ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

DEPARTMENT OF MEDICAL LABORATORY SCIENCES

Assessment of Laboratory service interruption and its associated factors in Public Hospitals, Addis Ababa, Ethiopia

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This is to certify that the thesis prepared by **Tilanesh Mulu,** entitled: **"Assessment of laboratory service interruption and its associated factors in public hospitals in Addis Ababa, Ethiopia.** "Submitted in partial fulfillment of the requirements for Master of Science degree in Clinical Laboratory Sciences (Laboratory Management and Quality Assurance Specialty Track) complies with the regulations of the University, and meets the accepted standards with respect to originality and quality.

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Abbreviations /Acronyms

AFSH	Armed force specialized hospital.
DC	Data collector
FMOH	Federal ministry of health
GH	General Hospital
HR	Human Resource
LAB	Laboratory
PI	Principal Investigator
RLS	Resource limited setting
SPSS	Statistical Package for Social Science
SH	Specialized hospital
TASH	Tikur anbessa specialized hospital
WHO	World Health Organization

Abstract

Background: Medical laboratory service is very essential for sustainable and reliable patient diagnosis and treatment. Interruption is a global problem and much higher in resource limited settings. However, there is no adequate evidence on the magnitude and contributed factors. Thus, this study aimed to assess the laboratory service interruption and its associated factors in public hospitals found in Addis Ababa, Ethiopia.

Methods: Facility based cross sectional study design was conducted in public hospitals found in Addis Ababa using qualitative and quantitative data from April-June/ 2020in Ethiopia. Standardized check list was developed to assess level of interruption and also structured dichotomous questioners' were used for related factors. Data was entered and analyzed using SPSS version 23. Binary and multiple logistic regression analysis were used to explanatory factor that affect the outcome variable.

Result: Totally 190 laboratory professionals were participated with a response rate of 95.5%. In public hospitals averagely 17(23%) tests were interrupted for 76(84%) days. In specialized and General hospitals averagely 13(17%) and 19(28%) tests were interrupted, respectively. In this study serology and hematology tests accounts the highest level of interruption which is 5(6.9%) and 4(5.5%) respectively. While parasitological, urinalysis and body fluid analysis were consistently available. Absence of laboratory annual plan at [AOR=3.028, p-value=0.044, 95%Cl (1.030-8.903], inappropriate equipment maintenance at [AOR=9.350, p-value=0.003, 95%Cl (2.102-41.596], and shortage of reagents and supplies at [AOR=3.845, p-value=0.049, 95%Cl (1.008-14.663] were the major factors that affect laboratory service interruption.

Conclusion: Even though sustainable laboratory service is important in the health care service, most public hospital laboratories found in Addis Ababa did not provide continuous diagnostic service for all expected tests**.** Therefore, to improve service interruption, hospital managers, health professionals and other stakeholders should undertake effort to intervene the factors that affect laboratory service interruption.

Key words: Laboratory, service, interruption, Ethiopia

1. Introduction

1.1 Back ground

Medical laboratory services are basic component of a health-care system and necessary for maintaining successful diagnosis in the hospitals(1). In developing sub-Saharan African countries, the major challenging for delivering quality and sustainable laboratory service is the availability of laboratory test interruption(2).

Sustainable and reliable laboratory results are essential for many health care diagnoses and to give confirmed results for patients. For example, in many developed countries more than 70% of medical decisions are made based on medical laboratory diagnosis(3). But due to lack of awareness on medical laboratory service role in many developing sub Saharan African countries laboratory services sometimes thought after other health care components for managerial and economic views. Because of this, most laboratories are illed equipped and poorly resourced, poor management support, shortage of training and poor motivation system; resulting service interruption, these lead physicians to give medical decisions based on clinical judgment and empiric diagnoses and resulting suffering patients for different drug resistance bacterial diseases(4). More over patient's safety and economy also influenced by try to get laboratory diagnosis from privet laboratories.

It's well known that laboratory service interruption is mainly depend on shortage of reagents and supplies, shortage of equipments, poor management support, inadequate maintenance unavailability of infrastructures. However studies also showed motivation of staffs, high maintenance cost and lack of spare parts, insufficient monitoring of health quality, lack of close follow up are lead to service interruption due to equipment down time and laboratory professionals try to get additional income to satisfy their living cost(5).

More over studies done in sub-Saharan African countries Explained that the major factors for implementation of laboratory quality management system were shortage of reagents, poor management support, shortage of back up equipments, unavailability of good sample referral linkage system, good procurement and supply system; also leads laboratory service interruption(6).

To develop the basic health care system in resource limited setting countries, building adequate and sustainable laboratory medicine is essential. Efficient, reliable and sustainable

laboratory operations require an uninterrupted availability of reagents, supplies, consumables, enough infrastructure, good national regulatory and networks system, good procurement and supply systems, stable quality of laboratory performance, equipment maintenance, and adequate human resource and the ability to follow manufacturers' recommendations to ensure proper operational capacity of laboratory instruments(7).

To undertake these factors, several efforts are made in sub-Saharan African countries, however there are still numerous challenges hindering the consistency of laboratory service (8). More over Ethiopia is one of the sub-Saharan African countries to intervene those factors and to minimize service interruption Ethiopia starts the implementation of Strengthening Laboratory Management towards Accreditation (SLMTA) and include test interruption under laboratory service indicators. But, still it is one of the major factors that affecting the medical laboratory services as well as the health care system.

1.2 Statement of the Problem

Laboratory service is one of the most essential parts in health care process to generate accurate information about the patients. The laboratory result used as evidence for medical decisions and possible management plans that considered by physicians. To bring quality and reliable result for a wide range of diagnosis, treatment and monitoring in health care delivery uninterrupted laboratory service is essential(9). According WHO, Laboratory service interruption is worldwide problem it causes low client satisfaction related to the reliability and sustainable laboratory service(10).In sub-Saharan countries Diagnosis of infectious diseases without laboratory confirmation occurs due to poor quality and interruption of service. These lead to misdiagnosis with effect of increased morbidity and mortality (11).

In sub-Saharan African countries, failure to create and/or implement national laboratory policies, weak national regulatory and laboratory networks system, weak procurement and supply systems, variable quality of laboratory performance due to lack of standardization and quality standards, lack of equipment maintenance, and the inability to follow manufacturers' recommendations to ensure proper operational capacity of laboratory instruments and unavailability of adequate human resource are factors affecting for delivering quality and sustainable laboratory service, and effective health care(12).

In Ethiopia different studies indicates, the existence of laboratory service interruption is a major and common factor that affecting Clients and clinician satisfaction, the quality and consistency of health care delivery and the beginning of accreditations program (13).

Interruption of laboratory services, shortage of resources, poor management support, poor equipment quality, high workload; lack of equipment calibration and lack of knowledge are the major reported factors affecting provision of quality services and implementation of accreditation of laboratory service(14).

In Ethiopia laboratory, insufficient quality and quantity of consumable supplies forced service interruptions, which prevented implementation of accreditation under ISO 15189 standards(15).

More over different studies conducted in Ethiopia on laboratory service, interruption is one of the major problems which affect delivery of consistent quality laboratory service, clinicians and patients' satisfaction and Strengthening Laboratory Management Towards Accreditation (SLMTA) on laboratory quality management system(16), and also causes for wastage of

resources and drug resistance micro organisms' due to giving inappropriate treatment without confirmation of laboratory diagnosis for the patients. Even though the laboratory service interruption is the major factor to deliver consistent quality health care service,as far as I know there is no study conducted to assess the status of laboratory service interruption in public hospitals found in Addis Ababa recently. These problems initiate the principal investigator to conduct the study.

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1.3. Significance of the study

Laboratory services are essential and one of the most important departments at any health care services. The highest quality and consistent laboratory service is the basis of medical decisions and possible management plans of patient's health. Interruptions in laboratory services are not compatible with ongoing hospital operations and would have immediate negative impact on the quality of clinical services. Laboratory service interruption is one of the major factors affecting patient and physician's satisfaction.

This study will help to provide information about level of laboratory service interruption, and identify factors affecting laboratory service interruption in public hospitals in Addis Ababa, Ethiopia. The finding helps the health policy makers and managers to take intervention on factors affecting laboratory service interruption to fill the gaps in the health care system sustainability and efficiency. In addition, it will support the physicians to decide and manage the patient easily using quality and sustainable laboratory services, increase customer satisfaction and also helps to minimize additional expenditure of the clients, organization and government for health, and it also used as an input for other related studies.

2. Literature Review

2.1. Laboratory service interruption

The study conducted by Maria Concepcion Alonso-Cerezo and colloquies in 2009, in Spain found that, usually clinical laboratory tests are performed when requested by the physician, regardless of the frequency of request or the clinical indication. As consequence, inappropriate consumption of resources can occur. This action increases total health care costs and shortage of resources results service interruption (17),and other study conducted by Prakash S, in2017, in Napale found that, Lack of adequate resources, equipment breakdowns, interruption of supplies can lead to considerable inconsistency in the service and accuracy of results, leading to incorrect diagnosis, inappropriate treatment or withholding of life saving (18).

A study conducted by Mills D and colliques in 2017 in Uganda found that, to improve the central health care system and to provide sustainable laboratory service in resource limited countries availability of long term human resource, funding for infrastructure and quality system are the major capacity building in the laboratory service (19). And other study conducted by Audu RA,in 2011 in Nigeria found, delay in turnaround time came from interruption in laboratory services due to unavailability of test kits, failure of quality control, network problems (support infrastructure), and staff rotation (20). Furthermore a meta-analysis study conducted by Rubinstein M, Hirsch R, BandyopadhyayK, MadisonB, TaylorT, RanneA, et al, in 20218, explained that unnecessarily duplicative with variations in test ordering, poor quality and insufficient availability of consumable laboratory supply leads to laboratory service interruption (21)

Another study conducted by Moyo K, in 2015 in Malawi found most physicians used laboratory result for patient management, but sometimes laboratory tests were interrupted by shortage of reagents and unavailability of back up equipments. Because of this physicians managed patients without confirmed laboratory results (22).Similarly other study conducted by Petrose LG and colloquies in 2016 in Malawi; even though the hospital is referral, but because of unavailability of back up machine some tests interrupted up to six months this results decreasing patients and physicians' satisfaction on laboratory service and also decrease laboratory staff motivation (23).

