THE ASSESSMENT OF FOOD SAFETY PRACTICES, KNOWLEDGE AND ATTITUDE AMONG FOOD HANDLERS, SUPERVISORS AND MANAGERS IN SELECTED FOOD INDUSTRIES IN ADAMA, ETHIOPIA

BY:-

NIGUSSIE GETACHEW

A Thesis Submitted to Adama Science and Technology University

The Department of Applied Biology

School of Natural Science

Presented In Partial Fulfillment of the Requirements for Degree of Masters in Applied Biology (Biotechnology)

June, 2023

ADAMA, ETHIOPIA

The Assessment of Food Safety Practices, Knowledge, and Attitudes among Food Handlers, Supervisors and Managers in selected Food Industries in Adama Town, East Shoa Zone, Ethiopia

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Declaration and Recommendation

Declaration

I hereby declare that this Master Thesis entitled “The Assessment of Food Safety Practices, Knowledge, and Attitudes among Food Handlers, Supervisors and Managers in selected Food Industries in Adama Town, East Shoa Zone, Ethiopia” is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

Name: ---------- Signature: ---------- Date: ----------

Recommendation

I/we, the advisor(s) of this thesis, hereby certify that I/we have read the revised version of the thesis entitled entitled “The Assessment of Food Safety Practices, Knowledge, and Attitudes among Food Handlers, Supervisors and Managers in selected Food Industries in Adama Town, East Shoa Zone, Ethiopia” prepared under my/our guidance by Nigussie Getachew submitted in partial fulfillment of the requirements for the degree of Mater’s of Science in Applied Biology (Biotechnology).

Therefore, I/we recommend the submission of revised version of the thesis to the department following the applicable procedures.

Major Advisor	Signature	Date
Co-advisor	Signature	Date

Approval Page

Thesis I/we, the advisors of the thesis entitled "The Assessment of Food Safety Practices, Knowledge, and Attitudes among Food Handlers, Supervisors and Managers in selected Food Industries in Adama Town, East Shoa Zone, Ethiopia" and developed by Nigussie Getachew, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

_____ _____ _____

Major Advisor Signature Date

_____ _____ _____

Co-advisor Signature Date

We, the undersigned, members of the Board of Examiners of the thesis by ---------- (Name of student) have read and evaluated the thesis entitled "The Assessment of Food Safety Practices, Knowledge, and Attitudes among Food Handlers, Supervisors and Managers in selected Food Industries in Adama Town, East Shoa Zone, Ethiopia" and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Applied Biology (Biotechnology).

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Final approval and acceptance of the thesis is contingent upon submission of its final copy to the Office of Postgraduate Studies (OPGS) through the Department Graduate Council (DGC) and School Graduate Committee (SGC).

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School Dean	Signature	Date
Office of Postgraduate Studies, Dean	Signature	Date

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Abbreviation and Acronyms

WHO:-World Health Organization

CDC:-Disease Control and Prevention

GM:-Modified Food

FBD:-Foodborne diseases

GMP:-good manufacturing practices

FBI:-Foodborne Illness

LHD:-Local Health Department

ABSTRACT

Food contamination was a challenge for many developing countries and food manufacturing practices is the major risk factor which associated with foodborne illnesses. Several researches were conducted to provide evidence for the assessment of food safety practices, knowledge, and attitudes among food handlers, supervisors and managers in selected food industries associated with foodborne diseases. However information in the assessment of food safety practices, knowledge, and attitudes among food handlers, supervisors and managers in selected food industries in Ethiopia and developing countries is limited. The aim of this study was to investigate the assessment of food manufacturing practices on foodborne diseases. A total of 214 participants were involved in the study. To obtain the necessary data the researcher was used both primary and secondary data collection methods. Primary data collection sources were surveys, observations, experiments, questionnaire, personal interview, and the secondary data health record, publications, websites, books, journal articles, internal records. The researcher used purposive sampling techniques. To conduct a research both quantitative and qualitative survey method were employed. A Culture-based methods and Gram stain procedure were used to isolating target bacteria on selective media and Gram stain procedure were used distinguishes between Gram positive and Gram negative groups by coloring these cells red or violet. Through our investigation foodborne pathogens E. coli were isolated from the food samples and none were positive for Gram positive bacteria. In addition, the findings confirm that gram-negative E. coli and bacillus K. pneumonia were found as an etiological agent of UTI, and female were more venerable for urinary infection and urinary disorder. Education is an important factor that influences to change attitude of food handlers. However, positive attitudes and practices towards food safety issues which could reduce contamination of the food in the food industry. This study concludes that ensuring the safety of food products and addressing important of food safety practice of food handlers in food industry should be taken to reduce risk of food borne illness.

Keywords:-foodborne illness; food industry; Food Safety

CHAPTER ONE

1. INTRODUCTION

1.1 Background

The issue of food-borne disease incidents associated with the consumption of contaminated food has recently grown in low- and middle-income countries. Questions have been raised about contamination of food supply with the pathogens and have received considerable critical attention on Foodborne disease. However, these rapid changes are having a serious effect on public health and food safety practices. Previous studies have reported that millions of the people are affected by foodborne diseases in every year and estimated number of cases of foodborne disease, "approximately 600 million cases of foodborne disease and 420,000 related deaths every year due to foodborne pathogens (Abegaz, 2022). In low- and middle-income countries, there has been a rise in risk of contamination due to microbial toxins produced by bacteria, parasites and virus. It is been found that microbial contamination such as Salmonella, cholera and toxigenic E. coli are the three diarrhea genic foodborne diseases that are responsible for the greatest loss of disability-adjusted life years in East Africa (Sharma *et al.,* 2020).

Recent evidence suggests that lack of training in food hygiene, less than one year of professional experience, little knowledge and unfavorable attitude, not paying attention to the safety of utensils and cooking surfaces, not covering hair when cooking food, and not washing hands before beginning to handle food are significantly associated with poor food safety practices and has existed as a health problem for many years(Abegaz, 2022). Foodborne intoxication is caused by ingesting food contaminated with microorganisms or their toxins; contamination from inadequate preservation methods, unhealthy handling practices, cross-contamination from food contact surfaces, or from persons hiding the microorganisms in their nails and on the skin. Different foodborne diseases are occurred by the presence of poor hygienic practices during food preparation, handling and storage which resulting the conditions that allow the proliferation and transmission of disease causing organisms such as bacteria, viruses and other food-borne pathogens(Mekonnen *et al.*, 2021).

Finding shows that the presences of unsafe water that used for the cleaning and processing of food, poor food-production processes, inadequate storage, and food-handling practices including infected food handlers

and cross-contamination of food are the major underlying cause for foodborne diseases. Most food-borne diseases are preventable by periodic training programs for food handlers that include training of food handlers in good hygiene practices (training in safe food handling), good personal hygiene, the provision of adequate and well maintained workplace sanitation is the key risk reduction measure in the prevention of foodborne diseases in food industry(Faour-Klingbeil & Todd, 2020). Food-handling practices including infected food workers and cross-contamination of food were responsible for food-borne illness. This contamination occurs due to lack of awareness of food-handling practices including infected food workers and cross-contamination of food was responsible for food-borne illness. Medical professionals can influence public understanding of food safety their increased attention to this subject may enable them to promote food safety knowledge more actively in their work (Luo *et al.,* 2021).

Foodborne disease globally is still a major public health problem can cause health and economic losses. A foodborne illness incident can have a negative impact on the society such as human illness costs due to foodborne pathogens are estimated most completely in the United States. Seven foodborne pathogens found in animal products were selected for analysis: their costs in human illness were estimated at US$ 6.5-34.9 billion annually. It also damaged reputation and lost revenue to lawsuits and fines(Buzby & Roberts, 2009). The study focused on describing the impact of food manufacturing practices on foodborne diseases. This study aims to ensure safe food manufacturing practices, food safety management system and to controlling food safety hazards within a food business in order to ensure that food is safe to eat. The issue of food contamination has received considerable critical attention on public health risks related with food safety issues in the food market. Despite this, very few studies have investigated the impact of food manufacturing practices in low-income and middle-income countries.

There has been little quantitative analysis of the assessment of food manufacturing practices on foodborne diseases in terms of food handling practices, lost and loss of life, direct and indirect costs associated with illness, financial costs (include transport costs to receive treatment, medical expenses paid by the patient), wages lost, and the cost of public health provision, effective interventions in practice related with food safety issues in the food market in low-income and middle-income countries. Through the study several literatures have been reviewed and has mentioned about major finding in line with objectives on factors has identified as impact on food safety. Studies have found evidence that most of the known burden of foodborne disease comes from biological hazards in low and middle income countries. Therefore, the risk of foodborne diseases massive increases due to in the consumption of risky foods(Grace, 2015).

Though those are several options for doing research, this study will carried out this research because foodborne diseases have a serious effect on public health risks related with food safety issues in the food market, and leading cause of death in low-income and middle-income countries. Additionally, evidence on foodborne disease in low and middle income countries is still limited. I consider this study is relevant, and significant in the following way: food contamination are common public health risks related with food safety issues in the food market; The correct practice of food safety and sanitation can greatly improve efficiency, keep productivity up, workers safe and consumer confidence high. The result from the study will be used to identify the risk of foodborne illness, public health implications and economic losses caused by food-borne diseases, the key factors and processes for targeting future quality control systems.

1.2. Statement of the Problem

Some common food production opportunities contribute to foodborne illness and lack of reliable measure and procedures in food industry is a key role in identifying food safety problems. The effects of unsanitary practices and improper food handling poor food-production processes inadequate storage, infected food workers and cross-contamination of food are the consequences of food contamination in the food industries, and health burdens of foodborne diseases(Faour-Klingbeil & Todd, 2020). On the other hand, many researchers conducted in Ethiopia indicated that foodborne diseases are still a major public health concern. In order to ensure food safety and proper management of the systems in food industries, there is still need further investigation to provide important information linking to improve the burden of foodborne illness and describe the various agents that cause foodborne illness to prevent foodborne illness in the food industry.

1.3. Research Objective

1.3.1. General Objective

: To assess safety practices, knowledge and attitude among food handlers, supervisors and managers in selected food industries in Adama, Ethiopia.

1.3.2. Specific Objectives

- To investigate food pathogen from manufacturing food sample in food industry industries.
- To identify the risks related with food contamination and food safety issues on food industries in Adama town.
- To determine technique used to test microorganism in the food industries.

- To determine the impacts of negligence to health and safety policies and procedures.

1.3.3. Research Question

The following research questions were addressed in this research.

