3rd industry (Table 10). In the 6th industry, none of the workers reported any injuries.

Table 10: Injuries at work in last three months in all industries

Industry	**Total number of workers in the industry**	**Interviewed workers**	**Number of persons with at least one injury in last 3 months among the interviewed**	**Expected number of persons with at least one injury in one year among the interviewed**	**Percent (%) of persons with injuries in last 3 months among the interviewed**	**Annual incidence rate**
1st	15	15	8	32	53.3%	2133
2nd	100	46	13	52	28.3%	1130
3rd	31	31	4	16	12.9%	516
4th	20	17	4	16	23.5%	941
5th	28	15	5	20	33.3%	1333
6th	20	4	0	0	0	0
Total	214	128	34	136	26.6%	1063

Annual injury incidence rate among all interviewed workers

*Expected Annual Number of injuries = 34*4 =136 among 128 workers.*

*Annual incidence rate of injuries=Expected Annual Number of injuries *1000/ number of interviewed workers =136*1000/128=1063 injuries per 1000 workers per year*

Table 11: Gender differences of injuries at work in last 3 months in all industries

Gender	Total number of workers	Interviewed workers	Number of persons with at least one injury in last 3 months among the interviewed	Expected number of persons with at least one injury in one year among the interviewed	Percent (%) of persons with injuries in last 3 months among the interviewed	Annual incidence rate
Male	88	69	11	44	15.9	638
Female	126	54	21**	84	38.9	1556

***Significant difference between gender and number of persons with at least one injury in last 3 months among interviewed (Chi-square test, p=0.004)*

Totally, the females had a higher incidence of injuries (1556 injuries per 1000 workers per year) than the males (638 injuries per 1000 workers per year).

4.3.4 Experiencing injuries at the workplace during operating machines

Machine operators were more vulnerable to injuries than workers who performed other types of work in all observed coir industries (Figure 15) (Table 12).

Table 12: Injuries at work in last 3 months in the industry (n=125) *

	Machine operator/ N (%)	Non-machine operator/ N (%)	P-value (Chi-square test)
Experiencing injuries at work in last 3 months	11 (44%)	22 (22%)	0.026
Not experiencing injuries at work in last 3 months	14 (56%)	78 (78%)	
Total	25 (100%)	100 (100%)	

** Missing data (Total n=3) because the data assistants did not note the information during the industry visit*

Figure 15: A common injury caused by work at the traditional coir machine. The left hand was crushed inside the machine and deformed due to a lack of proper treatment.

4.3.5 Type of injury events

The major injury event for all workers was in total slipped, tripped, and fall (64%) and this was the most frequent type of injury event among both males (71.4%) and females (56.3%) workers (Table 13).

Table 13: Type of injury events

Type of injury events	**Total /Percent N (%)**	**Male N (%)**	**Female N (%)**
Slipped, tripped, and fall	16 (64%)	5 (71.4%)	9 (56.3%)
Cut by a sharp object or machine	5 (20%)	1 (14.3%)	4 (25%)
Pressure damage by machine	3 (12%)	1 (14.3%)	2 (12.4%)
Trapped by the assembly line	1 (4%)	0	1 (6.3%)
Total	25 (100%)	7 (100%)	16 (100%)

** Missing data (Total n=9; type of injury event n=9 and gender n=11) among 34 who had experienced at least one injury because the data assistants did not note the information during the industry visit.*

The next most frequent injury event in both genders was cut by a sharp object or machine, which accounted for 14.3% in males and 25% in females of the injuries in the study population. Pressure damage by machine and trapped by the assembly line accounted for 12.4% and 6.3% in females, respectively (Table 13).

4.3.6 Type of injury

The common type of injury among the workers were cuts and bruises (50%) (Table 14). The females were likely to suffer from Cut and bruises (55%), often due to handling sharp tools like the combing machine.