A study conducted by Zhang HL, Omondi MW, Musyoka AM, Afwamba IA, Swai RP, Karia FP, et al.in 216 in Tanzania; discussed that challenges for inability to achieve uninterrupted

and sustainable provision of high-quality diagnostic laboratory services were inappropriate instrument maintenance services, limited backup testing options, contribute to the frequently prolonged and debilitating nature of instrument breakdowns, sourcing of quality reagents and consumables for laboratory testing is often performed internationally due to lack of reliable local or national vendors and is burdened by a slow and costly customs clearance process, considering the fixed costs of sustaining the laboratory, including instrument maintenance service contracts and personnel wages, the low testing demand of the laboratory precludes self sustainability (24).

A research conducted by MesfineA,TayeB, BelayG, Ashenafi A, GirmaV, in 2017 in Addis Ababa found that 74 (34.7%) of study respondents believed that their laboratory did not provide a diagnostic services for all requested tests and 111 (52.1%) of laboratory service interruption and (64.3%) shortage of resources, poor management support (57.3%), poor equipment quality (53.4%), high workload (41.1%), lack of equipment calibration (38.3%) and lack of knowledge (23.3%) (25).

A study conducted by Mindaye T, in 2012 on antiretroviral therapy clinics in public hospitals in Addis Ababa explained that waiting time to get blood drawing service, availability of ordered laboratory tests and waiting time to get laboratory result were statistically significant association with the level of clients satisfaction(36)and a study conducted by Hailu HA, DesaleA, YalewA, AsratH,KebedeS, DejeneD, et al in 2017 in Ethiopia; due to unavailability of requested laboratory service and laboratory personnel on their working area during their arrival in the laboratory nearly one-fourth up to half of the respondents were dissatisfied (26).

2.2 Factors Affecting Laboratory Service Interruption

A research done by Nkengasong JN, Nsubuga P, Nwanyanwu O, Gershy-Damet GM, Roscigno G, Bulterys M, et al in 2010 on global health found that Laboratory systems and services are often neglected in resource-poor settings. But to sustainably strengthen national laboratory systems in resource-poor countries developing integrative national laboratory strategic plans and policies and building systems to address multiple diseases, establishing public private partnerships, ensuring effective leadership, commitment, and coordination by host governments of efforts of donors and partners, establishing and/or strengthening centers of excellence laboratory training programs to meet short- and medium-term training and retention goals; and establishing affordable, scalable, and effective laboratory accreditation schemes to ensure quality of laboratory tests and bridge the gap between clinicians and

laboratory experts on the use of test results were essentials (27).The study done by Wertheim HFL, Puthavathana P, Nghiem NM, Rogier van Doorn H, Nguyen T, Pham H, et alin 2010, in Asia; identified the major challenges of developing effective laboratory capacity in resource limited settings including lack of infrastructure, weak national regulatory and laboratory networks system, weak procurement and supply systems, lack of equipment maintenance, and the inability to follow manufacturers' recommendations to ensure proper operational capacity of laboratory instruments (28). And other Studies done by Wanjau KN, Muiruri BW and Ayodo E, in 2012, in Kenyata hospital found that major factors affecting laboratory services were lack of resource, equipment failure, poor management system, shortage of staff, and low staff motivation (29).

The Study conducted by Tesfay A, Alemayehu B, Yehualashet T, Sintayehu G, Abebe T, Leykun D, et al, in 2014 in Ethiopia; found lack of properly designed laboratory rooms, lack of well trained staff in microscopy, interruption of water and electricity power, lack of functional microscopy and supplies and absence of effective maintenance and spare parts were the major factors that affect the diagnostic capacity of malaria in health facilities (30). Moreover other study conducted by Tegbaru B, Meless H, Kassu A, Tesema D, Gezahegn N, Tamene W, et al, in 2004, in eastern Ethiopia; showed high workloads, lack of equipment calibration, lack of knowledge and skills and poor staff motivation were the major factors that affecting the provision of quality of laboratory services (31).

Other Study conducted by Girma M, Desalegn A, Hassen F, Sisay A and Tsegaye Ain 2017, in Addis Ababa hospitals on ISO15189 accreditation standards implementation found that , lack of top management support (50.5%), inadequate space and utilities (infrastructure) (51.4%), Laboratory Reagents and Supplies are major factors that causes for service interruption (32). Similarly study done by MisganawAS, in 2016 in Addis Ababa; showed 76% of study participants replied laboratories had no work plan and budget for laboratory specific purpose, lack of resources (24%) which is followed by absence of system in the health system, 105(73.4%) no enough equipment in their laboratory and 115 (79.9%) of the lab equipment did not serviced according to the scheduled in the laboratory because of poor resource allocation and 53.9% the available equipment don't conduct preventive maintenance in the laboratory (33). Due to lack of motivation 27(18.8%) the laboratory didn't communicate regularly with upper management and 54(37.5%) of the laboratory professionals did not conduct their customer satisfaction survey because of poor staff communication and resource allocation (34).

According to the study done by Mosadeghrad AM, in 2014 in Iran; health care provider felled satisfied when they saved patients life, but because of insufficiency and unfair payment in public hospitals most of them work additional job in other health facilities to afford the living expense earn because of this they were not motivated and satisfied on their job (35).

A study conducted by Desalegn DM, Taddese BD, Yemanebrhane N, Getahun MS, Kitila KT, Dinku TT, et al, in2019, in Addis Ababa; Lack of internal quality control materials and other reagents, inconsistent electric power supply and a limited number of trained laboratory personnel, limited availability of qualified engineers for equipment service, high maintenance costs and lack of equipment and spare parts were the major challenges the laboratory encountered and had to overcome. This led to extended equipment downtime, service interruptions and delays in service delivery. which resulted in increased complaints from clinicians and customers (36). In addition, due to the limited availability of qualified engineers high maintenance costs and lack of equipment and spare parts equipment service and calibration were challenging to procure at minimal cost (37).

2.3 Conceptual Framework

Based on the review of the literature the following conceptual model aims to combine and structure the connection among the following variables. Variables identified from the literature are used to build the following conceptual Framework (17, 19, 27, 28 and 30). The main variables of interest in laboratory services are high work load, poor communication & motivation, socio-demographic characteristics, shortage of resources, low management support, lack of backup system and limited infrastructure.

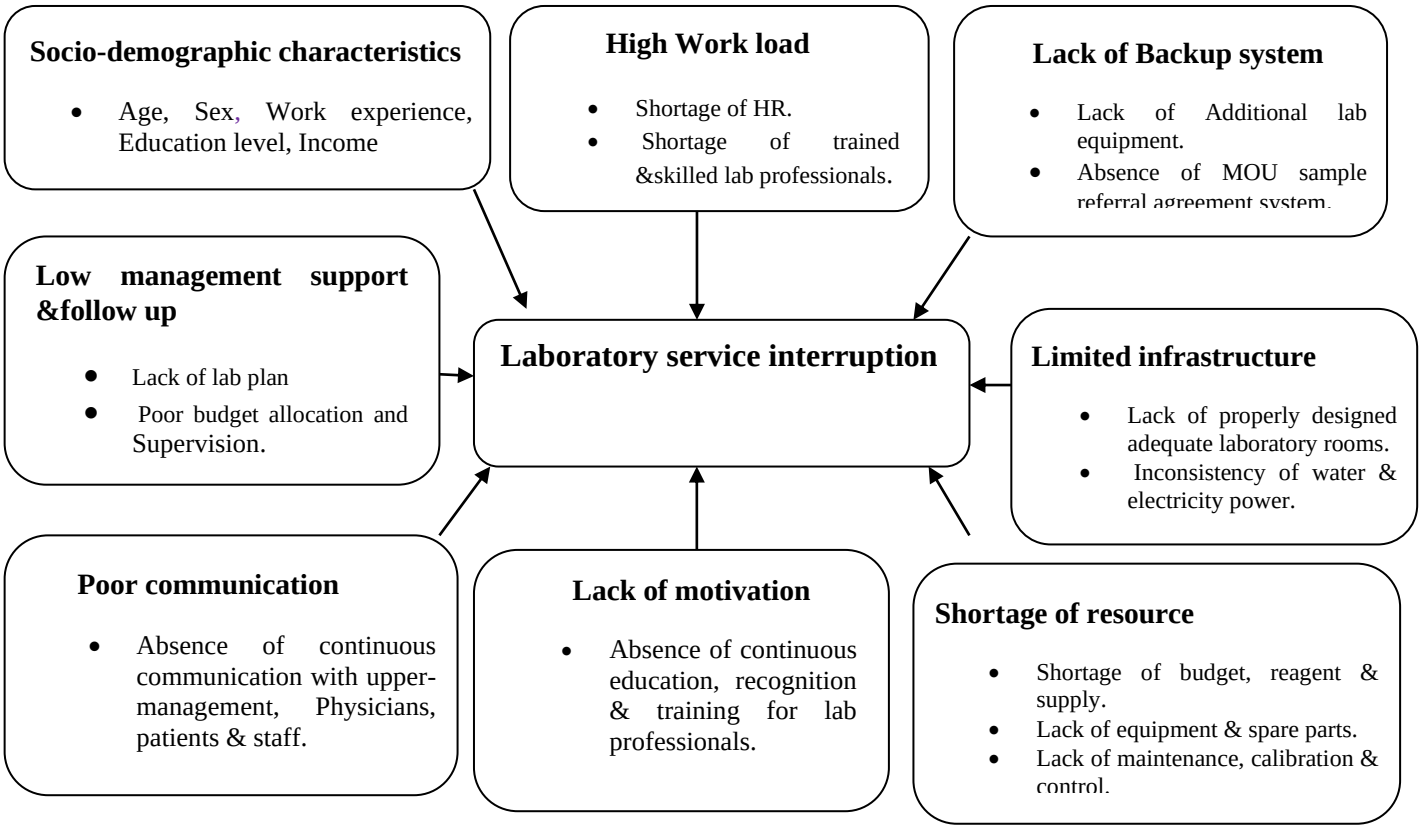

Figure 1: Conceptual framework for laboratory service interruption in public hospitals, Addis Ababa, April-June/2020.

3. Objectives

3.1. General Objectives

To assess the level of laboratory service interruption and its associated factor in public hospitals found in Addis Ababa from April-June/2020.