- What are the major contributing factors associated with food-borne diseases?
- Which groups of bacteria are frequently responsible for food-borne illnesses?
- What is the impact of neglecting health and safety polices?
- How do you isolate bacteria from a food sample?
- Which microorganisms are responsible for most cases of foodborne illness?
- What is the burden of disease in low and middle income countries?

1.4. Significance of the Study

The study intended to find out the factors affecting foodborne illness occurs with consumption of contaminated food product or microbial contaminate\ food product resulting foodborne diseases. Some of the most prevalent factors that contribute to foodborne illness include: Food that is not properly date marked, lack of awareness, Cross contamination, and poor personal hygiene (the consumption of food prepared outside) exposure of individuals to hazards(Camino Feltes *et al*., 2017). This is due to the challenges faced in people of low socio-economic status. This is the reason why this study aims to assist food industry sectors to identify the key factors and processes for targeting future quality control systems.

It was also decrease the burden on health care resources and reduced indirect costs such as those suffered by industry. And the result from the study will be used to design effective intervention strategies for foodborne diseases that are the challenges faced in public health and effort from food suppliers, industries, and to ensure food production. The study will be significant to provide information how food safety measures can prevent foodborne diseases and importance of proper food handling in avoiding foodborne diseases. It important to identify microorganism that is responsible for food-borne illness and suggesting possible recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Food processing and food manufacturing

Food processing is any method used to turning raw product or fresh foods into food products. Some of the common methods of food processing includes traditional (heat treatment, fermentation, pickling, smoking, drying, curing) and modern methods (pasteurization, ultra-heat treatment, high pressure processing, or modified atmosphere packaging). Food supply chain has 5 stages of the food system: production, processing, distribution, retail and consumption. Over the past years, much more information has become available on food quality assurance in production processes and establishments has made mandatory from the year 2012. It has been suggested that food hygiene practice in food establishments and are expected to be aware of the principles of food hygiene to lay the foundation for food safety in food establishments(Mendis, 2016).

2.2 Factors affecting food production

There are many factors affecting food production which have led to the global shortage of food such as :rainfall and temperature are important climatic elements that determine how and when crops are grown in most parts of the world; Climate has affected food production globally because not all places can depend on irrigation; economic policies, which affect agriculture, are made by politicians Soil is a major environmental factor that affects food production; biological stressors like disease, animals, humans, insects and weeds can affect food production by damaging crops in the field(Gabriel *et al.,* 2016). Biological and geophysical factors that influence production can include water availability, soil fertility, and risks of floods, droughts, frost, or pest or weed infestations, and the importance of each of these factors varies with the types of crops planted (Loomis *et al*.2013). Other studies have shown the relationship between Climate change and agriculture in Eastern Africa (in Tanzania, Kenya, Somalia, Ethiopia and Djibouti). Over the past century, the issue of climate variability and extreme climate events (such as drought and floods) has recently grown. However, Eastern Africa has been experienced drought, and putting climate sensitive sectors such as agriculture, livestock, water resources and health at high risk(Wo, 2010).

2.3 Environmental factors

A very recent study with regard to climate changes indicated that, climate changes are the Challenging food safety issues. As climate change continues and/or intensifies, it will increase the risk of an adverse on food safety, increased public health burden to the emergence of risks and increase the risk of an adverse on food safety(B. Smith & Fazil, 2019).A study finding by Smith et al.2019, identified how climate change (i.e. Temperature and precipitation patterns, extreme weather events and ocean warming and acidification) significantly interrelated with the entire length of the food chain. Foodborne diseases are caused by bacteria, fungi, parasites and viruses, and the prevalence of these diseases is modified by climate change.

2.4 Food handling problem

Another study has identified the risk of foodborne pathogens and chemical contaminants entering the food chain: Food products may become contaminated during production, processing, distribution, preparation, and/or final consumption. Poor food handling and sanitation practices, inadequate food safety laws, weak regulatory systems, lack of financial resources to invest in safer equipment, and lack of education for food handlers are often the source of food contamination and occurrence of food-borne diseases in low- and middle-income countries like Ethiopia (Abebe *et al.*, 2020). In addition, they also found that low level of food safety knowledge and handling practices were the factors associated with knowledge of food safety, and should be given continuous training for food handlers to improve food handlers' knowledge of food safety and practice level(Alemayehu *et al*., 2021).

2.5 Source of contamination

The sources of food contamination caused by: living organisms (Biological) such as viruses, bacteria, and parasites which are pathogenic; substances (Chemical) such as heavy metals, pesticides, insecticides, disinfectants, which can cause harm; solid objects (Physical) that can cause harm such as glass shards or nails (Yen et al., n.d.). This contaminated product creates an enormous social and economic burden on health systems and community(Ajayi et al., 2011). Food-borne diseases are major health problems and affecting food safety by the spread of food-borne microorganisms pathogens result of consumption of chemical hazards produced by industry or natural chemicals (for example, those produced by heating food or toxic metals); Biological hazards (including viruses, bacteria, protozoa, moulds and parasites); Physical hazards include stones and fragments of metal or glass as well as sub-microscopic nanomaterial and radionuclides)(Mekonnen *et al*., 2021).

2.6 Microbiological contamination of foods associated with the impact of food safety

Food security is a growing concern for public health safety and the presence of harmful chemicals in food and microorganisms lead to contaminated food. Safe food is the process of ensuring the safety of food that were responsible for food-borne illness and protected from contamination. Unsafe foods are associated with the presence of harmful chemicals and microorganisms lead to negative effects to animal and human health(Focker & van der Fels-Klerx, 2020). Several studies have clarified that recognizing food safety as a priority and an important public health issue, enhancement in communication and collaboration among the different agencies and food chain stakeholders are effective in prevention of foodborne diseases(Faour-Klingbeil & Todd, 2020). There are also a number of global factors that have an impact on food safety; study finding in Bangladesh described microbiological contamination of varieties foods associated with the impact of food safety result due to the lack of awareness on hygiene followed by the defective legislative action (Patel *et al*., 2008).

2.7 Diversity of pathogenic microbial

2.7.1 Bacteria pathogen

Previous studies shows that several microorganisms which associated with food-borne illness including: bacteria mainly *Salmonella* spp., *Escherichia coli*, *Klebsiella* spp., *Shigella* spp., *Enterobacter* spp., *Proteus* spp., *Citrobacter* spp. *Staphylococcus aureus*, *Campylobacter* spp., *Listeria* spp., *Vibrio*, *Alklegens* spp., *Bacillus cereus*, *Pseudomonas* spp., *Clostridium perfringens*, *Arcobacter* spp., and *Enterococcus* spp. Study finding conducted on food safety and food quality shows that microorganisms such as *Staphylococcus spp.*, *Escherichia coli and Salmonella* spp were factors regarding the food-borne illness highlighting the impact of good manipulation practices on the food safety and food quality(De Sousa, 2008a). Urinary Tract Infections (UTIs) are the most common bacterial infections caused by *K. pneumoniae and Escherichia coli* and current challenges for antibiotic resistance. It's been proven that gram-negative *E. coli* and *K. pneumoniae* was determine as the most common gram negative bacterial agents causing UTI and females were more vulnerable to UTI. It also a severe public health problem resulting billions of dollars in health care costs annually UTI(Okojie & Omorokpe, 2018). However, E. coli was occurred more frequently and common agent of urinary tract infections(Trześniewska-Ofiara *et al*., 2022)

2.7.2 Fungi pathogen

Moreover, different fungus such as *Blastomyces*, *Fusarium* spp., *Mucor* spp., *Aspergillus niger*, *Fusarium avenaceum*, *Penicillium digitatum*, *Rhizopus stolonifer*, *Saccharomyces* species, *Fusarium solani*, *Aspergillus flavus*, *Saccharomyces dairensis*, and *Saccharomyces exiguus* were identified from different food items from food stores or shops(Alemayehu *et al*., 2021).

2.7.3 Viral pathogen

There has been significant association between food safety knowledge of food handlers with proper handling, storage of food and preparation. This study indicates that infected farmers and handlers are responsible for transmission food-borne illnesses caused by food-borne virus infections (Hepatitis A virus, diarrhoea)(Hashanuzzaman *et al*., 2020).

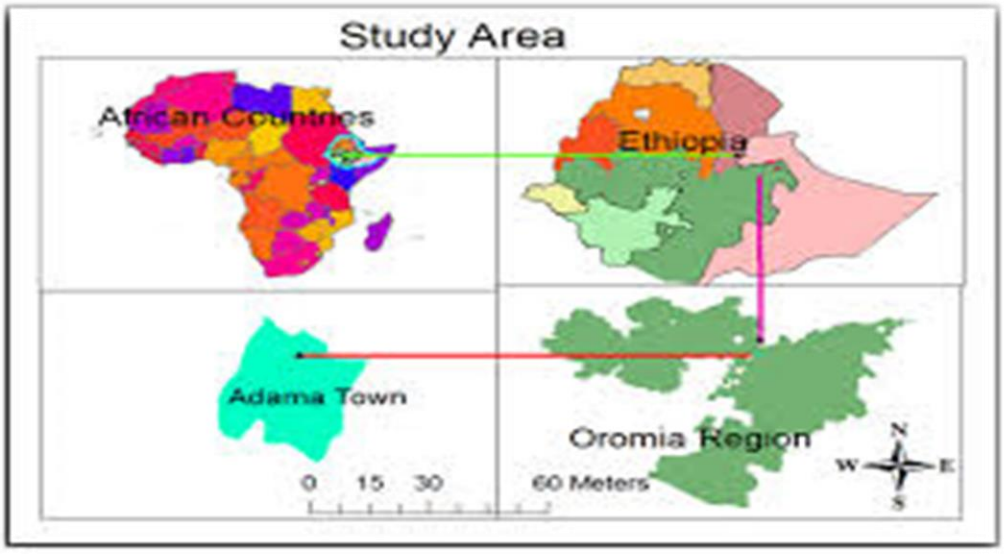
CHAPTER THREE

3. MATERIAL AND METHODS

3.1. Description of the Study Area

The study was carried out in district site at industries area of Adama city from December 2014 E.C to April 2014 E.C. Samples of different food products were also taken from T.M food complex, Bereket Food Complex, Fikir Food complex, Endalk food complex, Africa Pasta and Macaroni Food Complex, Alhinan Food Complex and Brother Flour and Biscuit factory. Adama town is located in the Main Ethiopian Rift, East Showa Zone of Oromia National Regional State. Geographically, the town is located at 8.54°N 39.27°E at an elevation of 1712 meters, 99 km southeast of Ethiopian capital, Addis Ababa. The city sits between the base of an escarpment to the west, and the Great Rift Valley to the east. According to the climatic zones of Ethiopia, area with an altitude ranging from1500 - 2000 m above mean sea level is classified as subtropical climate. The annual rainfall ranges from 678.1-973.5mm, and highest annual and seasonal average maximum temperature recorded over district is 29.7 0 c & 31.00 c during 2011 and lowest is 13.10 c & 10.40 c respectively. It receives maximum rainfall during summer season(Shewa, 2020).