Table 14: Type of injury

Type of injury	**Total /Percent N (%)**	**Male N (%)**	**Female N (%)**
Cut	5 (15.6%)	2 (20%)	3 (15%)
Bruises	6 (18.8%)	3 (30%)	3 (15%)
Fracture	4 (12.5%)	1 (10%)	2 (10%)
Cut and bruises	16 (50%)	4 (40%)	11 (55%)
Cut, bruises and fracture	1 (3.1%)	0	1 (5%)
Total	32 (100%)	10 (100%)	20 (100%)

** Missing data (Total n=2; type of injury n=2 and gender n=4) among 34 who had experienced at least one injury because the data assistants did not note the information during the industry visit.*

Other types of injuries comprised Bruises (18.8%), Cut (15.6%), fracture (12.5%) and cut, bruises and fracture (3.1%) in the total study population.

4.3.7 Type of injury in different industries

The type of injury varied between the factories (Table 15). The most common types of injuries included different combinations of cuts and bruises, while fractures were less frequent.

Table 15: Type of injury in different industries

Type of injury	1st industry	2nd industry	3rd industry	4th industry	5th industry	6th industry	Total
Total number of interviewed workers	15	46	31	17	15	04	128
Cut	0	1	2	0	2	0	5
Bruises	0	0	2	2	2	0	6
Fracture	0	3	0	1	0	0	4
Cut and bruises	8	6	0	1	1	0	16
Cut, bruises and fracture	0	1	0	0	0	0	1
Total	8	13	4	4	5	0	32

**Missing data (Total n=2) among 34 who had experienced at least one injury because the data assistants did not note the information during the industry visit*

4.3.8 Type of help needed for different types of injuries

Injured persons needed medical help to recover from the injuries. Bandages and rest were the most needed help for Cut and bruises (n=13) type of injury (Table 16).

In contrast, fractures were less common type of injury compared to other types of injury, which was only four in number. Medication, bandages, and rest were the help needed for fractures.

Table 16: Type of help needed for a different type of injuries

Type of help needed for injury	**Cut**	**Bruises**	**Fracture**	**Cut and bruises**	**Cut, bruises and fracture**	**Total number**
Medication	0	1	0	0	0	1
Bandages	1	0	0	0	0	1
Medication and rest	1	0	0	0	0	1
Bandages and rest	0	1	0	13	0	16
Medication, Bandages, & rest	2	0	3	1	0	6
Medication and bandages	0	0	1	0	0	2
Medication, rest and visit to health clinic	0	0	0	1	0	1
Stopping work, Med, Bandages, and rest	0	0	0	0	1	1
Total						29

** Missing data (Type of injury n=2 and type of help needed for injury n=5) among 34 who had experienced at least one injury because the data assistants did not note the information during the industry visit.*

Chapter Five

Discussion

Several injury-related risk factors were detected in the workplace environments in this study. Most coir workers used machinery with dangerous moving parts, which is hazardous to workers both indoors and outdoors. Most of the workers were not wearing any kind of personal protective equipment (PPE). The expected annual incidence of injuries per 1000 workers was 1063, which is a high number, and female workers suffered from more injuries than male workers. One reason for this might be that more women than men were operating machines. Slipped, tripped, and fall is the most common events of injury seen among all the workers. Also cuts and bruises were common types of injuries. More serious injuries such as fractures (12.5%) were also seen in this study.

5.1 Injury risks among the coir workers

In this study, the risk of injury was high among all workers, with 34 of the 128 workers suffering from at least one injury each during the last three months period. To our knowledge, no previous studies on occupational health in the coir industry has specifically focused on injury and injury risks among the workers.

Several other industries have calculated annual incidence rates among workers, but different methods have been used for the calculation. Furthermore, the type of physical hazards varies considerably between different industries and countries. Thus, care should be taken when comparing our results with other studies. However, the present study revealed that the expected annual incidence of occupational injuries was 1063 per 1000 workers per year, which is higher than among small-scale gold miners in Ghana, reporting an annual incidence rate of mining-related injuries of 289 per 1000 workers (Nakua *et al.*, 2019). We compared with this study as miners in Ghana have some similarities at work as the coir workers, hard physical work, partly inside the mine and partly outside the mine. However, the registration methods in these two studies were different, as the Ghanaian study used a household-based approach to obtain a representative sample of gold miners who were asked if they had suffered any mining-related injuries in the previous year. In contrast, our study used an industry-based approach in which we interviewed all coir workers.