3.2. Specific Objectives

To determine the magnitude of laboratory service interruption in public hospitals found Addis Ababa.

To identify associated factors for laboratory service interruption in public hospitals found Addis Ababa.

4. Materials and Methods

4.1. Study Area

The study was conducted in Addis Ababa, which is the capital city of Ethiopia. It is located at the heart of the country with the area of about 540 square kilo meters. It is the biggest city in the country having 10 sub cities and 116 woredas, with a total population size of 4,793,699 with annual growth rate of 4.37 (44). The city has 15 public hospitals and close to 100 health centers with a health facility to population proportion of 1:283,818 and 1:50,355 respectively. Moreover, it has 79% primary health coverage and 100% geographical health coverage. Of those 15 public hospitals, 6 hospitals are under Addis Ababa Health Bureau, 1 armed force referral and teaching hospital, 1 federal police hospital, 1 federal prison hospital, 5are referral Hospitals under the federal Ministry of Health and 1 referral and teaching hospital is under Addis Ababa University (45).

The investigator interested to conduct study in study area because of most public hospitals found in Addis Ababa used as referral hospitals for the country and the suitability of study area for investigator.

4.2. Study Design and Period

Facility based cross-sectional study was employed using quantitative and qualitative data collected from April –June/ 2020.

4.3. Population

4.3.1. Source Population

All facility laboratories and laboratory professionals which are found in public hospitals in Addis Ababa have been the source of population.

4.3.2. Study Population

Laboratory facilities and selected laboratory professionals who are working in public hospitals have been the study population.

4.4. Inclusion and Exclusion Criteria

4.4.1. Inclusion Criteria

Facility laboratories and selected laboratory professionals those having greater than or equal to one year working experience would be included in the study.

4.4.2. Exclusion Criteria

Facility laboratory and laboratory professionals those are not volunteer to participate and professionals in annual leave and students in practice would be excluded in the study.

4.5. Study Variables

4.5.1. Dependent Variable

Laboratory service interruption

4.5.2. Independent Variables

Socio Democratic characteristics
Shortage of Resources
Low management support and follow up
High Work load
Lack of Backup system
Lack of Motivation
Poor Communication
Limited Infrastructure

4.6. Measurement and Data Collection

4.6.2 .Sample Size Determination

The sample size for laboratory professionals who are working in the public hospitals found in Addis Ababa were calculated using single population proportion formula by taking p=50 % due to absence of previous similar study. Level of significance (α) =0.05, marginal error (d) =5%, Z (α/2) = Z- score at 95% confidence interval=1.96. The formula for calculating the sample size (n) would be:

$n= [Z_{a/2}2 \times p (1-p)] / d2$

$n= (1.96)^2(0.5). (0.5)/ (0.05)^2 =3.8416*0.25/0.0025 =0.9604/0.0025 = 384.$ According to the information got from Addis Ababa health bureau and FMOH there are 344 laboratory professionals in public hospitals found in Addis Ababa, therefore, the correction factor were made using the finite population formula (nf) from a target population (N) and the sample size (n) were reduced according to the following formula:

$$nf=n/(1+n/N)$$

$$nf=384/(1+384/344)=181$$

$$nf=181$$

After adding 10% for non response rate, the sample size of laboratory professionals have been **181 + 18=199.**

Finally, sample size has been allocated proportionately for all public hospitals according to number of laboratory professionals working in their laboratories and individual study participants would be selected using simple random sampling technique.

4.6.2. Sampling Techniques

The number of laboratory professionals who were included in the study from each hospital was determined in proportion with the total number of Laboratory professionals found in each hospital. Number of Laboratory professionals in each hospital was obtained from each hospital Human Resource department; individual study participant was selected using simple random sampling technique.

See the following sampling frame show how laboratory professionals sample size determination process was going on.

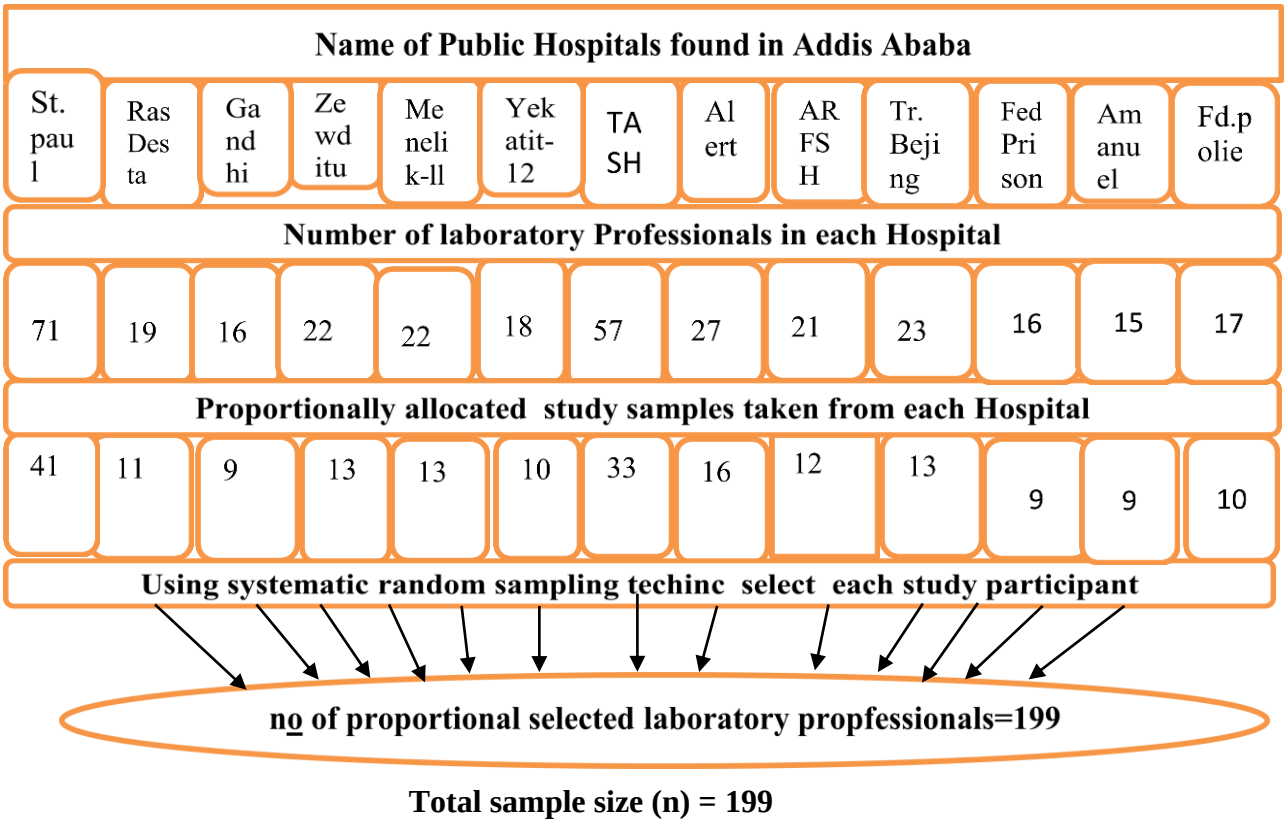

Figure 2; Proportional sampling technique in public hospitals, Addis Ababa, April-June / 2020.

4.7. Data Collection Procedure

Checklist adopted from Ethiopian hospital standard transformation guide line (EHSTG) and questioners were used to collect data (46).

Checklist: the check list was used to assess the status of laboratory service interruption. Assessment was conducted in nine laboratory departments and the whole laboratory facilities, the major sections were routine chemistry, hematology, serology, parasitology, urinalysis and body fluid analysis, bacteriology, hormone, cardiac function and electrolyte. The checklist for specialized hospitals (that were under federal ministry of health) and general hospitals (under Addis Ababa city administration) were used to collect interrupted tests based on the number of tests expected to done for three consecutive months in all hospitals.

Questionnaire: considering the study participants were laboratory professionals that can easily understand English language the questionnaire was developed in English no need of translation for Amharic language.

Structured closed ended self-administered questioners were used to get data for socio-demographic characteristic of the study participants and factors that affect laboratory service interruption.

Four trained data collectors and two supervisors were used to assess the status of laboratory interruption using EHSTG check list and self-administered questioners to collect data for affecting factors.

4.8. Data Quality Management

To assure the data quality the questionnaire originally prepares in English were pre-tested on 5% of total sample size. The collected data based on the pretested questions were again revised, edited, and those to be unclear or confusing were removed. Four data collectors and two supervisors were trained for one day on the method of data collection and way of handling data.

The principal investigator was collected the completed questionnaire every day and checked each for inconsistencies and omissions. Where those questionnaires found incomplete, inaccurate and inconsistent was returned back for data collectors to be filled again. The principal investigator was responsible for collection, coordination and supervision of the overall data collection.

Phone calls, direct visits to health facility as well as weekend discussion among data collectors, supervisors and the researcher were used as a way for following during the study. During these supervisory activities quality and completeness of gathered information by the data collectors were checked.

4.9. Measurement

The level of laboratory service interruption was measured using a standard check list adopted from Ethiopian hospital standard transformation guide line (EHSTG) by putting ‘’tick’ if the test is done or not interrupted and ‘’x’’ if the test not done or interrupted for three consecutive months in the hospital laboratories. Then the test counted as interrupted, if the test not done for one or more than one day.

Number of test interruption days for each type of service (hematology, serology, routine chemistry, hormone, parasitology, electrolyte, cardiac function, bacteriology, urinalysis and body fluid analysis) were recorded and counted. Then calculation done as;

- Percentage of interrupted tests in each service= Number of interrupted tests in a specific service/ Number of tests reviewed (expected) in each service*100.
- Percentage of interrupted tests in a specific service from the total number of expected tests done in the hospital=Number of interrupted tests forma specific service/ Number of tests expected to done in the hospital*100.
- Percentage of interrupted tests in each hospital= Sum of interrupted tests from all services / Number of tests expected to done in the hospital*100.
- Percentage of interrupted tests in specialized hospital= Sum of interrupted tests in all specialized hospital/Number of tests expected to done in specialized hospital*100
- Percentage of interrupted tests in general hospital= Sum of interrupted tests in all general hospital/ Number of expected tests in general hospital*100.
- Percentage of total average number of interrupted tests in public hospital= Average number of interrupted tests in all public hospital/ Number of expected tests done in public hospital*100.
- To calculate interruption days of interrupted tests, first of all, number of interruption days for each test in each hospital counted and recorded; then take

average number of interrupted tests and days of test interruption in public hospitals, then calculate;

- Number of interruption days for tests in public hospitals= Average number of interruption days in all hospitals.
- The independent variable measured using a dichotomous (Yes/ No) questions. Then participants responded as ‘’Yes’’ interpreted as the variable not affect laboratory service interruption and those who reported ‘’No’’ interpreted as the variable would affect laboratory service interruption.