Figure 1: The map which describes the location of the study area shown in figure below.



3.2. Research Design

This study was focused on people from a specific demographic, people with a certain job like food handler, managers and supervisors, or medical personnel. Both qualitative and quantitative research is the survey conducted for the assessment of food safety practices, knowledge, and attitudes among food handlers, supervisors and managers in selected food industries in Adama Town. A researcher has investigated the assessment of food manufacturing practice 0n foodborne diseases (barriers to food safety in food industry) and how food safety measures can prevent foodborne diseases and importance of proper food handling in avoiding foodborne diseases. A pre-test was done in form of a baseline survey of food handlers.

3.3. Source Population

Foodborne illness can affect anyone who eats contaminated food; however, the source of populations were all food handlers working in the food processing area, managers and supervisors (these populations include all adults, 18 years old and above, the elderly, pregnant women) which lives in the demarcated area.

3.4. Population and Eligibility Criteria

The population of the study was grouped in to three major target groups for this study. The first group were all staffs of **(**Food handlers) in the industry age 18 years old and above working in preparation, cleaning and service areas of food establishments at the time of the study regardless of their sex and employment status were included in the study. The second group was Management members which are responsible in job duties set and implement standards, procedures, and processes for the manufacture of high quality food products in the food industry. The other groups were medical personnel or investigation team or document employees work on diagnosis foodborne illnesses (including regional epidemiologists, nurses, and public health officer or doctor) at each local health department (LHD).

3.5. Sampling Procedure and Technique

The sampling techniques employed by researcher were purposive sampling which include staffs from food industries and respondents from each medical institution at the town level. These target groups of the study was contains the Food Handlers, Control of food processing departments, Management members, all other Supportive staffs of the food industries, and also an inspection program was being carried out, waste piles that will cause pollution around the workplace, areas and storages of food industry. Stratified random

sampling was used to selected managements, supervisor and food handlers working in preparation, cleaning and service in the food industry (Hashanuzzaman *et al*., 2020).

In addition, researcher was choose these targets because; to understand the mishandling of Equipment that result in illness, modes of cleaning and sanitizing utensils by the Food Handlers ; Managerial supervision of workers in the food industry to get information about the safety of the products they. The researcher was conducted interviews with managements of food industry, supervisor, the Food Handlers, and medical institution to gain multi-perspective understanding of the issues under investigation and as they will believed by researcher to have the potential to reveal multiple, and sometimes conflicting, attitudes about a given topic(Ahmed et al., 2021).

The advantages of using an interview technique is that; the respondents expanded on areas of interest and used non-verbal communication such as facial expressions to emphasize their responses though it will be time consuming as they will involve protocol in setting up appointments and being granted authority to conduct them.

3.6. Sample Size

The sample size was calculated by using single population proportion formula

$$n = \frac{Z^2_{\alpha/2} P(1-p)}{d^2}$$

- where n= minimum sample size

  P= Prevalence rate of foodborne disease, 50% because it is not known

  d= Margin of error i.e. =0.5

$Z^2_{\alpha/2}$ = Standard deviation at 95% = 1.96 (confidence level)

$$n = \frac{(1.96)^2(0.5)(0.5)}{(0.05^2} = 384$$

If the sample size is <10,000 we can use final sample size formula

$$n_f = \frac{n}{1 + \frac{n}{N}}$$

Where n = Minimum sample size

N = Total number of populations include all adults, 18 years old and above, the elderly, pregnant women

nf = Final sample size required

$$n_f = \frac{n}{1 + \frac{n}{N}}$$

$$= \frac{384}{1 + \frac{384}{628}}$$

= 238

Taking to consideration the non-response rate of 10% of the total sample size of the study participants was 214**.**

3.7. Data Collection Tools and Procedures

Total 214 of participants, 174 were collect the data from food handlers (G-I) working at the food industries, 30 were managers and supervisors (G-II), working at the food industries, and 10 health professional (G-III) were randomly selected and included in the study. To obtain the necessary data the researcher was used both primary and secondary data collection methods. Both Open ended and closed ended questionnaires was distributed for 214 the selected groups and interview was made with selected food handlers, management members, and medical personnel to collect primary data. In order to use secondary data, the researcher was used published and unpublished data sources such as periodic reports, records, journals, working manuals and all possible related documents on the problem area. To ensure the consistence of data collection tool the questionnaire was translated to Amharic language & re-translated back to English to make the reliability of the instrument. Before undertaking the data collection the instrument was pre tested by taking 5% eligible for the feasibility of the questionnaires. The pre-tested data was not be included in the main data

3.7.1 Collection of Food Samples

210 food Samples were collected from seven food industry from December 2014 E.C to April 2014 E.C, in Adama town, Oromia region. 30 samples were collected from each seven food industry. Samples were collected twice a month for three month during the first year. 5 samples were collected from seven food industry at each time. The samples were included milk products (fresh milk, and cheese), cereals, flour, pasta and macaroni, biscuit**.** Collection of Samples was obtained from T.M food complex, Bereket Food Complex, Fikir Food complex, Endalk food complex, Africa Pasta and Macaroni Food Complex, Alhinan Food Complex and Brother Flour and Biscuit factory. Food samples were collected randomly from selected food industries and placed into sterile glass bottles and the bottles were kept in the ice cooler for transportation.

The samples were labeled with date of sample collection, name of food sample and number of collected food samples. All the samples were stored at freezing temperature and transported to the laboratory for further investigation. Then these were analyzed within 24 hours. Previous studies have based their criteria for selection, small sample was chosen because of the expected difficulty of obtaining. Using the enumeration data of the recalled batch, stratified random sampling method is one of the more practical ways of sampling to improve the detection probability of microorganisms as compared to random sampling. Taking many small sample units systematically increased the probability to detect the localized contamination. However, taking more and smaller sample units, while keeping the total sampling weight constant, improved the performance of the sampling plans(Jongenburger, 2012).

3.8 Methods for detecting the microorganisms from food

.Culture-based methods were used to confirm the presence of food contamination. There are several basic steps were used to isolating target bacteria from food samples:

The first step, or pre-enrichment, involves adding a specific amount (determined by weight, typically 10–25 grams) of the food to be tested in a large (100–250ml) volume of a non-selective broth medium. After an incubation period of 18–24 hours at 37°C, a small sample of the enrichment culture is transferred to one or more types of selective media designed to inhibit growth of competing microbes while allowing the target pathogen to multiply. The cultures were streaked onto MacConkey agar media plates and Mannitol Salt Agar media plates to tests independently. To assess the growth of gram-negative bacteria spp. a small sample were streaked on the MacConkey agar cultures were used in the differentiation of lactose fermenting from lactose non-fermenting gram-negative bacteria. First, samples were sub cultured on MacConkey agar media plates

and incubated at 37 °C for 24 hr. Second, a small sample of the enrichment culture were streaked on the Mannitol Salt Agar media plates and incubated at 37 °C for 24 hr (Prasad et al., 2022).

Each morphology of the bacterial cultures on MacConkey agar media plates and Mannitol Salt Agar media plates were observed. Based on the first Observations, cultured on MacConkey agar media plates which were produced pink colonies. In the first Color change confirm the presence contamination of food sample with potential food borne pathogens the lactose positive species (lactose fermentation) confirm the presence of E.coli. Second, cultured on Mannitol Salt Agar media plates were produced no color change of phenol red indicators were observed(Hemalata & Virupakshaiah, 2016). Culture-based methods remain necessary for detection and enumeration, to determine viability, and to validate phenotype predictions. Because culture may be used to amplify the number of bacterial pathogens, by pre-incubating the food sample in a non-selective medium that promotes growth of any bacteria that might be in the sample(Bonnet et al., 2020).

Gram staining

The researcher was used Gram stain procedure to test food contamination from the samples. There are several types of reagent were used to tested food contamination in Gram staining. These are: Make a slide of cell sample to be stained; Heat fixes the sample to the slide by carefully passing the slide with a drop or small piece of sample on it through a Bunsen burner three times; add the primary stain (crystal violet) to the sample/slide and incubate for 1 minute; Rinse slide with a gentle stream of water for a maximum of 5 seconds to remove unbound crystal violet; add Gram's iodine for 1 minute- this is a mordant, or an agent that fixes the crystal violet to the bacterial cell wall; rinse sample/slide with acetone or alcohol for ~3 seconds and rinse with a gentle stream of water; the alcohol will decolorize the sample if it is Gram negative, removing the crystal violet. However, if the alcohol remains on the sample for too long, it may also decolorize Gram positive cells; add the secondary stain, Safranine, to the slide and incubate for 1 minute; wash with a gentle stream of water for a maximum of 5 seconds.

If the bacteria is Gram positive, it will retain the primary stain (crystal violet) and not take the secondary stain (safranine), causing it to look violet/purple under a microscope. If the bacteria are Gram negative, it will lose the primary stain and take the secondary stain, causing it to appear red when viewed under a microscope. Gram positive bacteria stain violet due to the presence of a thick layer of peptidoglycan in their cell walls, which retains the crystal violet these cells are stained with. Alternatively, Gram negative bacteria stain red, which is attributed to a thinner peptidoglycan wall, which does not retain the crystal violet during the

discoloring process. Gram staining test helps to differentiate the organism, whether it is gram-positive or gram-negative and gives an early indication of potential bacteria through visualization of the bacteria. Gram-positive bacteria appear purple in color and gram-negative bacteria appear pink (A. Smith & Hussey, 2016).

3.9. Method of Data Analysis

In this research, quantitative and qualitative data was obtained through questionnaires and interviews and analyzed using descriptive methods of data analysis. The researcher was used of computer in coding data and the formal process of developing the coding scheme began shortly after the first few interviews. The data collected were checked by the researcher on daily bases for incompleteness or inconsistency. Data has checked for validity and reliability. The data obtained were analyzed using statistical package for social sciences (SPSS) version 26 and were expressed as frequencies and percentages using qualitative, quantitative and descriptive statistical technique which includes table, frequency distribution, and percentage through SPSS and excel application computerized system.