A study from the Finnish fishing industry, similar to the coir industry with hard strenuous work and use of machines, has reported only 32 injuries per 1000 people annually. However, the difference in injuries might also here to be caused by using different research methods. The Finnish study extracted their data from a registry of insurance claims 1996-2015. A registry is more likely to register fewer, more serious injuries filed for compensation instead of all injuries. For our study, we used an industry-based approach in which we interviewed all coir workers at work. The possible underreporting of injuries in the Finnish study has been mentioned as a limitation by the authors in their article discussion (Kaustell *et al.*, 2019).

Another working group with hard physical work is construction workers. A study from Gondar town of Ethiopia had a three-month incidence of occupational injuries of 39%, which is higher than in our coir study (Berhanu *et al.*, 2019).The Gondar study included 566 construction workers from eight construction sites, and the workers were interviewed using a structured questionnaire. The methods were quite similar to the present coir study. The reason why the injury reporting was different might be explained by the different type of work. The construction industry might be more dangerous, with many falls from heights.

Other Ethiopian studies reveal a higher annual incidence of occupational injuries than ours (26.6%), with 37.9% among hotel workers (Abune *et al.*, 2020), 38% among soap and detergent plant workers (Kibret *et al.*, 2018), and 33.3 % among iron and steel industry workers. The methods used were quite similar, but it is mentioned in one of the articles (Abune *et al.*, 2020) that differences in injury rates might be due to differences in the nature of activities performed in the different sectors and different work environments.

Slipping, tripping, and falling are among some of the most common injuries reported in a wide variety of industry contexts, from the Finnish fishing industry (Kaustell *et al.*, 2019) to the American nursing home industry (Bell *et al.*, 2013). According to our study findings, the most common events causing injuries are slipping, tripping, and falling (50%). Many workers worked prolonged periods in hazardous conditions such as uneven floors or grounds and dusty floors, where they may easily slip, trip, and fall, resulting in injuries. This has also been showed in several other studies. Cut by the sharp object (20%) and pressure damage by machine (12%) and trapped by the assembly lines (4%) were other injury events observed in five of the six coir industries in Sri Lanka.

In the present study, injuries were grouped as cut and bruises, cut only, bruises only, fracture only, and cut, bruises, and fracture. Cuts and bruises were the most common among all injuries, accounting for 50% of the total. Fractures had a lower incidence (12.5%) than the other types of injuries in our study, but they must be considered more serious than most other types of injuries. However, this cannot be told with certainty, as the location of the injuries was not reported.

5.2 Injury risks associated with the type of work

The finding from our study indicated that injuries happened as a result of the type of work they were doing, such as packing of coir, operating dangerous machines, and coir drying and packing. Around 50% of workers were involved in the packing of coir and 26% in operating machines. Machine operators had a higher risk of injuries compared with non-operators. Another factor that was found to be significantly associated with the incidence of occupational injury in our study was machine operators compared with non-operators. This increased risk on operating machines and tools was similar to studies in other industries, such as the gold mining industry in Ghana (Nakua *et al.*, 2019) and the iron and steel industry in Ethiopia (Kifle *et al.*, 2014). The Ghanaian study revealed that operating machinery/tools (46.1%) was the most common cause of injuries. We compared this study to our study having the similar tools and equipment that are mainly manually operated and built with insufficient safety safeguards as the traditional coir machines resulting injuries among the workers. Furthermore, workers should make proper use of safer automated equipment or make necessary modifications to manually operated machines to make it safer for them to minimize the risks of injury.

5.3 Risk factors associated with injuries at the workplace

Several risk factors for injuries were observed while surveying workplaces in this research. There were more risk factors for injuries reported indoors than outdoors. In the information we obtained about injuries at the coir industries, we found that slipped, tripped and fall were important factors for injuries to occur. Several of these factors might be related to the risk factors and is described in more detail below.

5.3.1 Uneven floors

Uneven flooring may lead a person to step down to a lower level than intended causing people to slip, trip, and or fall. It can lead to a range of injuries like fracture, traumatic brain injury and broken bones etc. In our study, uneven floor or ground were seen indoors for four out of six industries and five out of six industries outdoors. Every industry should check and replace each floor that is loose, damaged, or old to avoid slip, trip and fall in future.