4.9. Data Analysis Interpretation

The collected data were cleaned, edited, coded and entered in to SPSS version 23 statistical software by principal investigator. After entry the data were re-cleaned to correct errors and they also categorized as it’s necessary.

The data entered were checked its consistency in infrequency and cross tabulation to checked the missed variables. Descriptive statistics were used to calculate the percentage of interruption of tests in each laboratory and the response of laboratory professionals. Binary and multiple logistic regression analyses were computed to identify the relationship between dependent and independent variables. Independent variables that had association in the Binary logistic regression analysis with p-value less than 0.25 were entered in to multiple logistic regression analysis. The independent variables those had significant association with dependent variables were declared at p-value less than 0.05. And the results were summarized and presented in tables with adjusted odds ratios and the corresponding 95% CI.

4.10. Ethical Consideration

Before data collection proper ethical clearance were obtain from Addis Ababa University College of health science, department of medical laboratory research and ethics review committee. Permission letter were obtained from Addis Ababa health bureau to each hospital under its administration, and permission were obtained from each hospital to conduct the study. Informed written consent were taken from each study participant after explaining the objective of the study, and all studied laboratories were coded to maintain confidentiality of the respondents for the information given.

4.11. Dissemination of the Result

The finding of the study would be present at department of medical laboratory science, and then submitted to Addis Ababa University. Copy of the result would be send to Addis Ababa health administration bureau and respective hospitals. The result would be presented on different seminars, meetings and workshops. Manuscript would be submitted for publication on local or international peer reviewed journal.

4.11. Operational Definitions of Variables

Interruption: If the test expected to done in the hospital is not done for one day or more than one day counted as interrupted (46).

Resources: means availability of Budget, reagent and supply, quality equipment, calibration and control, and equipment maintenance with spare parts.

Management Support and Follow Up: Availability of plan, and budget allocation on time & follow up the function of laboratory department performance.

Work load: Availability of sufficient human resource and adequate laboratory professionals to execute daily laboratory function.

Backup system: availability of additional ready equipment and supplies and establishment of MOU referral agreement system with other laboratory to do if the test is interrupted.

Communication: Availability of weekly regular communication of laboratory professionals within the department and out of the department.

Motivation: Availability of staff recognition, continuous educational development, and training for laboratory professionals.

Infrastructure: Availability of properly designed adequate laboratory rooms, consistency water & electricity supply.

Specialized hospitals: Are those hospitals that are expected to done at least 77 laboratory tests according to the democratic republic of Ethiopia FMOH standard.

General hospitals: Are those hospitals that are expected to done at least 68 laboratory tests according to the democratic republic of Ethiopia FMOH standard.

5. Result

5.1 Socio-Demographic Characteristics of Study Participants

In this study, totally 190 laboratory professionals were participated in public hospitals found in Addis Ababa, with a response rate of 95.5%. The majority of respondents were males 101(53.2%), 91(47.9%) were between ages of 31-40 years, with regard to the educational back ground most of the respondents 138(72.6%) were BSC (first degree) holders. In addition 58(30.5%) had 7-10 years work experience and in terms of the salary 73(38.4%) of laboratory professionals have got >7500 birr, (indicated in table 1).

Table1:Socio-Demographic characteristics of study participants in public hospitals, Addis Ababa, April-June/ 2020.

Variable	Frequency (%)
Sex	
M	101(53.2)
F	89(46.8)
Age	
20-30	75(39.5)
31-40	91(47.9)
41-50	19(10)
51-60	5(2.6)
Education status	
Diploma (laboratory technician)	18(9.5)
Degree (laboratory technologist)	138(72.6)
Master and above	34(17.9)
Work experience	
1-3 years	45(23.7)
4-6 years	53(27.9)
7-10 years	58(30.5)
>10 years	34(17.9)
Position	
Lab Head	10(5.3)
Lab quality officer	8(4.2)
Other laboratory professionals	172(90.5)
Salary	
3000-5000	66(34.7)
5500-7500	51(26.8)
>7500	73(38.4)

5.2. Volume of laboratory tests expected to do in public hospitals.

Volumes of tests done by hospitals were assessed compared with the number of tests expected done in specialized hospital (77) and general hospitals (68) separately which is developed by FMOH. As shown in figure 2, all laboratories did not give continuous diagnostic service for all expected tests and the highest volume done in specialized hospital.

Table2: Volume of tests expected and done in public hospitals, Addis Ababa, April - June/2020.

Hospitals name (labeled)	Volume of tests expected	Volume of tests done	Percent
A	77	67	87
B	77	64	83.1
C	77	52	67.5
D	77	69	89
E	77	68	88.3
F	68	50	73.5
G	68	48	70.5
H	68	54	79.4
I	68	46	66.5
J	68	55	80.9
K	68	45	66.2
L	68	54	79.4
M	68	47	69.1

5.3. Total number of interrupted tests in public hospitals found in Addis Ababa.

Total numbers of interrupted tests in public hospitals were assessed based on nine laboratory services; hematology, routine chemistry, serology, bacteriology, parasitology, hormone, cardiac function, electrolyte, urinalysis and body fluid analysis. Calculation of interrupted tests in each service made compared with the number of tests expected to done in general and specialized hospitals. The result showed that, serology 5(6.9%) and hematology 4(5.5%) tests accounts the highest level of interruption, while parasitology, urinalysis and body fluid analysis were consistently available. In public hospital averagely 17(23%) tests were

interrupted, and hospital ‘’I’’ account the highest interruption 27(40%) and hospital ’’E’’ 8(10.3%) had the lowest interruption. (Show in table – 3 below).

Table3: Interrupted tests compared with the expected numbers of tests in public hospitals, Addis Ababa, April-June/2020.

Institution code	**Level of Ho.**	**Tests expected**	**Hematology**	**Serology**	**Routine chemistry**	**Parasitology**	**U/A & body fluid**	**Bacteriology**	**Hormone**	**Cardiac function**	**Electrolyte**
			No int. (%)	**No int. (%)**	**No int. (%)**	**No int. (%)**	**No int. (%)**	**No int. (%)**	**No int. (%)**	**No int. (%)**	**No int (%)**
A	Sp	77	4(5.2)	3(3.9)	0(0)	0(0)	0(0)	1(1.3)	0(0)	2(2.6)	0(0)
B	Sp	77	5(6.5)	3(3.9)	0(0)	1(1.3)	0(0)	1(1.3)	3(3.9)	0(0)	0(0)
C	Sp	77	4(5.2)	4(5.2)	4(5.2)	0(0)	0(0)	3(3.9)	8(10.4)	4(5.2)	0(0)
D	Sp	77	3(3.9)	3(3.9)	1(1.3)	0(0)	0(0)	2(2.6)	0(0)	0(0)	0(0)
E	Sp	77	3(3.9)	3(3.9)	0(0)	0(0)	0(0)	2(2.6)	0(0)	0(0)	0(0)
F	Ge	68	2(2.9)	6(8.8)	4(5.9)	0(0)	0(0)	1(1.5)	0(0)	3(4.4)	0(0)
G	Ge	68	3(4.4)	8(11.7)	3(4.4)	1(1.5)	0(0)	1(1.5)	0(0)	2(2.7)	2(2.7)
H	Ge	68	3(4.4)	4(5.9)	3(4.4)	0(0)	0(0)	1(1.5)	0(0)	3(4.4)	0(0)
I	Ge	68	8(11.7)	4(5.9)	6(8.8)	0(0)	1(1.5)	4(5.9)	0(0)	1(1.5)	3(4.4)
J	Ge	68	3(4.4)	4(5.9)	3(4.4)	0(0)	0(0)	1(1.5)	0(0)	2(2.7)	0(0)
K	Ge	68	3(4.4)	7(10.3)	0(0)	0(0)	0(0)	2(2.9)	5(7.4)	3(4.4)	3(4.4)
L	Ge	68	4(5.9)	7(10.3)	0(0)	0(0)	0(0)	2(2.9)	0(0)	1(1.5)	0(0)
M	ge	68	3(4.4)	5(7.3)	7(10.3)	1(1.5)	0(0)	1(1.5)	0(0)	3(4.4)	1(1.5)
Total average interrupted		**72**	**4(5.5)**	**5(6.9)**	**2(2.7)**	**0(0)**	**0(0)**	**2(2.7)**	**1(1.4)**	**2(2.7)**	**1(1.4)**
Ho= hospital, Sp=Specialized, Ge= General, No= number, Int.= interrupted, U/A= urinalysis											

5.3.1. Number of interrupted tests based on type of laboratory services in specialized hospitals.

Numbers of interrupted tests in each type of laboratory service in specialized hospitals assessed based on number of expected tests. Number of expected tests were; hematology=12, serology=21, routine chemistry=19, bacteriology=5, hormone=8, cardiac function=4, electrolyte=3, parasitology=3, urinalysis and body fluid analysis=2.Bacteriology and hematology, 5 (2), 12 (4)(in figure 3) and 40% and 33.3% (in figure 4)respectively accounts the highest test interruption. But, Parasitology, electrolyte, urinalysis and body fluid analysis were continuously available.