Ethical Consideration

Ethical clearance was obtained from ethical review committee of Adama Science and Technology University, Department of Applied Biology and this will communicated to Adama University and written letter obtained. Because access to sensitive data, allowed to gain credibility and to gain support from Adama University. Permission and verbal consent were obtained from each respondent and confidentiality is also assured before conducting data collection process. All information that was obtained from the individual was treated confidential and was not be used to the determinant of the subject and for this reason their names was not be written on the questionnaire. The respondent right were guarantee to stop or refuse participation.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Socio-demographic characteristics of study participants (Food Handlers)

Total 214 of participants, 174 were collect the data from food handlers (G-I) working at the food industries, and 94(53.4%) of participants were females while 80(46.5%) were males. This shows that the administration is dominated by both the male and female group which can reflect the gender. Regarding the age of the respondents, the findings of this study implied that about 17(9.8%) of the respondents were aged < 25 years, followed by 26-35 (62.6%), 36-40(23.0%) and >46 8(4.6%). The majority 126(72.4%) of participants were between the age of 18-24, and 25-35 years. Therefore, the age information indicates that most of the respondents were young adults (early adulthood). Concerning their qualification, 1(0.6%) of the respondents were found as no formal education, 37(21.3%) elementary school, 75(43.1%) secondary school, 44(25.3%) Certificate holders, 13 (7.5%) diploma holder, and 4(2.3%) of the respondents were found as degree holder. Among the food handlers, most 75(43.10%) workers had attained secondary education**.** Regarding the work experience of the respondents, the majority or 88(50.6%) of them had over 5 year had 1-4 years of experience, and 51(29.3%) of the respondents had 4-5 years of experience.

Table 1: Frequency distribution represents the demographic characteristics of the respondents.

Variables		Frequency	Percentage
sex distribution	Male	80	46.5
	Female	94	53.4
	Total	174	100%
Age group	<25 years(18-24 years)	17	9.8
	25-35 years	109	62.6

Variables		Frequency	Percentage
	36-45 years	40	23.0
	>46 years	8	4.6
	Total	174	100
Educational status	No formal education	1	0.6
	Elementary school	37	21.3
	Secondary school	75	43.1
	Certificate holders	44	25.3
	Diploma holders	13	7.5
	Degree holders	4	2.3
	Total	174	100
Work experiences	Less than 1 years	12	6.9
	1-4 years	23	13.2
	4-5 years	51	29.3
	over 5 years	88	50.6
	Total	174	100

4.1.2 Correlation analysis for Socio-demographic characteristics of study participants (Food Handlers).

The results, as seen in Table 2, indicate that Pearson correlation coefficient between sex distribution and age group($r = 0.559$), educational status with sex distribution ($r = 0.666$), and sex distribution with educational status ($r = 0.820$), educational status with age group ($r = 0.853$), age group with work experiences ($r = 0.629$) and educational status with work experiences ($r = 0.76$). Findings in the present study indicate that a Correlation coefficient value between work experiences with sex distribution($r = 0.820$) and educational status with age distribution($r = 0.853$)

were found a fairly strong positive linear relationship (because the value r value is closer to +1) and would be statistically significant ($p<0.001$) with number of pairs (N=174). From the results, it is clear that a significant positive correlation association between educational status with work experiences, sex distribution with age groups and educational status.

Table 2: Presenting the Results of a Correlation Analysis for Socio-demographic characteristics of study participants (Food Handlers).

		sex distribution	Age group	Educational status	work experience
Sex distribution	Pearson Correlation	1	.559**	.666**	.820**
	Sig. (2-tailed)		.000	.000	.000
	N	174	174	174	174
Age group	Pearson Correlation	.559**	1	.853**	.629**
	Sig. (2-tailed)				
	N	174	174	174	174
Educational status	Pearson Correlation	.666**	.853**	1	.706**
	Sig. (2-tailed)	.000	.000	.000	.000
	N	174	174	174	174
work experience	Pearson Correlation	.820**	.629**	.706**	1
	Sig. (2-tailed)	.000	.000	.000	.000
	N	174	174	174	174

4.1.3 Safety knowledge and handling practice of food handlers.

This section summarizes the findings about food handlers who had responded about factors associated with food safety knowledge and handling practices in food industry. The results, as seen in Table3, from the total participants, more than half of the food handlers 99(56. 89%) responded that they had no adequate personnel in food industry. Among food handlers, only 75(43.10%) of food handlers responded that they had adequate personnel in food industry. The data in Table3, indicates that majority 85(48.85%) of food handler responded that food safeties in food industry were important. Of the total food handlers, 60 (70.56) of respondents indicating that food safety in food industry were important to reduce the cost of health care. Additionally, our study was found that majority of respondents (food handler) who had responded good 77(44.25%) and better 83(47.70%) had a positive attitude toward food safety. A small number 14(8.05%) of those respondents had negative attitude toward food safety knowledge. Strong evidence on periodic training programs on production and hygiene issue, and develop personal hygiene was essential for improving food safety knowledge and practices.

Table 3:Food Handlers response on Food Safety Knowledge.

Variables			Frequency	Percentage
Do you have adequate personnel in your department?	Yes	Male	35	46.67
		Female	40	53.33
		Total	75	43.10
	No	Male	45	45.45
		Female	54	54.54
		Total	99	56. 896
Do you think that food safety is important in the food industry?	Yes	Male	39	45.88
		Female	46	54.12
		Total	85	48.85
	No	Male	39	49.37
		Female	40	50.63
		Total	79	45.40
	I don't know	Male	2	33.33
		Female	4	66.67
		Total	6	3.45
			Frequency	Percentage
If your answer is yes in question No.2, Why food safety is important in the food industry?	a. It protects the consumer from the risk of food borne illnesses		60	70.56
	b. It also protects financial losses due		19	22.35

Variables			Frequency	Percentage
	to unsafe products			
	c. These illnesses contribute significantly to reduce the cost of Health care.		6	7.06
		Total	85	100
How food handling practices are protecting to consumer from the risk of food poisoning?	Good	Male	34	19.5
		Female	43	24.7
	Better	Male	35	20.1
		Female	48	27.6
	Poor	Male	11	6.3
		Female	3	1.7
		Total	174	100
Food handling practices including infected workers and cross-contamination of food were responsible for food-borne illness due to lack of awareness of food handling practices?	Strongly agree	Male	30	17.2
		Female	44	25.3
	Agree	Male	29	16.7
		Female	29	16.7
	Disagree	Male	18	10.3
		Female	15	8.6
	Strongly Disagree	Male	3	1.7
		Female	6	3.45
	Total		174	100
The employer should establish periodic training programs that include production and hygiene issue, and develop personal hygiene habits in these training programs	Strongly agree	Male	41	23.6
		Female	43	24.7
	Agree	Male	28	16.1
		Female	30	17.2
	Disagree	Male	10	5.8
		Female	11	6.3
	Strongly disagree	Male	1	0.6
		Female	10	5.8
		Total		100

4.1.3 Food safety practices and their associated factors.

The results as seen in Table 4, several ethical issues were used in food production such as: About 13(43.33%) of issue were mishandling; 12(40%) of issue were working conditions of people producing the food; 9(30%) of were impact of chemicals and other production; 5(16.67%) were environmental protection, and 4(13.33%) were the impact of small local producers and businesses. Contamination17 (56.7%) and mishandling13 (43.33%) were most pressing issue facing the food

industry today. From the results, it is clear that food safety and sanitation laws 18(60%) were the major ethics to be followed in food industry. Additionally, our study was found that knew how to work with all equipment and tools required for the job 13(43.33%), hand-washing 8(26.67%), personal responsibility 7(23.33%), and learn safe lifting techniques 5(16.67%) were the safe behaviors in a food industry. Chemical contamination 12(40%), microbial contamination 8(26.67%), Misuse of food additives 6(20%), and genetically modified foods 4 (13.33%) were the problems that affect food safety in a food industry.

Table 4: The Response of the supervisor and administrative manager about the Food Safety practices in food industry.

Variable	Category	Frequency	Percentage
most pressing issue facing the food industry today	Mishandling	13	43.3
	Contamination	17	56.7
What are ethical issues in food production?	Environmental protection	5	16.7
	The impact of chemicals and other production	9	30
	The working conditions of people producing the food	12	40
	The impact of small local producers and businesses	4	13.3
What are the ethics to be followed in food industry?	Tap into local resources	1	3.3
	Obey all food safety and sanitation laws	18	60
	Create consistent portion size	3	10
	Don't be afraid to waste (time, money, or food)	1	3.3
	Personal responsibility	7	23.3
What are the safe behaviors in a food industry?	Wash hands frequently	8	26.7
	Learn safe lifting techniques	5	16.7
	Know how to work with all equipment and tools required for the job	13	43.3

Variable	Category	Frequency	Percentage
	Keep the work area tidy	4	13.3
What are the problems that affect food safety?	Microbial contamination	8	26.7
	Chemical contamination	12	40
	Misuse of food additives	6	20
	Genetically modified foods	4	13.3

4.1.4. Qualitative evidences which obtained from expert response on Food Safety Knowledge and Handling Practice.

Table 5 presents an overview of the Qualitative evidences on Food Safety Knowledge and Handling Practice which obtained from expert response in this study were treated as follows: We describe the results of a positive association between hygiene and foodborne diseases, which show that unsanitary practices, improper food handling, and poor food safety practices were found the leading cause to foodborne illness. Poor employee health and hygiene were challenges that hinder the causes of foodborne diseases and proper employee hygiene, effective cleaning and sanitizing of the manufacturing equipment were most important way to prevent foodborne illness from bacteria. On the other hand the results of the study reveal that ensuring safety of food products has been identified as importance factor for food handling safety practices. Therefore, washing of hands before handling the food was the most important ways to avoid food related risks.

Table 5:Qualitative evidences which obtained from expert response on Food Safety Knowledge and Handling Practice.