5.3.2 Dusty floors

In the current study, dust was seen and reported indoors in all coir factories. The dust is a well-known risk in the coir industry (Nayar *et al.*, 2007). During the many steps of coir manufacturing, large amounts of dust is produced. The dust may cause slippery floors and be a part of the reason why people slip and fall, which again may lead to injuries. Thus, the floors should be kept clean and dust-free and slip resistant footwear to maximize traction should be used to avoid falls.

5.3.3 High Noise level

High noise level is one of the most common and well-known concerns in industrial workplaces. In this study, the noise level was not measured. We asked if the workers need to raise their voices to be heard at the workplace. It is considered that when people have difficulties in talking together, the sound levels are about 85 dB(A) or higher. Difficulties in talking together were confirmed indoors for four out of six industries and two out of six industries outdoors. The noise was produced by machines and vehicles in the coir area. Workplace noise is a safety threat, as it for instance may prevent people from hearing warnings shouted to them, and also if the workers develop hearing loss due to the high noise levels, they do not hear warnings (Ramage-Morin & Gosselin, 2018).

5.3.4 Transport routes

Unplanned transportation routes can lead to serious accidents. In this present study, transport routes were not marked in most coir factories. Unmarked transport route was observed indoors for all six industries and in two out of six industries outdoors. Each industry should mark transport routes to ensure that transportation hazards and conditions are routinely addressed and brought up to standard in order to ensure worker safety.

5.3.5 Use of personal protective equipment

Most of the workers did not use personal protective equipment in this present study, they did not have proper clothing and not proper shoes to protect them. In Tanzania, a study in the Sisal industry observed similar occupational risk factors (Kayumba *et al.*, 2009) compared to our present study. Walkthrough surveys were carried out in six sisal factories' brushing and decorticating sections. The study reported visible dust, particularly in the brushing section, wet contaminated work floors in the decortication plants, and a general lack of protective equipment/clothing for workers. It is rather common to use machines or tools without proper clothing in some low-income countries like Sri Lanka, resulting in injuries among the workers (Kayumba *et al.*, 2009; Keyserling, 1994; Nakua *et al.*, 2019).

5.3.6 Use of dangerous machines

Our study found that most of the workers used machinery with dangerous moving parts both indoors and outdoors, like brushing machines and drums. They did not wear any gloves or protective equipment for eyes or face, which may cause harm to their hands, fingers, and eyes. Also, handling sharp tools, such as metal combs on the manual coir machines, was seen in all coir industries and might be the cause for of the cut injuries in this study.

5.4 Injury risks associated with gender at the workplace

Gender differences are often seen in work task performance between men and women in various industries, which may explain differences in injury rates. Females accounted for almost half of the workers in this study (42.2%) and had an annual injury rate of 1556 per 1000 workers, while males had a rate of 638 per 1000 workers. Females worked to a larger extent as machine operators than males, which may explain the higher injury rate among females. As previously stated, machine operators had a high rate of injuries, with 18 of the 25 injured employees being female. Also, operating large machinery requires a great deal of exertion; female workers may not be equipped with the same physical strength as male workers, making operating the machines unsafe.

In contrast to our research, previous studies have found that males are likely to sustain more physical injuries such as musculoskeletal system, tendon injury, wounds, and fractures than females (Berecki-Gisolf *et al.*, 2015). This Australian study enrolled workers who claimed workers' compensation for accidents or illness between 2003 and 2011. The gender variation in injury claim rates was explained mainly by gender distribution within occupational categories rather than by gender distribution throughout industries. The study's limitations were selection bias like underrepresentation of serious injury claims and gender bias such as underreporting by women and young males.

Also, our study showed gender differences in the type of injury event, for instance, for slipped, tripped, and fall, where nine out of sixteen workers were female.

Despite these notable gender-based differences in injury in the present study, there were no considerable socio-demographic differences between males and females in terms of age, years of work, school years, working hours, and permanent job. This study is one of the few studies that found significant variations in occupational exposure patterns between men and women, even when working in the same industry. As a result, the impact of gender on the coir sector should not be neglected.

5.5 Strengths and limitations of the study

The strengths of this study include having a high response rate from workers and industry managers in the coir industry in Sri Lanka, where there are almost no previous studies. There have been a few studies on the health of coir industry workers but to our knowledge, not on injuries.