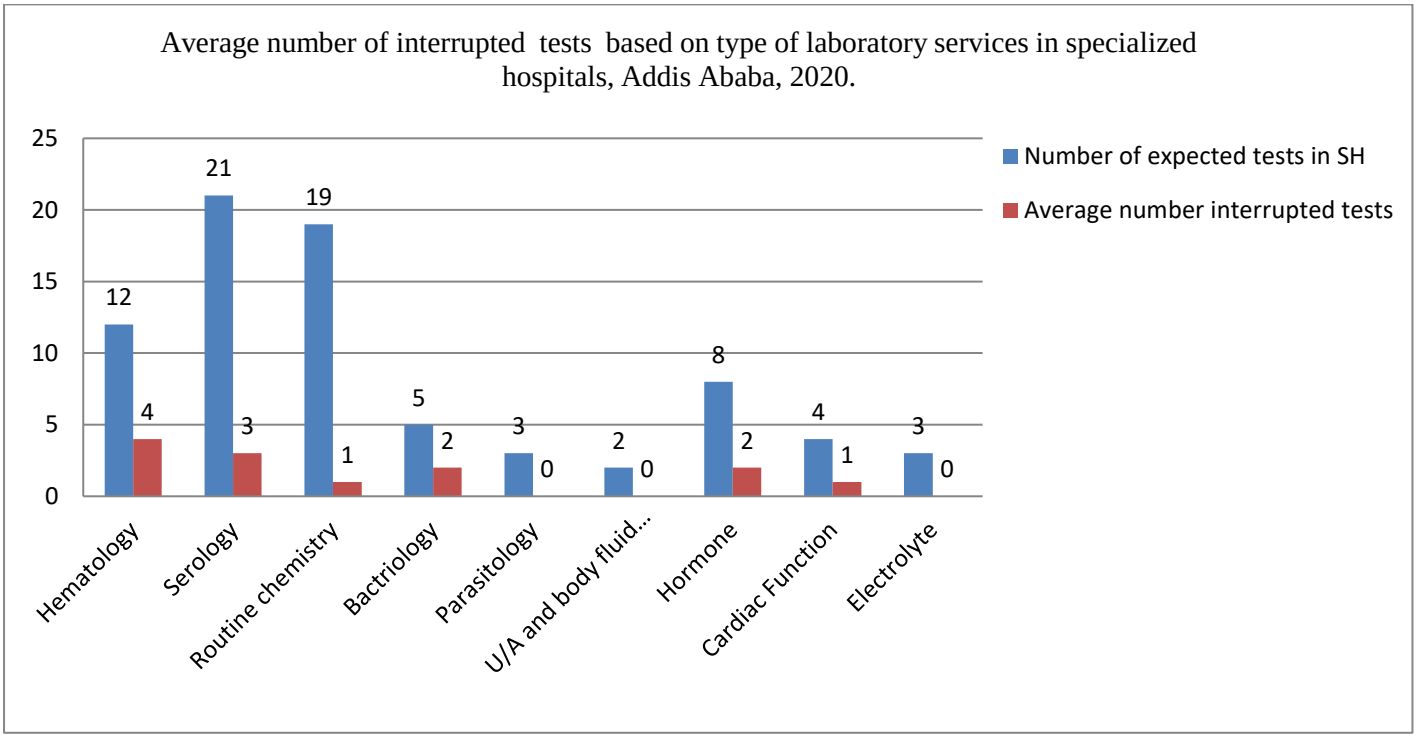

Figure 3: Average number of interrupted tests compared with expected numbers based on type of laboratory service in specialized hospitals, Addis Ababa, April-June/2020.

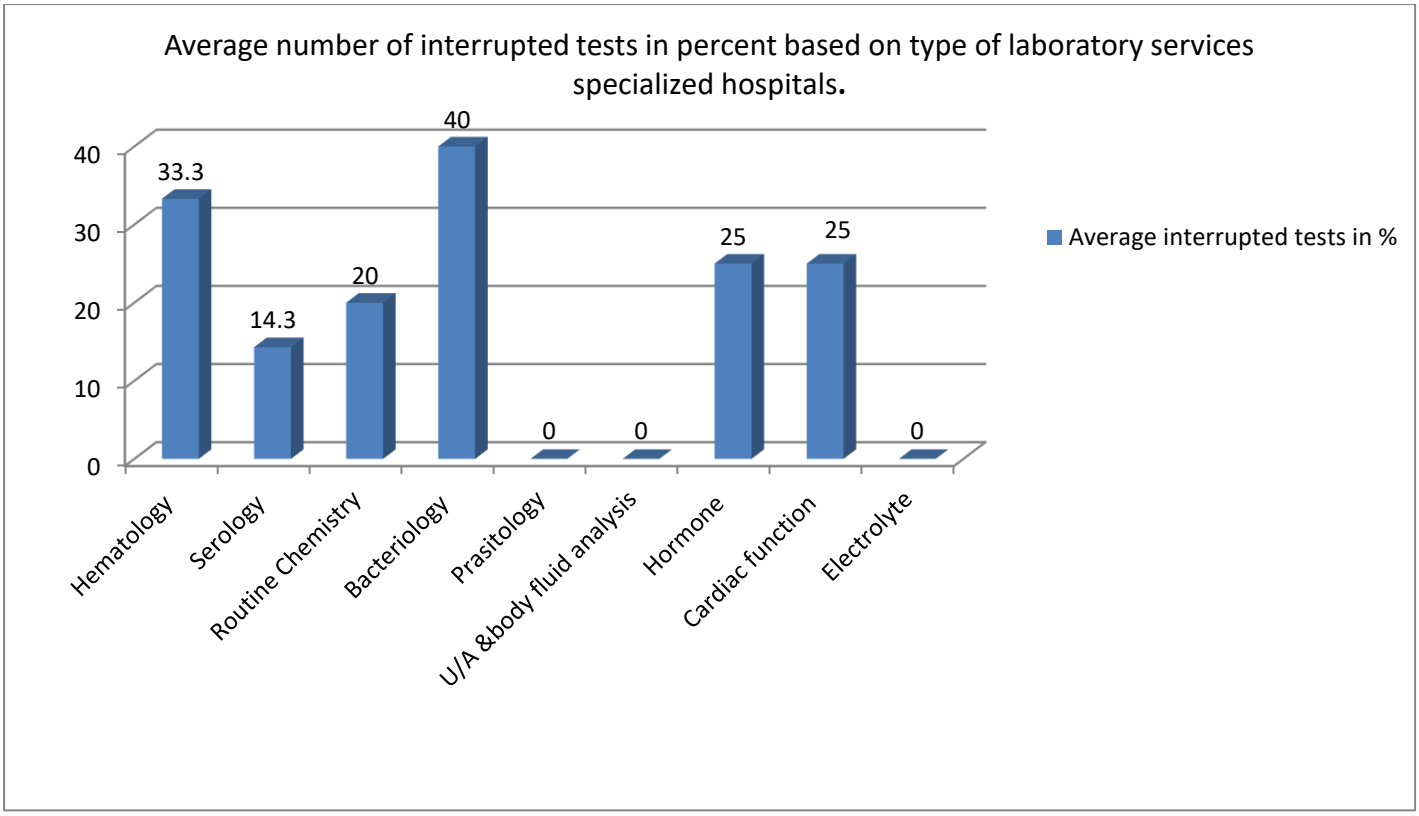

Figure 4: Average number of interrupted test in percent based on type of laboratory services in specialized hospitals, Addis Ababa, April-June/2020.

5.3.2. Total average number of interrupted tests in each specialized hospitals

Total average number of interrupted tests in individual specialized hospitals were calculated compared with total number of expected tests 77(100%) .As can see figure 5below,the maximum number of interrupted tests availed in hospital "C", it was 27(35%) and the lowst was in hospital "E "8(10.4%). Total average number of interrupted tests in specialized hospitals were 13(17 %).

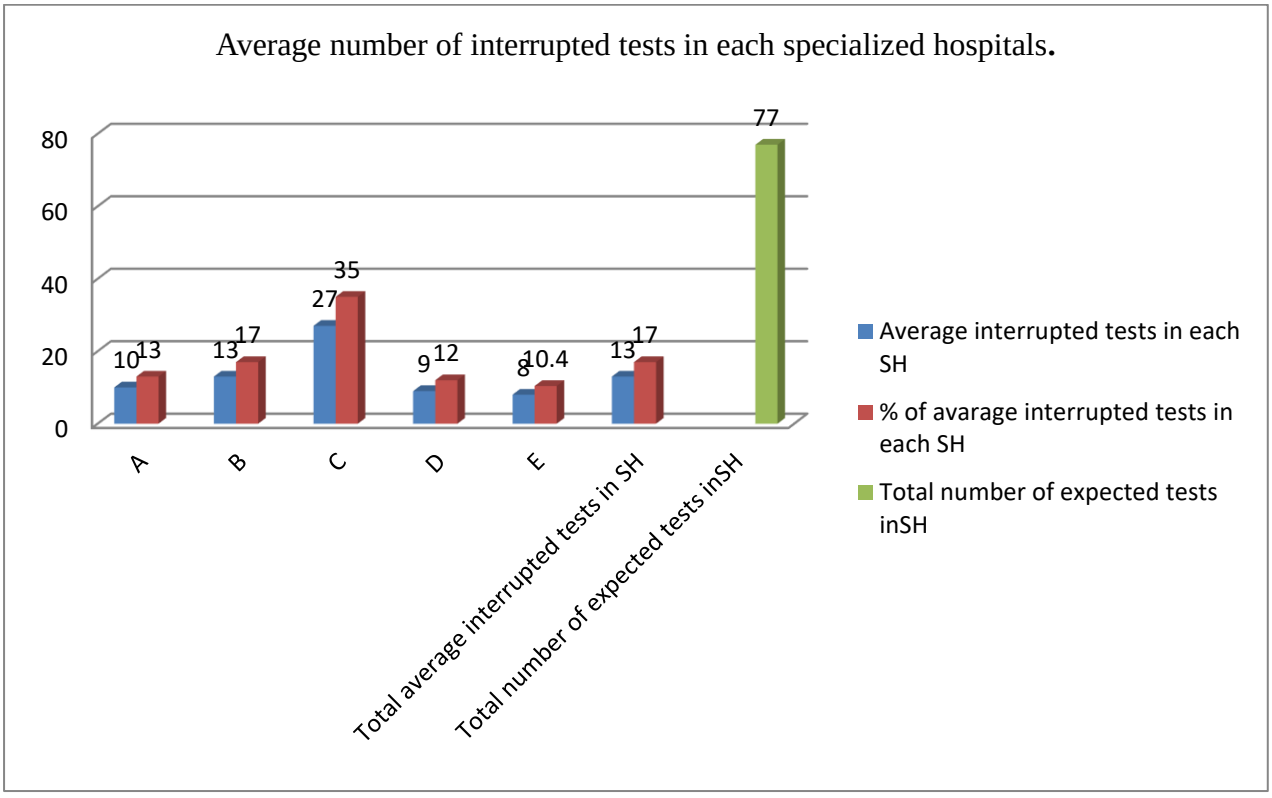

Figure 5: Average numbers of interrupted tests in each specialized hospitals, Addis Ababa, April-June/2020.