Expert		Recommendation
Medical personnel	Which poor food handling practice would likely lead to foodborne illness?	unsanitary practices, improper food handling, and poor food safety practices
	What are the importance food handling safety practices	Ensuring the safety of food products
	What is the most important way to prevent foodborne illness from bacteria?	proper employee hygiene, effective cleaning and sanitizing of the manufacturing equipment
	What are the effects of unsanitary practices and improper food handling?	Increasing the risk for transmission of pathogenic microorganism

Expert		Recommendation
	What are the most important ways to avoid food related risks?	washing of hands before handling the food
Supervisor and Administrative Manager	How does a foodborne illness impact the food industry?	Increase the cost of health care and additional cost for buying medication
	What is the biggest cause of foodborne illness in the workplace?	microbial contamination and chemical contamination
	What are the causes of foodborne diseases?	Poor employee health and hygiene
	What are the main risks leading to foodborne illness?	improper food handling, and poor food safety practices
	What food setting is most responsible for foodborne illnesses?	Raw material contamination and Inadequate storage
	Why hygiene is important in food industry?	ensure safe food manufacturing practices
	How food safety measures can prevent foodborne diseases?	controlling food safety hazards within a food business
	What can consumers do to protect themselves from foodborne illness?	Avoid food from unsafe source(ensure food is safe to eat) and good hygiene practices

4.1.6 Correlation analysis between foodborne illnesses annually screened and registered with sex and age distribution.

These finding are in accordance with finding case reported by Adama Specialized Zone Health Department in 2014 E.C and correlation analysis between foodborne diseases with sex and age distribution were found. The data in table 8 indicates that correlation analysis between foodborne diseases with sex and age distribution. The results, as seen in Table8, indicate that

the Pearson correlation coefficient between foodborne diseases and age distribution were found -.203 with a significance level is 0.000 and the number of pairs (*N*=19194). Again, the Pearson correlation coefficient between the food borne diseases and sex distribution was 0. 002 and *p*-value was 0.800. The Pearson correlation coefficient between sex distributions and age among food-borne case report were found 0.064 with a significance level is 0.000 and the number of pairs (*N*=19194).

Table 6:Correlations analysis between foodborne diseases with age and sex distribution.

		Food-borne diseases	Age distribution	Sex distribution
Food-borne diseases	Pearson Correlation	1	.-.203**	.002
	Sig. (2-tailed)		.000	.800
	N	19194	19194	19194
Age distribution	Pearson Correlation	-.203**	1	.064**
	Sig. (2-tailed)			
	N	19194	19194	19194
Sex distribution	Pearson Correlation	.002	.064**	1
	Sig. (2-tailed)	.800	.000	.000
	N	19194	19194	19194
**. Correlation is significant at the 0.01 level (2-tailed).				

4.1.7. Cross- tabulation descriptive statistical analysis which determines whether the association between the variables or may have impact on association.

The data in table 7 indicates that from the total male case report (9324), majority of male 2940(31.6%) were between age 15-29 years, 2867(30.7%) of case report were between age 30-64 years,1091(11.1%) of case report were between age 1-4 years, 939(10.1%) of case report were between age < 1 years,861(9.2%) of case report were between age5-14 years and 617(6.6%) of case report were between age $\geq$ 65 years. From total female of case report, majority 3726 (37.8%) of case report were between age15- 29 years, 3252 (32.9%)of case report were between age 30- 64 years, 871 (8.8%) of case report were between age 1-4 years, 782 (7.9%) of case report were between age 5- 14 years, 675 (6.8%) of case report were age < 1 years , and 564 (5.7%)of case report were between age >= 65 years 5- 14 years. Strong evidence was found that both males and females were more venerable to food-borne illness at the age age 15-29 years and age 30-64 years.

Table 7:Cross- tabulation descriptive statistic shows how correlations change between sex and age.

			Age distribution						
			< 1years	1-4 yeas	5-14 years	15-29 Years	30-64 yer	>= 65years	Total
Sex distribution	Male	Count	939	1091	861	2949	2867	617	9324
		Expected Count	784.0	953.1	798.1	3242.6	2972.5	573.7	93240
		%within Sex distribution	10.1%	11.%	9.2%	31.%	30.%	6.6%	100%
		%withinAge distribution	58.2%	55%	52%	44.2%	46.9%	52.2%	48.6%
		% of Total	4.9%	5.7%	4.5%	15.4%	14.9%	3.2%	48.6%
	Female	Count	675	871	782	3726	3252	564	9870
		Expected Count	830.0	100.9	844.9	34324	31465	607.3	9870
		%within Sex distribution	6.8%	8.8%	7.9%	37.8%	32.9%	5.7%	100%
		%withinAge distribution	41.8%	44.4%	47.6%	55.8%	53.1%	47.8%	51.4%
		% of Total	3.5%	4.5%	4.1%	19.%	16.9%	2.9%	51.%
Total		Count	1614	1962	1643	6675	6119	1181	19194
		Expected Count	16140	1960	1643.0	6670	6110	1180	1910
		%within Sex distribution	8.4%	10.%	8.6%	34.%	31.%	6.%	10%
		%withinAgedistribution	100.%	100%	100.%	100.%	100.%	100. 0%	100. 0%
		% of Total	8.4%	10.2%	8.6%	34.8%	31.9%	6.2%	100. 0%

4.1.8. Cross-tabulation descriptive analysis which determines whether the association between food-borne diseases and sex distribution.

This is an important finding in the understanding of the microorganisms that were responsible for most cases of foodborne illness or groups of bacteria that were frequently responsible for food-borne illnesses. From these results it is clear that food-borne diseases such as Pneumonia 6378(33.2%) case report, disorders of urinary system 5242(27.3%) case report, typhoid 2911(15.2%) case, bacteria intestinal function 1977(10.3%) case, Amoebiasis 1390(7.2%) case report and 1296(6.8%) case of viral and other specified intestinal infections were reported as food-borne illness in Adama Specialized zone Health Department in 2014 E.C. These finding will be useful to clarify that Pneumonia was the major 6378(33.2%) etiological agent and males 3456(37.1%) were more venerable for Pneumonia. *E.coli* was the second major 5242(27.3%) etiological agent and female (32.7%) were more venerable for urinary infection and urinary disorder.

From total case report of Typhoid 2911(15.2%), 1445(15.5%) of case report was male and 1466(14.9%) case report were female. Thus, both male and females are venerable to Typhoid food borne diseases. It was also observed from this study that from total 1390(7.2%) case report of Amoebiasis, majority 725(7.8%) of case report were male and 665(6.7%) case report were female. Thus, male were venerable to Amoebiasis food borne diseases. Another finding of study was from total 1977(10.3%) case repot of bacteria intestinal function, majority 984(10.6%) of case report were male and 993(10.1%) case report were female. Thus, both male and females are venerable to bacteria intestinal function food borne diseases. From total 1296(6.8%) case of viral and other specified intestinal infections, majority 699(7.5%) of case report were male and 597(6.0%) were female. Male were more venerable for viral and other specified intestinal infections.

Table 8:Cross- tabulation descriptive statistic shows how food-borne diseases correlated with sex and age

Cross -tabulation									
			food borne disease						
			Typhoid	Amoebias	Intestinl Bacteria	Iintestinal.and virl	s.Urinary Disorders	Pneumoni	Total
Sex	Male	Count	144	725	984	699	2015	34	932
		Expected Count	1414.1	675.2	960.4	629.6	2546.4	3098.3	9324.0
		% within Sex distribution	15.5%	7.8%	10.6%	7.5%	21.6%	37.1%	100%
		% within food borne disease	49.6%	52.2%	49.8%	53.9%	38.4%	54.2%	48.6%
		% of Total	7.5%	3.8%	5.1%	3.6%	10.5%	18%	48.6%
	Female	Count	1466	665	993	597	3227	2922	9870
		Expected Count	1496.9	714.8	1016.6	666.4	2695.6	3279.7	9870.0
		% within Sex distribution	14.9%	6.7%	10.1%	6.0%	32.7%	29.6%	100%
		% within food borne disease	50.4%	47.8%	50.2%	46.1%	61.6%	45.8%	51.4%
		% of Total	7.6%	3.5%	5.2%	3.1%	16.8%	15.2%	51.4%
Total		Count	2911	139	1977	1296	5242	6378	191

			0					94
	Expected Count	2911.0	1390.0	1977.0	1296.0	5242.0	6378.0	19194.0
	% within Sex distribution	15.2%	7.2%	10.3%	6.8%	27.3%	33.2%	100%
	% within food borne disease	100%	100%	100%	100%	100%	100%	100%
	% of Total	15.2%	7.2%	10.3%	6.8%	27.3%	33.2%	100%

4.1.6 Laboratory Isolation of Food Microorganisms.

The purpose of this experiment was to see the effect of food handling practice on food contamination in food industry. The present study confirmed the findings about food contamination in food industry. In this section, we will illustrate some experimental results, 210 food products were collected from food stores in seven food industry in Adama town in Oromia region during summer 2022. 30 samples were collected from each seven food industry. The samples included milk products (fresh milk, and cheese), cereals, flour, pasta and macaroni, animal food were collected from 7 food industry**.** Out of the total samples (210), 70 samples tested cultures obtained on MSA medium, 70 samples tested from the MacConkey agar cultures, and 70 samples tested were used for gram stain.

4.1.6.1 Culture and Isolation.

In this test the food products were examined to check the presence of contaminated or food products get contaminated while handling during processing, storage and packaging, and transportation. The selective medium used for the detection of Gram positive and gram-negative bacteria were MacConkey agar and Mannitol salt agar. 140 food samples were selected to examine for bacterial growth in specific media such as MSA medium, and MacConkey agar. Testing was conducted on seven food industry, 140 food samples were collected from seven food industry. From the total sample, 70 cultures obtained on MSA medium, and 70 from MacConkey

agar and tested for Gram positive and gram-negative bacteria. MacConkey agar was used for the isolation of gram-negative enteric bacteria by culture method.

After a series of experiments pathogens were isolated by using specific Media MacConkey agar. Gram positive and gram-negative bacteria were identified based on color change in media and colony morphology. It was found that out of 140 food samples, 6(4.3%) samples were positive for gram-negative bacteria and none were positive for gram positive bacteria. Organisms Escherichia coli were capable of lactose fermentation, and form pinky-red colonies. The present study confirmed that foodborne pathogens E. coli were isolated from the food samples and none were positive for Gram positive bacteria. From these results it is clear that isolation of E. coli from food sample were a good indicator to food contaminated in food industry during production process. However, gram-negative bacteria were major risk factor for food contaminated or foodborne pathogens in food industry. Together, the present findings confirm that food products get contaminated while handling during processing, storage and packaging, and transportation.

Table 9:Experimental testing results conducted in isolation of microorganisms from the food samples growth in MSA medium, and MacConkey agar.