However, there are several limitations present in this study. Since the study had a cross-sectional design, the results could only be interpreted in terms of occupational injuries of coir workers at one point in time. The data was only collected once throughout the study and the severity of injuries and the anatomical location of the injuries could not be determined. We were not able to show the clear relationship between injuries and specific risk factors at these workplaces, only give an indication of the relationship. We would have needed to perform a more extensive observation of the workers overtime to give clear answers to these questions. However, the obtained information is helpful in describing the situation and directing future measures for improving workplace safety and for protecting coir workers' health.

In terms of the study's internal validity, the interview guides used were not validated or standardized, as there were no such instruments available. This may raise questions of whether we registered the experienced injuries correctly. However, the questions were constructed in cooperation with a physician who knew the industry and type of workers well, and by using an interview, we could make sure that the interviewers explained the questions for the workers. We tried to optimize the interview by performing them in a setting with only one interviewer and one worker present.

The external validity of this study is limited to coir workers in similar industry environments with similar demography and similar regulatory requirements. However, we think the findings from the studied industries are relevant for other coir industries in Sri Lanka. We do not know about any type of selection of the studied industries, and they probably show how a coir industry in this country is organized and how the injures are experienced.

With scarce resources and restrictions during the Covid 19 pandemic, data collection was done by data assistants while the researcher was in Norway. Training of the data assistants was completed through the internet, and we used videos, pictures, and explanations to obtain knowledge about the coir industry. Our study's researchers and data assistants would clearly have benefitted from a pre-visit as well as performing the study, but this was the best we could do when the study was performed from abroad.

Missing data was also a limitation to deal with this study. It is a common concern for researchers, and it can lead to biased results. The data collectors did not fill out some of the information in the questionnaires due to time pressure, so it is considered missing in data sets. We see no specific pattern of which data were missing and do not think it influenced the results very much. However, this made the numbers of some results small.

Another weakness of the study was the selection of workers with only one injury in the previous three months, while the plan was to record all injuries experienced by the workers. We also wanted to know which body part was injured, but the data assistants did not collect this information from the workers.

The study may suffer from recall bias of injuries. People tend to forget their injuries, especially if they are not very serious. However, this may have been minimized to some extent by reporting only recent injuries for the previous three months, not for one year. The results were based on self-reports of injuries as only one of the coir industries had a register of injuries. Also, as the data were limited in numbers, it was difficult to analyse for associations between the risk scale and annual incidence rate.

We were informed by the data collectors at the start that the employees mistook them for a labour department official; therefore, they might have withheld information. The assistants started quickly to ensure that no respondents' identities were included on the questionnaires, and workers were informed before better before consenting to the study. We do not know actually to what extent this changed the information given from the workers. There may have been some incidences of workers underreporting injuries as they might have been apprehensive of the consequences from the management.

Chapter Six

Conclusion

This study from the coir industry in Sri Lanka shows that:

- Several risk factors were identified in the workplace environments, such as uneven floors, dusty floors, high noise levels, unmarked transport routes, not using PPE, and handling of dangerous machines. All these factors may contribute to injuries from slipping, tripping, and falling.
- The estimated annual incidence of injuries per 1000 workers was 1063, which is a high number compared to many similar industries. Workers reported having experienced a variety of injuries, including cuts, bruises, and fractures.
- Female workers were injured at a higher rate than male workers, possibly because more females than males operate machines. Most of the workers operated machines with potentially dangerous moving parts and without wearing any personal protective equipment (PPE).

The findings raise concerns for the need for stronger preventative measures in this industry to minimize injury risks and hazards.

Chapter Seven

Recommendations

Our findings have created concern when considering occupational injuries and health risks among the workers in the coir industry of Sri Lanka. It seems necessary to improve the workplaces to reduce the number of injuries among the workers. Operating hazardous machines seemed to be the riskiest job in this industry, mainly affecting the female workers. The high injury rate among the workers puts a heavy burden on not only coir workers' families but also on the health systems of Sri Lanka.