5.3.3. Number of interrupted tests in General hospitals based on type of laboratory service.

Numbers of interrupted tests in each type of laboratory service in general hospitals also assessed based on number of tests expected. Number of expected tests were; Hematology=10, Serology=20, Routine chemistry=16, Bacteriology=5, Hormone=5, Cardiac function=4, Electrolyte=3, Parasitology=3, Urinalysis and Body fluid analysis=2.Among services cardiac function, hematology and bacteriology tests scored the highest interruption, 4(2), 10(4) and 5(2) in figure 6 and 50%, 40%and 40% in figure 7,respectively. There were no interrupted test in parasitology, urine analysis and body fluid analysis.

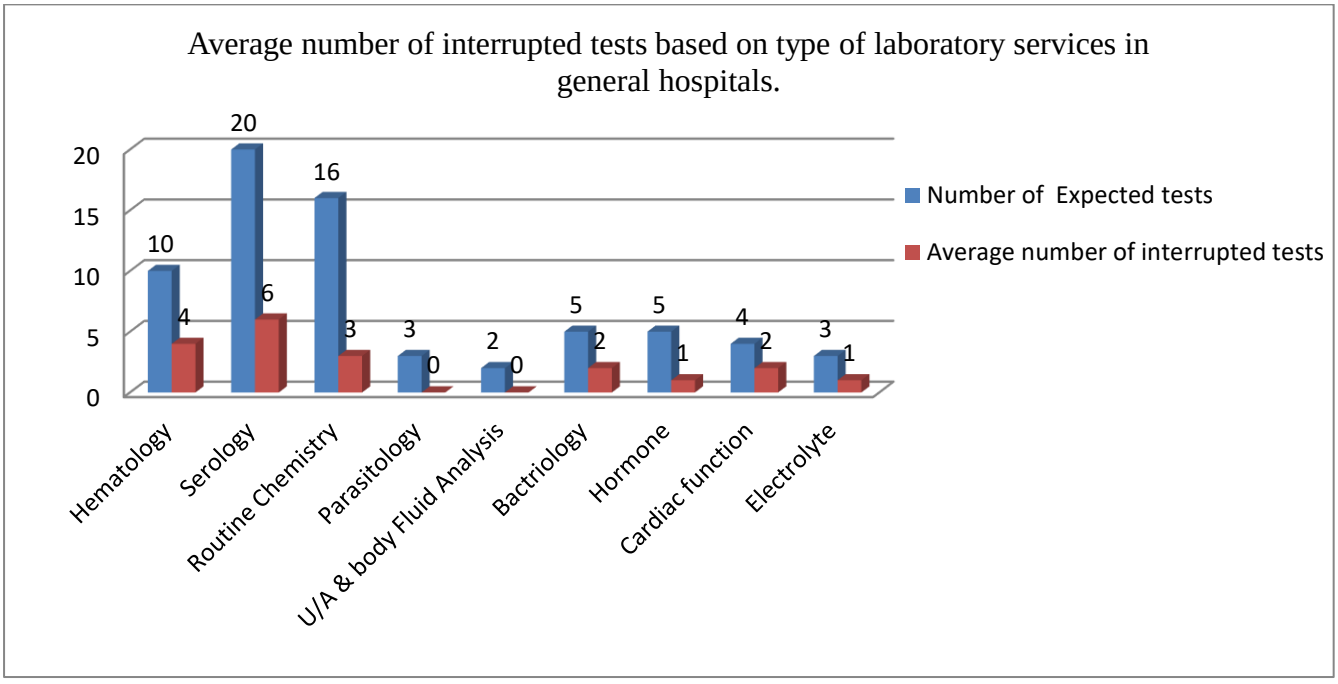

Figure 6: Average number of interrupted tests compared with expected numbers based on type of laboratory services in general hospitals, Addis Ababa, April-June /2020.

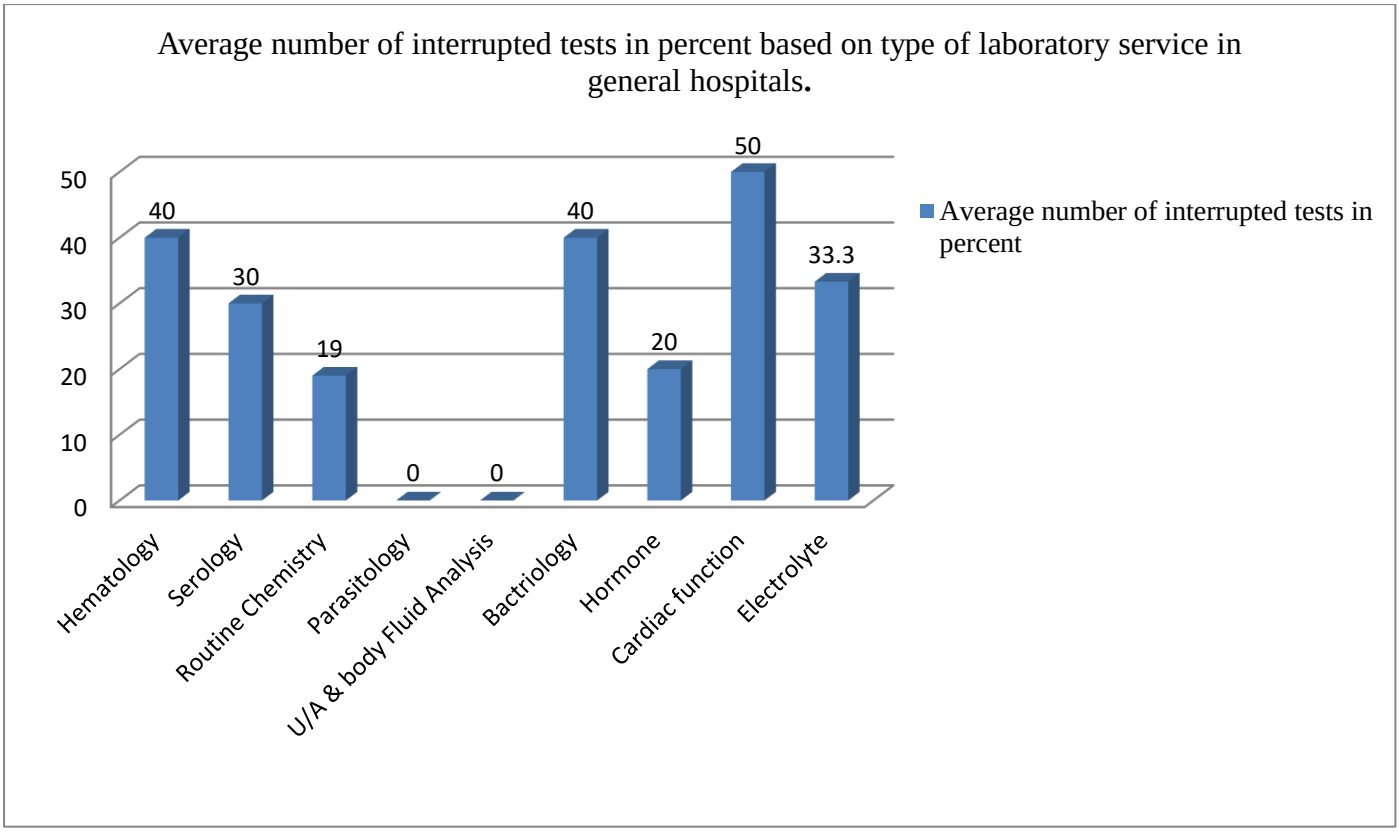

Figure 7: Average number of interrupted tests in percent based on laboratory services in general hospitals, Addis Ababa, April- June/2020.

5.3.4. Total average number of interrupted tests in each general hospital.

Total average number of interrupted test in each general hospital assessed based onnumber ofexpected tests done in general hospital68(100%). Hhospital ‘’I’’, ‘’K’’ and ‘’M’’ had the highestamount of interrupted tests, 27(40%), 23(34%) and 21(31%) respectively, and hospital ‘’J’’13(19%) had thelowest interrupted tests. Total average interrupted tests in general hospitals were 19(28%), (showed below figure8).