R.no	Specific Media for bacterial growth	Tested food samples	Type of bacteria Tested	Samples positive	Testing results revealed in food samples
1	MacConkey Agar (MAC)	70 samples tested	Gram-negative bacteria	6(4.3%)	Pinky-red colonies were Observed and confirmed that foodborne pathogens E. coli were isolated from the food samples
2	mannitol salt agar (MSA)	70 samples tested	Gram-positive bacteria	none were positive for gram positive bacteria	none were positive for gram positive bacteria

4.1.6.2 Gram staining a sample

In this experiment, gram staining was used to isolate gram-negative and gram- positive bacteria. Out of the total sample, 70 samples were used for gram stain. Pink-red appearance observed

under a light microscope following Gram staining. Under a microscope, gram-negative bacteria were appeared stain pink-red. However, 4 samples were a positive result for gram-negative bacteria in the gram stain test. The bacteria were gram- negative because gram-negative bacteria have a thinner layer, so do not retain the purple stain and counter-stained pink by Safranine. Among all food industry samples, gram-negative bacterial pathogens were found as causative agent for food contamination in food industry. Of particular interest was that no gram- positive.

Table 10: A Gram stain test used to isolate gram-negative and gram- positive bacteria present in food samples.

Tested food samples	Type of bacteria Tested.	Gram staining bacteria appear under a microscope	Bacteria present in Gram stain
70 samples tested	Gram-negative bacteria or	4 samples were a result positive and appear pink to red under the stain	Gram-negative bacterial pathogens were found and isolated as causative agent for food contamination in food industry
	Gram-positive bacteria	No samples were a appear positive result purple to blue under the gram stain test	No gram- positive bacteria were isolated as causative agent for food contamination in food industry

4.2 Discussion

These results build on existing evidence on: First, the correlation between age, educational status, and work experience with food safety knowledge and handling practice; Second, correlation between attitude and safety knowledge of food handler's in food industry; Third, Food safety practices and their associated factors among food handlers in food industry, and foodborne illness annually screened and registered in Adama Specialized Zonal Health Department (ZHD), In 2014 E.C. Fours, A Culture-based methods used to isolating target bacteria on selective media and Gram stain procedure were used distinguishes between gram positive and gram negative groups by coloring these cells red or violet. Foodborne pathogens which identified as causative agent for food contamination and isolated from food sample in food industry.

4.2.1. Socio-Demographic Characteristics (sex distribution, age, educational status, and work experience) of the respondents.

Table 1 shows the correlation between age, gender, educational status, and work experience with food safety knowledge and handling practice. As it is displayed in table1, regarding the age of the food handlers, the findings of this study implied that majority 126(72.4%) of participants were between the age of 18-24, and 25-35 years. Therefore, the age information indicates that most of the respondents were young adults (early adulthood). Additionally, study finding shows that among the food handlers, most 75(43.10%) workers had attained secondary education and 88(50.57%) of them had over 5 years 'work experience**.** From these results it is clear that work experience and educational status were important to gain knowledge and skill among food handlers in order to maximize handling practice.

From the table 2, it is clear that educational status with age distribution($r = 0.853$), and work experiences with sex distribution($r = 0.820$) were found a fairly strong positive linear relationship. Thus, work experiences among food handlers had positive correlation(r value is closer to ± 1) with educational status and sex distribution in food handling practices. Therefore, work experiences, educational status and sex distribution were important to gain knowledge and food handling practice. Together, the present findings confirm that there was a positive correlation between work experiences, and education with safety knowledge among food

handlers. Therefore, study finding shows that educational level and work experiences were significant association with safety knowledge and handling practice. A similar pattern of results was found in work experiences that had prolonged work experience would help food handlers to gain good knowledge and skill to performing good handling practice(Alemayehu *et al.*, 2021).

4.2.2 The correlation between safety knowledge, attitudes and practices of food handler's in food industry.

From the results, it is found that strong positive relation between safety knowledge, attitudes and practices of food handler's in food industry. From the table 3, it can be observed that majority of food handlers who had responded good 82(47.13%), and better 77(44.25%) had good food safety knowledge and handling practices. Our findings also shows that food handlers who had chooses strongly agree 74(42.53%) and 76 (43.68%) agree replied importance of periodic training on food safe in food industry. Therefore, majority of food handler believe that periodic training on food safe would help to maximized safety knowledge for engagement of food handling practice. The data suggest that there is positive correlation between safety knowledge and food safety handling practice. However, high food safety knowledge could be bringing into good food safety practice. Similarly, food handlers who had chooses strongly disagree 21(12.07%) and disagree 3 (1.07%) had no a positive attitude toward food safety in food industry. Through our investigation lack of safety knowledge among food handlers were observed.

When comparing our results to those of older studies, there is a significant positive association between attitude and safety knowledge. However, food handlers who had good knowledge of food safety would have favorable attitude towards food safety compare to those food handlers who had an unfavorable attitude. Only food safety training, knowledge of food safety, and work experience remains significant(Alemayehu et al., 2021). Another similar conclusion was found that food safety knowledge was highly association with food safety practices. Therefore, Food handler who had high food safety knowledge would have 5.7 times engages in food safety practices(Al Banna et al., 2021).

4.2.3 Food safety practices and their associated factors among food handlers in food industry.

Assessment of safety practices towards the foodborne diseases were obtained based on statement Supervisor and administrative manager. From the results, it is clear that Table 4 suggest a correlation between food safety practices and handling practices. These findings suggest that unsanitary practices, improper food handling, and poor food safety practices were lead to foodborne illness. However, ensuring safety food products was the importance foods handling safety practices. It also found that proper employee hygiene, effective cleaning and sanitizing of the manufacturing equipment were most important way to prevent foodborne illness from food borne pathogen. On the other hand the results of the study reveal that the effects of unsanitary practices and improper food handling had increasing the risk for transmission of pathogenic microorganism. Therefore, washing of hands before handling the food was the most important ways to avoid food related risks.

Unsanitary practices and improper food handling were a major risk factor for food-borne diseases. It is focused on describing the impact of food manufacturing practices on foodborne diseases. A similar conclusion was reached by Abebe et al., indicated that poor food handling and sanitation practices, inadequate food safety laws, weak regulatory systems, lack of financial resources to invest in safer equipment, and lack of education for food handlers are often the source of food contamination and occurrence of food-borne diseases in low- and middle-income countries like Ethiopia (Abebe *et al.*, 2020).

Another important finding was that: ensuring the safety of food products; Proper employee hygiene; effective cleaning and sanitizing of the manufacturing equipment were most important way to prevent foodborne illness. Therefore, several measurements should be taken to protect themselves from foodborne illness such as washing of hands before handling the food was the most important ways to avoid food related risks. There are several measurement should be taken to reduce risk of food borne illness such as addressing important of food safety practice of food handlers in food industry. This result ties well with previous studies where in recognizing food safety as a priority in food industry and washing of hands before handling the food should be exercised by food handlers(Ahmed *et al.*, 2021).

It is clearly indicated that microbial contamination and chemical contamination were the biggest cause of foodborne illness in the workplace. This result ties well with previous studies wherein unsafe foods are associated with the presence of harmful chemicals and microorganisms lead to negative effects to animal and human health(Focker & van der Fels-Klerx, 2020). In addition, poor employee health and hygiene were challenges that hinder the causes of foodborne diseases. Duo to this, food-borne illness had impact in the food industry by increase the cost of health care and additional cost for buying medication(Buzby & Roberts, 2009). Because of this, respondents believe that microbial contamination and chemical contamination were the biggest cause of foodborne illness in the workplace. On the other hand the results of the study reveal that food safety measures can prevent foodborne diseases controlling food safety hazards within a food business.

Studies finding by were identified that hygiene was important in food industry to ensure safe food manufacturing practices. On the other hand the results of the study reveal that food safety measures could prevent foodborne diseases to controlling food safety hazards within a food business. There are several measurement should be taken by consumers to protect themselves from foodborne illness such as avoiding food from unsafe source (ensure food is safe to eat) and good hygiene practices. It has recently been demonstrated that that the local and international food marketing continues to have significant impacts on health of the public. The food market increases internationalization of health risks as the food supply chains cross multiple national borders. Therefore, effective national risk-based food control systems are essential to protect the health and safety of the public. Countries need also assure the safety and quality of their foods entering international trade and ensure that imported foods conform to national requirements(Gizaw, 2019).

4.2.4 Foodborne illness annually screened and registered in Adama Specialized Zonal Health Department (ZHD), In 2014 E.C.

Results, finding and reports generated as a result of the case reported by Adama Specialized Zone Health Department in 2014 E.C. From the results, it is clear that *Escherichia coli, bacillus K. pneumonia, Salmonella spp*, protozoa, Bacteria and viral etiological agent that were identified as food borne diseases. Study finding conducted on food safety and food quality shows that microorganisms such as *Staphylococcus spp., Escherichia coli and Salmonella* spp were factors

regarding the food-borne illness highlighting the impact of good manipulation practices on the food safety and food quality(De Sousa, 2008a).

Pneumonia was the major etiological agent and almost both female and male were venerable to *K. pneumoniae. E.coli* was the second major etiological agent and female were more venerable for urinary infection and urinary disorder. Through my analysis, it's been proven that gram-negative *E. coli* and *K. pneumoniae was* the major etiological agent of UTI. A similar conclusion was reached in Study was done from January-March 2006 shows that *E. coli* 43.5% (25.2% in men and 74.8% in women) and *K. pneumoniae* 13.3% (38% in men and 62% in women) was determine as the most common gram negative bacterial agents causing UTI and females were more vulnerable to UTI(Okojie & Omorokpe, 2018). However, E. coli was occurred more frequently and common agent of urinary tract infections(Trześniewska-Ofiara *et al*., 2022).

4.2.5 Laboratory Isolation of Food Microorganisms.

MacConkey agar cultures were used in the differentiation of lactose fermenting from lactose non-fermenting gram-negative bacteria. 140 food products were collected from food stores in seven food industry and 20 samples were collected from each seven food industry. The present study confirmed that foodborne pathogens E. coli were isolated from the food samples and none were positive for Gram positive bacteria. The present findings seem to be consistent with other research which found that culture was used for detection of foodborne pathogens and E. coli were isolated from food sample (Hariri, 2022).