Our recommendations are as follows:

Coir workers

- Health education campaigns should be conducted to raise health awareness among coir workers about the various injury risks and how they may help to improve their working environment and/or practices.
- Training of the workers on personal protective equipment (PPE); we recommend that all the workers should have knowledge on PPE and how to use it properly when they are operating coir machines in order to avoid experiencing any type of injury at the workplace.

Coir Industry managements

- Workplace improvements, particularly indoor machine areas, must be made more worker-friendly by installing proper safeguards on the machines and expanding access to PPE to avoid potential workplace injuries. PPE like proper shoes, clothing, and gloves should be made available for all workers.
- Registration of work-related injuries and illnesses in each industry might benefit in their prevention in the future. Also, data on workplace injuries and illnesses can be used to find and rectify potentially hazardous working conditions.
- Workplace safety and health program could be one of the most effective methods to protect employees from the potential risks of injuries and illnesses at work.

Ministry of Health in Sri Lanka

- The Ministry of Health should include proper investigation of coir industry occupational health injuries in order to give appropriate treatment and counseling on the prevention and control of these workers' injuries and health risks.
- To maintain statistics of fatal and non-fatal injuries related to coir industries and their consequences on health to help them identify and avoid them as much as possible.
- Workplace safety assessment of the small and medium scale of the coir industry should have clear regulations regarding the work environment, and controls should be conducted routinely to ascertain risks of injury and minimize the risks among those workers.

Labour office

- Develop policies and a safe work code of practice specifically for coir workers of both genders in Sri Lanka, which would act as standards for workplace safety.
- Inspectors should check all industries and conduct investigations into accidents or harmful events, issuing improvement or restriction notices until the risk is eliminated or reduced to a safe level.
- Develop strategies to reduce gender inequalities at the workplace to improve the workplace environment.

Researchers

In order to preserve the health of coir workers in Sri Lanka's small and medium scale industries, more research is recommended to investigate sustainable preventive measures to minimize or reduce exposure to workplace injury and health hazards.

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Appendix

Appendix 1 Coir project

Permission for taking photographs in the project

'Work and health in the coir industry in Sri Lanka: a descriptive study with a specific focus on risk factors for injuries and incidence of injuries at these workplaces'

This project is a descriptive study in the coir industry in Sri Lanka. The purpose of the project is to obtain information about work and health in this industry, focusing on the risk factors at the work place and workplace injuries. There is minor knowledge about the health of workers in this industry, and we would like to obtain more information to be able to improve the working situation for coir workers, if needed. This study is a part of a master study performed at the University of Bergen (UiB). It is a co-operation between the Ministry of Health in Sri Lanka and the University of Bergen in Norway. We would appreciate the possibility of taking some photographs of the working process, to be able to illustrate the master thesis, and to show others how this industry works. The photos will not show faces of the workers.

Our industry allows the University of Bergen, Norway, to take photos at our workplace.
The purpose is to take photos of the work process for use as illustration in a master's thesis, and to show photos to other students for educational purposes in occupational health.

Sri Lanka, date____________________

(Signed by the industry owner)

Appendix 2 Coir project consent
Request for participation in the research project

'Work and health in the coir industry in Sri Lanka: a descriptive study with a specific focus on risk factors for injuries and incidence of injuries at these workplaces'

Background and purpose
This project is a descriptive study in the coir industry in Sri Lanka. The purpose of the project is to obtain information about work and health in this industry, focusing on the risk factors at the workplace and workplace injuries. There is minor knowledge about the health of workers in this industry, and we would like to obtain more information to be able to improve the working situation for coir workers, if needed.
This study is a part of a master study performed at the University of Bergen (UiB). It is a co-operation between the Ministry of Health in Sri Lanka and the University of Bergen in Norway.

We ask you to answer questions in an interview
All workers in five coir industries in Sri Lanka will be asked to participate in the study, and that means to answer questions in an interview about your age, work experience, work tasks and injuries the past three months.

What will happen to the samples and the information about you?

The data registered about you will only be used in accordance with the purpose of the study as described above. The data will be plotted in a data file without your name, just a number. Your name will not be registered anywhere.
The information from each worker will not be made available to the hospital management. We will publish the results summarized from the study in a Master thesis and a scientific publication, and the information will this way be public available. We will give your workplace the results from the study but summarized on a group level. There will not be any possibility of identifying the participants.
Project period
The project started Jan 2020 and will continue to Jan 2023. Then all data in the project will be deleted.