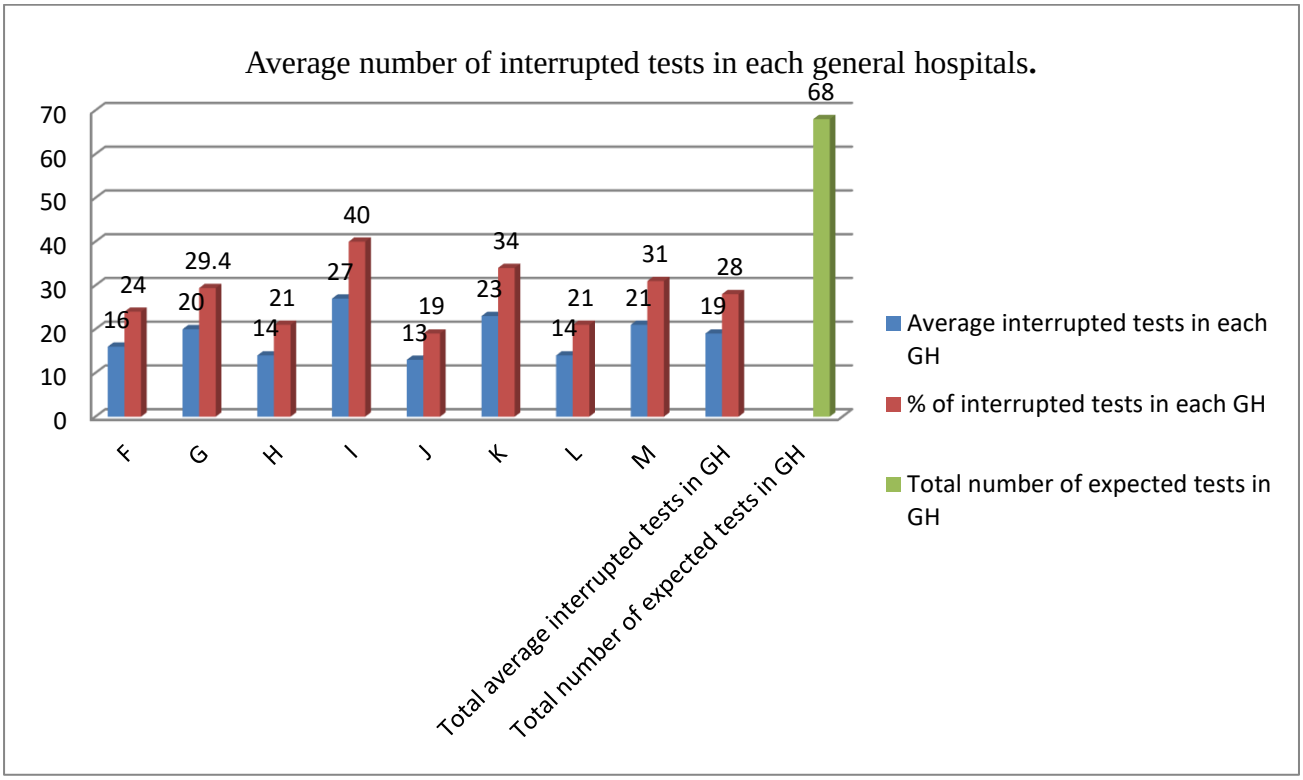

Figure 8: Average number of interrupted tests in each general hospital, Addis Ababa, April-June/20202.

5.3.5. Test interruption days in public hospitals.

Test interruption days in all public hospitals were assessed by recording the name and days of each interrupted tests for three consecutive months. Then, number of interruption days for each test was counted and the percentage calculated compared with the study period. As the result showed in table-4, some hematology and serology tests were interrupted for three months (100%) in all hospitals. But, bacteriology in 12 hospitals and cardiac function in 7 hospitals, routine chemistry in 2 hospitals and hormone tests in 2 hospitals were interrupted for 90 days (100%), and some hormone tests in 9 hospitals, electrolyte in 11 hospitals and parasitology in 10 hospitals, urinalysis and body fluid analysis in all hospitals were fully available (0.0%) interruption. Total average interruption days of tests in public hospitals were 76(84%) days.

Table4: Summary of interrupted tests and day of interruption in public hospitals, Addis Ababa, April-June/2020.

Hospitals code	**Type of laboratory service**	**Name of tests**	**Interrupted in the day of study period(yes)**	**Interruption date from April-June/2020.**	**%**
A	Hematology	Bleeding time, prothrombinetime, Hb-electrophoresis, Lupus erythromatosus,	yes	90	100
	Serology	Toxoplasma latex, TPHA, CRP	yes	90	100
	Bacteriology	Indian ink	yes	90	100
	Cardiac function	Troponin, CPK	yes	90	100
B	Hematology	ESR, Bleeding time, prothrombine time, Hb electrophoresis, Lupus erythromatosus	yes	90	100
	Serology	ASO, Toxoplasma Latex, CRP	yes	90	100
	Hormone	LH, FSH, Prolactine,	yes	41	45.5
	Bacteriology	Indian ink	yes	90	100
	Parasitology	Occult blood	yes	47	52
C	Hematology	Reticulocyte count, Bleeding time, Hb-electrophoresis,lupus	yes	90	100

		erythematous			
	Serology	ASO, TPHA, CRP, Toxoplasma latex	yes	90	100
	Chemistry	LDL,HDL,AST,GGT	yes	90	100
	Bacteriology	Indian ink	yes	90	100
	Hormone	T3,T4, TSH,FSH,LH	yes	90	100
	Cardiac function	LDH,TROPONIN,CPK, CK-MB	yes	90	100
D	Hematology	Bleeding time, Hb-electrophoresis, lupus erythematous	yes	90	100
	Serology	TPHA, CRP, Toxoplasma latex	yes	90	100
	Chemistry	Uric acid	yes	9	10
	Bacteriology	Indian ink and fungal culture	yes	90	100
E	Hematology	Bleeding time, Hb- electrophoresis, lupus erytheromatous	yes	90	100
	Serology	Toxoplasma latex, ASO,CRP	yes	90	100
	Bacteriology	Fungal Culture, Indian ink	yes	90	100
F	Hematology	Bleeding time, prothrombine time, and Reticulocyte count	yes	90	100
	Serology	HCV, RF	yes	41	45.5
		CRP, ASO, Troponin toxoplasma latex	yes	90	100
	Clinical Chemistry	GGT, Total-bilirubin, Direct bilirubin,uric acid	yes	49	54.4
	Bacteriology	Indian ink	yes	90	100
	Cardiac function	LDH,CK-MB,TROPONIN,CPK	yes	90	100
G	Hematology	Retculocyte count, bleeding time, prothrombine time	yes	90	100
	Serology	ASO, Toxsoplasma latex, CRP, TPHA	yes	90	100
		HCV, H.Pylori,	yes	30	33.3
	Clinical Chemistry	GGT, uric acid, Total protein	yes	56	62.2
	Electrolyte	Na+,K+	yes	37	41.1

	Parasitology	Occult blood	yes	30	33.3
	Cardiac function	LDH,CPK	yes	90	100
	Bacteriology	Indian ink	yes	90	100
H	Hematology	Retculocytecount , bleeding time, prothrombin time	yes	90	100
	Serology	TPHA,CPR, Toxoplasma latex, ASO	yes	90	100
	Bacteriology	Indian ink	yes	90	100
	Clinical Chemistry	HDL,GGT, Albumin	yes	67	74.4
	Cardiac function	CK-MB,TROPONIN,CPK	yes	90	100
I	Hematology	CBC,	yes	30	33.3
		Retculocyte count, bleeding time, prothrombin time	yes	90	100
	Serology	Troponon, Toxoplasma latex, CRP,HCG	yes	90	100
	Clinical Chemistry	ALKP, Total protein, Albumin,	yes	90	100
		Urea	yes	60	66.6
		Creatinine	yes	30	33.3
	Bacteriology	KOH, gram stain, ziehlNeeson stain, Indian ink	yes	90	100
	Cardiac function	Troponin	yes	90	100
	U/A & Body fluid analysis	CSF analysis	yes	90	100
	Electrolyte	Na+, K+, Cl-	yes	30	33.3
J	Hematology	Bleeding Time, Prothrombin Time, Reticulocyte count	yes	90	100
	Serology	ASO,RPR,CRP, Troponin	yes	90	100
	Clinical Chemistry	HDL,GGT, ALKP	yes	47	52.2
	Cardiac function	LDH,CPK	yes	65	72.2
	Bacteriology	Indian ink	yes	90	100
K	Hematology	Bleeding time, Reticulocyte count, Prothrombin time	yes	90	100
	Serology	Toxoplasma latex, RF,TPHA,CRP, ASO,Salmonella typhi- H, and salmonella typhi -O	yes	90	100

	Bacteriology	Indian ink, culture and sensitivity	yes	90	100
	Hormonal	T3,T4, TSH,FSH,LH	yes	90	100
	Cardiac function	LDH,TROPONIN,CPK	yes	90	100
	Electrolyte	Na+,K+,Cl-	yes	90	100
L	Hematology	ESR, Bleeding time, Reticulocyte count, Prothrombin time	yes	90	100
	Serology	HCV, H.pylori, TPHA, CRP, Salmonella typhi- H, and Salmonella typhi –O, Proteus-OX19	yes	90	100
	Bacteriology	Indian ink, ZiehlNeelson stain	yes	90	100
	Clinical Chemistry	GGT	yes	34	37.7
	Cardiac function	CK-MB	yes	76	84.4
M	Hematology	Bleeding time, Reticulocyte count, Prothrombin time	yes	90	100
	Serology	H.Pyliori, Toxoplasma latex, ASO,RPR,CRP	yes	90	100
		RF	yes	40	44.4
	Cardiac function	LDH,CK-MB,CPK	yes	84	82.2
	Clinical Chemistry	GGT, Total bilirubin, Direct bilirubin, Albumin, LDL	yes	74	82.2
	Parasitology	Occult blood	yes	66	73.3
	Electrolyte	Cl-, k+	yes	16	16.7
	Bacteriology	Indian ink	yes	90	100
	Total average interruption days in public hospitals			76	84

5.4. Factors that affect laboratory service interruption.

Regarding to the factors that affect laboratory service interruption, the result showed that unavailability of regular communication with upper managers, physicians and patients, un availability of staff recognition, continuous education and immediate feedback, inappropriate equipment maintenance, salary dissatisfaction, shortage of budget, shortage of reagents and supplies, shortage of back equipments account most of participants response.

Among those factors shortage of budget, unavailability of immediate feedback from upper manager, shortage of reagents and supplies, unavailability of regular communication with upper managers and salary dissatisfaction scored the highest percentage rated as, 91.6%, 82.1%, 79.5%, 75.8% and 73.7%, respectively(shown below table 5).

Table5: Summary of factors that affect laboratory service interruption reported by laboratory professionals in public hospitals, Addis Ababa, from April-June 2020.