In this study, gram-negative bacterial pathogens were found as causative agent for food contamination in food industry. Under a microscope, Gram-negative bacteria were appeared stain pink-red. Their peptidoglycan layer is thinner, so it doesn't retain the blue color. The bacteria were gram- negative due to the positive result. Of particular interest was that no gram-positive staining bacteria were isolated from food industry. Overall, only bacterial species were identified. It has been suggested that food pathogens during ingestion by the consumer related to the manipulation practices such as Staphylococcus spp., Escherichia coli and Salmonella spp. were the major causes of Food-borne illness and had impact on good manipulation practices on the food safety and food quality(De Sousa, 2008a).

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

This research has investigated on the assessment of food manufacturing practice on foodborne disease in the food industries. In summary, this paper argued that age, educational status, works experience, and training, were significantly associated with food safety knowledge and handling practice. Among all food industry samples, gram-negative bacterial pathogens were found as causative agent for food contamination in food industry. From the MacConkey agar cultures, 6 samples were positive for *E. coli* and none were positive for Gram positive bacteria. The foodborne pathogens E. coli were isolated from the food samples. Our data suggest that foodborne diseases in developed and developing countries were caused due to insufficient knowledge of safe food processing and handling practices. This is an important finding in the understanding of, lack of knowledge on food safety and poor food handling practice are still a problem for food industry. Therefore, education is an important factor that influences to change attitude of food handlers. However, positive attitudes and practices towards food safety issues which could reduce contamination of the food in the food industry. The research was limited in several ways. However, the findings are subject to at least two limitations. Several limitations need to be acknowledged, we did not used any biochemical tests used to identify gram positive and gram negative bacteria. Because these test was a time consuming process and more expensive. Future explanation into food safety hazards could be useful to find further investigation using biochemical tests in order to ensure both quantitative and qualitative information about the diversity of microorganisms present in a food samples.

5.2 Recommendation

Based on the findings of this study, the following recommendations were made:

This study was focused on the assessment of food safety practices, knowledge and attitude among food handlers, supervisors and managers in selected food industries. It explained the risk of contamination with sources of food hazards present in food industry and food pathogens which were found as causative agent for food contamination in food industry. However, gram-negative bacteria were major risk factor for food contaminated or foodborne pathogens in food

industry. Therefore, it can be concluded that food products get contaminated while handling during processing, storage and packaging, and transportation. This study concludes that ensuring the safety of food products and addressing important of food safety practice of food handlers in food industry should be taken to reduce risk of food borne illness. Because, there is positive correlation between attitudes, safety knowledge, and food safety handling practice. However, high food safety knowledge could be bringing into good food safety practice. Therefore, education is an important factor that influences to change attitude of food handlers. Thus, positive attitudes and practices towards food safety issues which could reduce contamination of the food in the food industry. In addition, the risk of contamination of food is present in food industry can be reduced by addressing good manufacturing practices such as proper employee hygiene, adequate training, and effective cleaning and sanitizing of the manufacturing equipment and environment.

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7. APPENDICES

ANNEXES

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

SCHOOL OF NATURAL SCIENCE

DEPARTMENT OF BIOTECHNOLOGY

Dear Respondents:

My name is ***Nigussie Getachew Meshesha,*** These are research questions; you are kindly requested to answer voluntary all questions completely so as to make the research successful. The questionnaire is designed to collect data for the thesis for partial fulfillment of MSC degree in Applied Biology (Biotechnology) in Adama Science and Technology University under the topic ***The* Assessment *of Food Manufacturing practice on Foodborne Diseases*** - the case of Oromia Zone, ***in Adama city***. The purpose is to identify the major factors contribute to the outbreaks of the food borne illness, pathogens to specific foods and identify where in the production life cycle the foods became contaminated.

Informed consent

Read the following paragraph for selected food handler. To conduct our study, I would like to ask you some questions which may take about 30 minutes. As your participation is very important to the outcome of the study, we kindly request you to give us year sincere and truthful answer. All the information that you and other respondents are going to provide us remains confidential and do not need to mention your name. Therefore are you voluntary to participate in this study?

Yes-------- No--------

If yes, proceed. If no, thank and stop here._____ (Signature of interviewer certifying that respondent has given Informed consent verbally).

APPENDIX-A

APPENDX-A11:Questionnaire to food handler (employer).

Annex 1.1. Questionnaire to food handler (employer)

Part I: General Information

***1. Personal Information* of Food Handlers**

Organization:_____

Job _____

Male ☐

Female ☐

Age <25 ☐ 26 - 35 ☐ 36 - 45 ☐ > 46 ☐

2. Educational status

- Status No education (illiterate) ☐
- Primary school education ☐
- Secondary school education ☐
- Certificate holder ☐
- Diploma holder ☐
- First degree holder ☐
- 2nd degree holder ☐

3. Work Experience

- Total _____ In the current Organization _____

Specific Information

1. Do you think that food safety is important in the food industry?

Yes ☐ No ☐ I don`t know

2. If your answer is yes in question No.1, Why food safety is important in the food industry?

It protects the consumer from the risk of food borne illnesses. ☐

It also protects financial losses due to unsafe products. ☐

These illnesses contribute significantly to reduce the cost of health care. ☐

3. Do you think that food safety measures can prevent foodborne diseases?

Yes ☐ No ☐ I don`t know ☐

4. If your answer is **yes** for question No. 3**,** please state the mechanisms

_____

_____

5. How is your organization process the food industry today?

Manual ☐ computerized ☐ Combination ☐

6. To what extent do managers assist in understanding the importance of food safety and implementing food safety training programs method is effective?

Very effective ☐ Effective ☐ Moderate ☐ Inefficient ☐

Very ☐ Ineffective ☐

7. Do you have adequate personnel in your department?

Yes ☐ No ☐

8. How food-handling practices are protecting to consumer from risk of food poisoning?

Better ☐ Good ☐ Poor ☐

9. Food-handling practices including infected food workers and cross-contamination of food were responsible for food-borne illness due to lack of awareness of food-handling practices.

☐ ☐ ☐ ☐

Strongly Agree Agree Disagree Strongly disagree

10. The employer should establish periodic training programs that include production and hygiene issues, and develop personal hygiene habits in these training programs.

Strongly ☐ Agree ☐ Agree ☐ Disagree ☐ Strongly ☐ disagree ☐

11. What is the most effective way for food handlers to reduce food contamination?

……

……

12. What are four sources of food hazards that could contaminate food?

…….....

.....

13. Why is safety and sanitation important in the food industry?

……

……

……

14. Who is most at risk for contaminating food?

……

……

……

15. What are things that can be done to prevent food from becoming contaminated?

……

……

……

THANK YOU FOR YOUR KINDNESS

APPENDIX-B

APPENDX-B 12:Questionnaire to supervisor and administrative manager.

Annex 1.2. Questionnaire to supervisor and administrative manager

1. What is the most pressing issue facing the food industry today?

Mishandling ☐

Contamination ☐

Industry's prime responsibility to consumers is public health and safety ☐

2. What are ethical issues in food production?

Animal welfare issues ☐

Environmental protection ☐

The working conditions of people producing the food ☐

The impact of chemicals and other production ☐

The impact of small local producers and businesses ☐

3. What are the ethics to be followed in food industry?

Tap into local resources. ☐

Obey all food safety and sanitation laws ☐

Create consistent portion size. ☐

Don't be afraid to waste (time, money, or food) ☐

Personal responsibility ☐

4. What are the safe behaviors in a food industry?

Wash hands frequently. ☐

Learn safe lifting techniques. ☐

Know how to work with all equipment and tools required for the job. ☐

Keep the work area tidy ☐

5. What are the problems that affect food safety?

Microbial contamination ☐

Chemical contamination ☐

A. Misuse of food additives ☐

Genetically modified foods ☐

6. Why food safety is important in the food industry?

It protects the consumer from the risk of food borne illnesses. ☐

It also protects financial losses due to unsafe products. ☐

These illnesses are a burden on public health and contribute significantly to the cost of health care ☐

Foodborne illnesses are a preventable and underreported public health problem. ☐

7. Why is safety and sanitation important in the food industry?

Improve efficiency ☐

Keep productivity up ☐

Workers safe and consumer confidence high ☐

8. How does a foodborne illness impact the food industry?

……

……

……

9. What is the biggest cause of foodborne illness in the workplace?

……

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……

10. What are the causes of foodborne diseases?

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……

……

11. What are the main risks leading to foodborne illness?

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……

……..

12. What food setting is most responsible for foodborne illnesses?

……

……

……

13. Why hygiene is important in food industry?

……

……

……

14. How food safety measures can prevent foodborne diseases?

……

……

…….

15. What can consumers do to protect themselves from foodborne illness?

……

……

…….

APPENDIX-C

APPENDX-C 13:Questionnaire to medical personnel.

Annex 1.3. Questionnaire to medical personnel

1. What is the situation regarding foodborne diseases in developed and developing countries?

a) Poor access to clean water to adequately wash food items ☐

b) Unsafe transportation and/or inadequate storage of foods, ☐

c) Insufficient knowledge of safe food processing and handling practices, ☐

2. What are the Major etiological agents causing food-borne diseases related with food involved in Adama town?

A. Norovirus ☐ D. Campylobacter ☐

B. Salmonella ☐ E. Shigella ☐

C. E. coli ☐ F. Listeria ☐

3. Who does foodborne illness affect the most?

A. Adults ☐ B. age 65 and older. ☐ C. Children younger than 5 years. ☐

D. People whose immune systems are weakened due to illness or medical treatment ☐

4. What are the most common causes of foodborne illness?

Improper hot/cold holding temperatures of potentially hazardous food ☐

Improper cooking temperatures of food ☐

Dirty and/or contaminated utensils and equipment ☐

Poor employee health and hygiene ☐

Food from unsafe sources ☐

5. What are the problems that affect food safety?

Microbial contamination ☐

Chemical contamination ☐

Misuse of food add ☐

6. Many outbreaks and individual cases of foodborne illness result from consuming the two most common types of foodborne pathogens:

Bacteria, like Salmonella, Listeria, or E. coli

Viruses, such as norovirus or hepatitis Aitives, mislabel ☐

Genetically modified foods ☐

Outdated foods ☐

7. Many outbreaks and individual cases of foodborne illness result from consuming the two most common types of foodborne pathogens:

Bacteria, like Salmonella, Listeria, or E. coli ☐

Viruses, such as norovirus or hepatitis A ☐

8. Which poor food handling practice would likely lead to foodborne illness?

……
……
……

9. What are the importance food handling safety practices?

……
……
……..

10. What is the most important way to prevent foodborne illness from bacteria?

……
……
……

11. What are the effects of unsanitary practices and improper food handling?

……
……
……

12. What are the most important ways to avoid food related risks?

……
……

APPENDX-D 14: Totally illness annually screened and registered in Adama Specialized Zonal Health Department (ZHD) in 2014 E.C.