Voluntary participation
Participation in the study is voluntary. You can withdraw your consent to participate in the study at any time during our field work in the industry and without stating any reason during the study. This will not have any consequences for you. If you wish to participate, please sign the declaration of consent on the next page. If you have questions concerning your rights during the study, feel free to contact us during our visit or by email.
The project has been approved by The Regional committee for Medical and Health research ethics, West, in Norway and the Ethical Committee in Sri Lanka.
Thank you.

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Dr. Asela Perera,
Ministry of Health, Sri Lanka
sjwprr@yahoo.com

Consent for participation in the project

'Work and health in the coir industry in Sri Lanka: a descriptive study with a specific focus on risk factors for injuries and incidence of injuries at these workplaces'

I have read the information about the study, and I am willing to participate in the study '**Work and health in the coir industry in Sri Lanka: a descriptive study with a specific focus on risk factors for injuries and incidence of injuries at these workplaces'**

Date____________________

(Signed by the project participant)

I confirm that I have given information about the study.

Signed by Anindita T. Onni, Researcher

Appendix 3 Workplace survey form - coir

Workplace observation – coir industry

Part 1 Indoor location	**Item for observation**	**YES**	**NO**
1	Do the floors have uneven areas, loose finishes, holes, spills etc.?		
2	Are the floors slippery, e. g., when they are wet due to cleaning, spilling of liquids (e. g., oil)?		
3	Are the floors dusty?		
4	Are there thresholds or other changes of level on the floors?		
5	Are there loose cables on the floor?		
6	Are there any obstructions from loose objects left lying around in work areas?		
7	If items are transported inside the building -are all transport routes marked?		
8	Is there any lighting inside the building/ and is it necessary?		
9	Is the lighting at the workplace sufficient to perform tasks efficiently and accurately?		
10	Are there assembly lines present inside the building?		
11	Are the transport lorries/ cars for husk and fibre ever overloaded?		
12	Are transport routes free of obstructions?		
13	Are loads on vehicles secured properly?		
14	How many machines have dangerous moving parts? (Brushing machine, drums)		
15	Are there any machine safeguards? Do the safeguards sufficiently prevent the worker's hands, arms, eyes, or other parts of the body from contact with dangerous moving parts?		
16	Are all machine guards secured firmly and not easily removable?		
17	Is it possible to remove safeguards without stopping dangerous movements?		
18	Is the noise level so high that you must raise your voice to be heard at any area?		
19	Other comments		
Part 2 Outdoor location	**Item for observation**	**YES**	**NO**
1	Do work areas have uneven areas, loose finishes, holes, spills etc.?		
2	Is the ground slippery, e. g., when they are wet due to cleaning, spilling of liquids (e. g., oil)?		

3	Are there loose cables on the ground?		
4	Are there any obstructions from loose objects left lying around in work areas?		
5	Are all transport routes marked?		
6	Is there any shed to protect outdoor workers from the sun?		
7	Are the transport lorries / cars for husk and fibre ever overloaded?		
8	Are transport routes free of obstructions?		
9	Are loads on vehicles secured properly?		
10	How many machines outdoors have dangerous moving parts? (Brushing machine, drums)		
11	Are there any machine safeguards? Do the safeguards sufficiently prevent the worker's hands, arms, eyes or other parts of the body from contact with dangerous moving parts?		
12	Are all machine guards secured firmly and not easily removable?		
13	Is it possible to remove safeguards without stopping dangerous movements?		
14	Is the noise level so high that you must raise your voice to be heard at any area?		
15	Are there assembly lines present outside? (describe)		
16	Other comments		

Part 3 Observation of the workers

	No.		Description
How many workers are present at the workplace?			
Describe the clothing of the workers			
How many of the workers work barefooted?			
How many of the workers have shoes?		Describe shoes	
How many of the workers wear gloves?		What type of gloves	
Describe any other protective equipment present, if any:			