Table 15:Disease Registration – 2014 E.C. in Adama Specialized ZHD.

Diseases	Sex	Age	Total
Abnormal products of conception Amoebiasis	Male	15 - 29 years	948
		30 - 64 years	400
		>=65 years	22
	Female	< 1 year	26
		1 - 4 years	79
		5 - 14 years	82
		15 - 29 years	286
		30 - 64 years	223
		>=65 years	35
		Total	1390
Acute lower respiratory infection	Male	< 1 year	129
		5 - 14 years	217
		1 - 4 years	80
		15 - 29 years	122
		30 - 64 years	120
		>=65 years	74
	Female	< 1 year	103
		1 - 4 years	151
		5 - 14 years	60

Diseases	Sex	Age	Total
		15 - 29 years	141
		30 - 64 years	149
		>=65 years	21
		Total	1367
		< 1 year	339
Acute tonsillitis	Male	1 - 4 years	714
		5 - 14 years	555
		15 - 29 years	292
		30 - 64 years	220
		>=65 years	22
	Female	< 1 year	289
		1 - 4 years	593
		5 - 14 years	488
		15 - 29 years	531
		30 - 64 years	244
		>=65 years	15
		Total	4360
Acute upper respiratory infections	Male	< 1 year	570
		1 - 4 years	662
		5 - 14 years	551
		15 - 29 years	753

Diseases	Sex	Age	Total
		30 - 64 years	796
		>=65 years	201
	Female	< 1 year	409
		1 - 4 years	621
		5 - 14 years	571
		15 - 29 years	1116
		30 - 64 years	846
		>=65 years	71
		Total	7167
Acute tonsillitis	Male	< 1 year	397
		1 - 4 years	714
		5 - 14 years	555
		15 - 29 years	292
		30 - 64 years	220
		>=65 years	22
	Female	< 1 year	289
		1 - 4 years	593
		5 - 14 years	488
		15 - 29 years	531
		30 - 64 years	244
		>=65 years	15

Diseases	Sex	Age	Total
Bacterial intestinal infections	Male	< 1 year	52
		1 - 4 years	88
		5 - 14 years	200
		15 - 29 years	323
		30 - 64 years	238
		>=65 years	83
	Female	< 1 year	27
		1 - 4 years	58
		5 - 14 years	197
		15 - 29 years	381
		30 - 64 years	217
		>=65 years	113
		Total	1977
Cataract	Male	< 1 year	2
		1 - 4 years	8
		5 - 14 years	26
		15 - 29 years	86
		30 - 64 years	463
		>=65 years	511
	Female	< 1 year	3
		1 - 4 years	5

Diseases	Sex	Age	Total
		5 - 14 years	14
		15 - 29 years	45
		30 - 64 years	523
		>=65 years	290
Conjunctivitis	Male	< 1 year	19
		1 - 4 years	38
		5 - 14 years	34
		15 - 29 years	203
		30 - 64 years	234
		>=65 years	46
	Female	< 1 year	15
		1 - 4 years	27
		5 - 14 years	19
		15 - 29 years	255
		30 - 64 years	359
		>=65 years	14
			1263
Type 2 diabetes mellitus	Male	< 1 year	2
		1 - 4 years	4
		5 - 14 years	7
		15 - 29 years	49

Diseases	Sex	Age	Total
		30 - 64 years	414
		>=65 years	133
	Female	< 1 years	3
		1 - 4 years	4
		5 - 14 years	4
		15 - 29 years	46
		Female, 30 - 64 years	341
		Female, >=65 years	110
		Total	1117
	Male	< 1 year	25
		1 - 4 years	40
		5 - 14 years	27
		15 - 29 years	81
		30 - 64 years	272
		>=65 years	183
	Female	< 1 year	15
		1 - 4 years	13
		5 - 14 years	20

Diseases	Sex	Age	Total
		15 - 29 years	56
		30 - 64 years	185
		>=65 years	68
		Total	985
Contact dermatitis	Male	< 1 year	76
		1 - 4 years	107
		5 - 14 years	60
		15 - 29 years	112
		30 - 64 years	114
		>=65 years	25
	Female	< 1 year	61
		1 - 4 years	98
		5 - 14 years	69
		15 - 29 years	134
		30 - 64 years	96
		>=65 years	7
		Total	959
Disorders of urinary system	Male	< 1 year	56
		1 - 4 years	98
		5 - 14 years	111
		15 - 29 years	715

Diseases	Sex	Age	Total
		30 - 64 years	749
		>=65 yr	172
	Male	< 1 year	39
		1 - 4 years	24
		5 - 14 years	153
		15 - 29 years	1613
		30 - 64 years	1294
		>=65 years	218
		Total	5242
Dorsalgia	Male	15 - 29 years	137
		30 - 64 years	222
		>=65 years	70
	Female	< 1 year	2
		5 - 14 years	13
		15 - 29 years	232
		30 - 64 years	215
		>=65 years	39
Epilepsy and recurrent seizures2789	Male	< 1 year	2
		1 - 4 years	27
		5 - 14 years	103
		15 - 29 years	812

Diseases	Sex	Age	Total
		30 - 64 years	571
		>=65 years	77
	Female	1 - 4 years	13
		5 - 14 years	84
		15 - 29 years	629
		30 - 64 years	453
		>=65 years	18
		Total	2789
Fever of unknown origin	Male	< 1 year	102
		1 - 4 years	167
		5 - 14 years	281
		15 - 29 years	708
		30 - 64 years	679
		>=65 yr	171
	Female	< 1 year	89
		1 - 4 years	140
		5 - 14 years	300
		15 - 29 years	986
		30 - 64 years	717
		>=65 years	159
		Total	4499

Diseases	Sex	Age	Total
Functional intestinal disorders	Male	< 1 year	1093
		1 - 4 years	555
		5 - 14 years	130
		15 - 29 years	242
		30 - 64 years	167
		>=65 yr	31
	Female	< 1 year	331
		1 - 4 years	436
		5 - 14 years	136
		15 - 29 years	333
	Female	30 - 64 years	194
		>=65 years	17
		Total	985
General medical examination	Male	5 - 14 years	33
		15 - 29 years	3885
		30 - 64 years	2372
		>=65 years	12
	Female	15 - 29 years	1543
		30 - 64 years	526
		>=65 years	34
		Total	8405

Diseases	Sex	Age	Total
Glaucoma	Male	< 1 year	25
		1 - 4 years	40
		5 - 14 years	27
		15 - 29 years	81
		30 - 64 years	272
		>=65 years	183
	Female	< 1 year	15
		1 - 4 years	13
		5 - 14 years	20
		15 - 29 years	56
		30 - 64 years	185
		>=65 years	68
		Total	985
Helminthiases	Male	< 1 year	21
		1 - 4 years	84
		5 - 14 years	176
		15 - 29 years	254
		30 - 64 years	251
		>=65 years	43
	Female	< 1 year	17

Diseases	Sex	Age	Total
		1 - 4 years	72
		5 - 14 years	149
		15 - 29 years	348
		30 - 64 years	228
		>=65 years	60
		Total	1703
Hypertension	Male	< 1 year	1
		1 - 4 years	3
		5 - 14 years	3
		15 - 29 years	128
		30 - 64 years	1111
		>=65 years	470
	Female	< 1 year	8
		1 - 4 years	2
		15 - 29 years	125
		30 - 64 years	1458
		>=65 years	410
		Total	3719
Malignant neoplasm		< 1 year	8
		1 - 4 years	1

Diseases	Sex	Age	Total
		5 - 14 years	3
		15 - 29 years	279
		30 - 64 years	618
Malignant		>=65 years	187
neoplasm2893	Female	< 1 year	1
		1 - 4 years	3
		5 - 14 years	8
		15 - 29 years	421
		30 - 64 years	1226
		>=65 years	138
		Total	2893
Pneumonia	Male	< 1 year	671
		1 - 4 years	705
		5 - 14 years	305
		15 - 29 years	696
		30 - 64 years	874
		>=65 years	208
	Female	< 1 year	515
		1 - 4 years	608
		5 - 14 years	242

Diseases	Sex	Age	Total
		15 - 29 years	614
		30 - 64 years	791
		>=65 years	149
		Total	6378
Schizophrenia	Male	< 1 year	4
		1 - 4 years	1
		5 - 14 years	14
		15 - 29 years	533
		30 - 64 years	692
		>=65 years	26
	Female	1 - 4 years	1
		5 - 14 years	11
		15 - 29 years	482
		30 - 64 years	641
		>=65 yr	27
		Total	2432
Soft tissue disorders	Male	< 1 year	22
		1 - 4 years	44
		5 - 14 years	132
		15 - 29 years	186

Diseases	Sex	Age	Total
		30 - 64 years	250
		>=65 years	38
	Female	< 1 year	6
		1 - 4 years	31
		5 - 14 years	85
		15 - 29 years	268
		30 - 64 years	230
		>=65 years	28
			1320
Superficial injury of unspecified body region	Male	< 1 year	1
		1 - 4 years	21
		5 - 14 years	62
		15 - 29 years	1194
		30 - 64 years	922
		>=65 yr	59
	Female	< 1 year	1
		1 - 4 years	10
		5 - 14 years	39
		15 - 29 years	503
		30 - 64 years	381

Diseases	Sex	Age	Total
		>=65 years	37
		Total	3230
Typhus fever2147	Male	< 1 year	1
		1 - 4 years	8
		5 - 14 years	66
		15 - 29 years	394
		30 - 64 years	369
		>=65 years	97
	Female	5 - 14 years	108
		15 - 29 years	677
		30 - 64 years	378
		>=65 years	49
			2147
Typhoid and paratyphoid	Male	< 1 year	5
		1 - 4 years	16
		5 - 14 years	96
		15 - 29 years	709
		30 - 64 years	525
		>=65 years	94
	Female	< 1 year	1

Diseases	Sex	Age	Total
		1 - 4 years	8
		5 - 14 years	77
		15 - 29 years	759
		30 - 64 years	574
		>=65 years	47
		Total	2911
Viral and other specified intestinal infections	Male	< 1 year	134
		1 - 4 years	109
		5 - 14 years	67
		15 - 29 years	109
		30 - 64 years	257
		Male, >=65 years	23
	Female	< 1 year	74
		1 - 4 years	106
		5 - 14 years	36
		15 - 29 years	181
		30 - 64 years	185
		>=65 years	15
			1296