Appendix 4 Interview management

Interview with management in a coir industry

Name of industry:	
Date of interview:	
Question	**Fill in answer**
Which year did this industry start?	Year=
How many persons are employed in total?	Permanent workers= Temporary workers=
How many women are employed?	Number=
Size of the production this year	Tons of coir:
	Husk production:
Do you register injuries in your company?	
If yes, can we be allowed to look at the figures for the last year?	
What type of machines do you have outdoors? Add production year of machines	
What type of machines do you have indoors? Add production year of machines	
Do you have routines for maintenance of the machines (e.g. oiling)	

Appendix 5 – Interview workers coir

Interview with a worker in a coir industry

Question	**Answer**
Background information	
Sex	Male/Female
What is your year of birth?	
How many years have you been at school?	
What type of work do you perform?	
How many years have you been working in this coir company?	(No of years) =
Do you have a permanent job here?	Yes /No, I work in a temporary job
How many hours per day do you work normally?	No of hours=

Questions about injuries

Q: Have you experienced any personal injury <u>at work</u> the past 3 months which have -caused a need for stopping your work or bandages or rest or medication or visit to (Saranya) health clinic or staying away from work?
At work means at the working site, during working hours.

Show this timeline and explain what three months is:

<u>Month1</u>

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	

<u>Month 2</u>

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	

<u>Month 3</u>

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	

Yes/No –
- if yes, continue asking and get information about each injury. Let the worker describe and fill in the table – next page - for each injury.

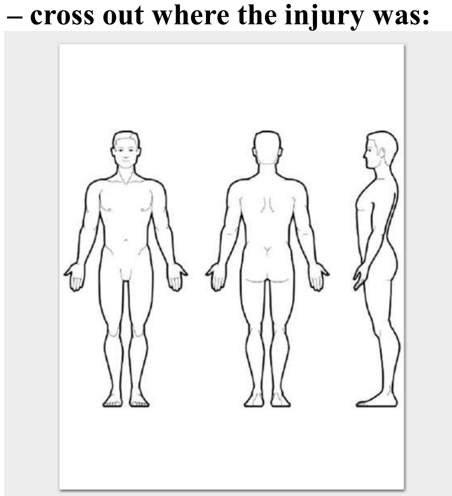
Injury 1

Type of event (What happened?)	**Mark out the correct one(s) and describe**
Slipped	
Tripped	
Fall	
Object falling down on you	
Cut by sharp object	
Cut by machine	
Pressure damage by machine	
Hurt by vehicle	
Trapped in assembly line	

Type of injury	Mark out the correct one(s) and describe
Cut	
Bruises	
Fracture	
Loss of consciousness	
Other	

Describe what type of help was needed due to the injury	Mark out the correct one(s) and describe
Caused a need for stopping your work	
Medication	
Bandages	
Rest	
Visit to (Saranya) health clinic	
Need to stay home from work	

Body location – cross out where the injury was:



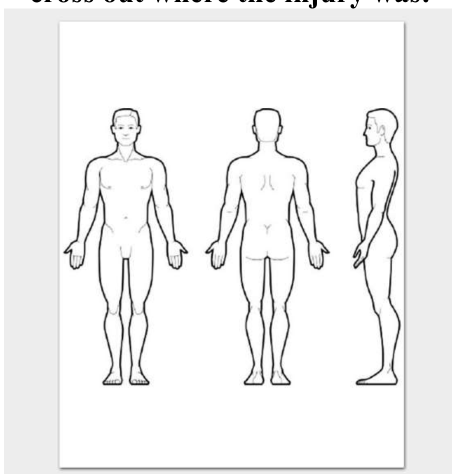
Injury 2

Type of event (What happened?)	Mark out the correct one(s) and describe
Slipped	
Tripped	
Fall	
Object falling down on you	
Cut by sharp object	
Cut by machine	
Pressure damage by machine	
Hurt by vehicle	
Trapped in assembly line	

Type of injury	Mark out the correct one(s) and describe
Cut	
Bruises	
Fracture	
Loss of consciousness	
Other	

Describe what type of help was needed due to the injury	Mark out the correct one(s) and describe
Caused a need for stopping your work	
Medication	
Bandages	
Rest	
Visit to (Saranya) health clinic	
Need to stay home from work	

Body location – cross out where the injury was:



Injury 3 each on separate sheet of paper