Variable	**Yes** **Frequency (%)**	**No** **Frequency (%)**
Infrastructure		
Availability of enough space	105(55.3)	85(44.7)
Availability of continuous electricity power	142(74.7)	48(25.3)
Availability of Continuous functional water	102(53.7)	88(46.3)
Communication		
Regular communication with upper management	50(26.3)	140(73.7)
Regular communication with physicians	62(32.6)	128(67.4)
Regular communication with patients	72(37.9)	118(62.1)
Regular staff meeting	124(65.3)	66(34.7)
Motivation		
Availability of Staff recognition	57(30)	133(70)
Availability of Continuous education	82(43.2)	108(56.8)
Availability of basic training for tests	95(50)	95(50)
Availability of enough orientation on equipments	127(66.8)	63(33.2)
Salary satisfaction	46(24.2)	144(75.8)
Management		

Allocation of budget for laboratory	20(10.5)	170(89.5)
Laboratory annual plan	144(75.8)	46(24.2)
Laboratory manger request and follow supplies	108(56.8)	82(43.2)
Lab manager follow daily activity	105(55.3)	85(44.7)
Immediate feedback from upper manager	34(17.9)	156(82.1)
Resource		
Availability of laboratory budget	16(8.4)	174(91.6)
Availability of enough reagents and supplies	39(20.5)	151(79.5)
Availability of enough laboratory equipments	82(43.2)	108(56.8)
Appropriate calibration and control	110(57.9)	80(42.1)
Appropriate equipment maintenance	64(33.7)	126(66.3)
Work load		
Sufficient laboratory human resource	129(67.9)	61(32.1)
Availability of trained and skilled lab professionals	157(82.6)	33(17.4)
Backup system		
Availability of backup equipments	69(36.3)	121(63.7)
Availability of sample referral system	117(61.6)	73(38.4)

5.5. Binary and multiple Logistic regression analysis.

In Binary logistic regression analysis adequate space, communication with physicians, continuous education, sufficient reagents and supplies, annual plan, equipment maintenance, sufficient human resource, skilled lab professional, and availability of back up machine were associated with laboratory service interruption at p- value<0.25. All variables significantly associated in binary logistic regression at p-value<0.25 were entered in multiple logistic regression analysis, equipment maintenance, reagents and supplies and annual plan were left in the final model. Thus, Absence of laboratory annual plan, inappropriate equipment maintenance, and shortage of reagents and supplies were the variables significantly associated at (p-value<0.05) with laboratory service interruption.

Based on the laboratory professionals response, laboratories those didn't have proper laboratory annual plan more likely 3.08 times increased laboratory service interruption compared to which had proper laboratory annual plan at [AOR=3.028, p-value=0.044, 95%Cl (1.030-8.903]. Besides, laboratories which had shortage of reagents and supplies increased laboratory service interruption more likely 3.845 times than those which didn't have at

[AOR=3.84, p-value=0.049, 95%Cl (1.008-14.663], and laboratories which didn't get appropriate equipment maintenance can increase laboratory service interruption 9.350 times than those which are got at [AOR=9.350, p-value=0.003, 95%Cl (2.102-41.596].

Table 6: Logistic regression analysis showing the relation between laboratory service interruption and associated factors based on participants response in public hospitals, Addis Ababa, from April-June/ 2020.

Participants response of the variables	**Laboratory service interruption**		**p-value**	**Crude odds ratio 95%Cl**	**p-value**	**Adjusted odds ratio 95%Cl**
	Yes	**No**				
Adequate space						
Yes	41	25		1		1
No	27	24	0.171	0.456(0.148-1.406)	0.394	0.664(0.259-1.702)
Continuous communication with physicians						
Yes	28	21		1		1
No	40	28	0.177	0.364(0.084-1.576)	0.176	0.512(0.194-1.350)
Continuous education						
Yes	30	15		1		1
No	38	34	0.129	2.369(0.777-7.219)	0.111	2.179(0.837-5.671)
Enough reagents and supplies						
Yes	19	17		1		1
No	49	42	0.170	3.202(0.607-16.897)	0.049	3.845(1.008-14.663)*
Annual plan						
Yes	12	14		1		1
No	51	27	0.040	4.189(1.070-16.392)	0.044	3.028(1.030-8.903)*
Equipment maintenance						
Yes	20	14		1		1
No	48	35	0.025	2.126(1.030-11.529)	0.003	9.350(2.102-41.596)*
Human resource						
Yes	24	10		1		1
No	39	31	0.127	0.371(0.104-1.325)	0.062	0.384(0.141-1.049)

Back up equipment						
Yes	22	14		1		1
No	46	35	0.233	2.343(0.579-9.482)	0.212	1.926(0.688-5.393)
Skilled and trained laboratory professionals						
Yes	07	08		1		1
No	56	33	0.097	4.256(0.770-23..535)	0.163	2.521(0.688-9.231)

**The odds ratio indicated there was significant association between laboratory service interruption and the independent variable.*

6. Discussion

Almost all public hospitals laboratories did not provide a diagnosed service for all tests that expected done from FMOH. In public hospitals averagely17 tests interrupted for 76 days and tests in serology and hematology services account the highest level of interruption. But, parasitology, urinalysis and body fluid analysis are not interrupted during the study period. Inappropriate equipment maintenance, absence of laboratory annual plan and shortage of reagents and supplies are the major factors that are associated with laboratory service interruption.

6.1. Laboratory service interruption.

In the finding of our study almost all public hospitals had laboratory test interruption; this may lead physicians to give medication without confirmed laboratory results and to additional health care costs. Which is consistent with studies conducted in spain; due to inappropriate utilization of resources laboratory service interruption came that increases total health care costs (17) and in Napale; documented that inconsistency in laboratory service with in different reasons results inconsistency in accuracy of results, incorrect diagnosis and incorrect treatment for patients (18). In addition a study conducted in Malawi; most physicians used laboratory result for patient management, but sometimes laboratory services were interrupted by shortage of reagents and unavailability of back up equipments because of this physicians managed patients without the availability of laboratory results (22), and a study conducted in Ethiopia Jimma zone health center; AFB service was interrupted for two weeks due to shortage of reagents, trained staffs and consumables (38).

According to our study participants response 101(49.5%), almost all public hospitals laboratories did not provide a diagnostic services for all requested test and averagely 17(23%) tests were interrupted for 76(84%) days. This is higher than a study conducted in 2016, Tanzania; requested tests suspended the testing required for 9 (1-55) days elapsed between instrument malfunction and biomedical engineer service(24). Other study conducted by Mesfin A et al in 2017, Addis Ababa;74(34.7%) and 111(52.1%) of study participants replied laboratories did not provide a diagnostic service for all requested tests and laboratory service interruption in public and private hospitals respectively (25). Additionally, a study conducted in Gondar; 63(61.2%) of the study participants respond their laboratory did not provide a diagnostic service for all requested tests due to unavailability of quality and adequate equipments, and reagents and supplies (43).Even though studies conducted at different

period, the result showed laboratory service interruption still availed at high level, this is may be due to lack of resources, low management support and commitment.

Even though most of the public hospitals found in Addis Ababa used as referral, but due to shortage of reagents, inappropriate equipment maintenance, and absence of laboratory annual plan some laboratory tests interrupted more than two months. Which is inconsistence with a study conducted in Malawi referral hospital due to unavailability of back up machine some laboratory tests were interrupted up to six months. These caused for decreasing patients and physicians' satisfaction on laboratory service and laboratory staff motivation (23) and, in Addis Ababa; unavailability of ordered laboratory tests and long waiting time to get laboratory result were statistically significant association with the level of clients dissatisfaction (26). It might be due to low attention of the laboratory service results, unavailability of resources and poor management support.

6.2. Factors affecting laboratory service interruption

In our finding inappropriate equipment maintenance, Absence of laboratory annual plan and shortage of reagents and supplies are the major factors that affect laboratory service interruption. Which is consistence with a study done in Asia; weak reagent and supply procurement and lack of equipment maintenance were the major identified challenges of developing effective laboratory capacity in resource limited settings (28).Also in Kenyatta national hospital; lack of resource and equipment failure were the major factors that cause laboratory services interruption (29), and other finding also showed due to the availability of those factors in most laboratories, there were difficulty to diagnosed even routine tests in public hospitals (30).

Furthermore, consistence to our finding a study conducted by MisganawAS in Addis Ababa; laboratory service interruption affected by laboratories had no work plan and budget for laboratory specific purpose, lack of resources and equipments did not serviced according to the scheduled in the laboratory (33), and in Addis Ababa in 2017, most of the study respondents replied insufficient quality and quantity of consumable supplies and poor-quality equipment forced service interruptions and obstructed accreditation under ISO 15189 standards (32).More over using quality management skills helps to create national and international public health laboratory networks leads to provide timely, accurate and sustainable laboratory services (34), and a study conducted in Addis Ababa; shortage of

reagents and supplies, lack of equipment maintenance were the major challenges that cause service interruption(36).

Inconsistent with our finding a study conducted in Uganda; long-term personnel and funding were essential to sustaining achievements in the national laboratory system (19), and on global health sustainably strengthen national laboratory systems in resource-poor countries establishing public private partnerships, ensuring effective leadership and commitment were fundamentals (27), and also a conducted in Ethiopia; high workloads, lack of equipment calibration, poor staff motivation, lack of knowledge and skills were the major factors that affecting the provision of sustainable laboratory services (31). Other studies conducted by Birx D et al, and Bates et al in resource poor setting African countries; shortage of staff, low staff motivation, lack of knowledge (40), and lack of training (41) were major factors that affect laboratory service. The difference might be due to poor management support and poor communication with managers, staffs and patients

Lastly, in our finding inappropriate equipment maintenance, shortage of reagents and supplies, and absence laboratory annual plan were the major factors that were associated with service interruption in public hospitals. This inconsistent with a study conducted in Uganda; unavailability of quality system, infrastructure and human resource were the major factors that affect sustainable laboratory service (37). It might be due to the difference of study methodology, place and time of studies conducted. But it is consistence with a study conducted in Tanzania; challenges for inability to achieve uninterrupted and sustainable provision of high-quality diagnostic laboratory services were underperformance of instrument maintenance services and limited backup testing options contribute to the frequently prolonged and debilitating nature of instrument breakdowns (42).

7. Strength and Limitation of the Study

7.1 Strength of the study

- The study collects data using qualitative and quantitative data collection technique consequently for three months to increase the accuracy of result.

7.2 Limitation of the study.

- Some concerned respondents were not included due to epidemics outbreak in our country.
- Absence of similar studies, especially directly to my title to makemore discussion with others findings.

8. Conclusion and Recommendation

8.1. Conclusion

In conclusion due to the availability laboratory service interruption, all public hospitals found in Addis Ababa did not provide a continuous diagnostic service for all expected number of tests. Totally out of expected number of tests done in hospitals, averagely 17(23%) tests were interrupted for 76(84%) days. The highest amount of test interruption was available in general hospitals compared with specialized hospitals. During this study periods, some tests in hematology and serology departments interrupted fully for three months, on the other hand like parasitology, urinalysis and body fluid tests were not interrupted. Shortage of reagents and supplies, inappropriate equipment maintenance and absence of laboratory annual plan were the major factors that affect laboratory service interruption.

8.2. Recommendation

Generally, to increase the sustainability of laboratory service in public hospitals, minimizing the level of service interruption is mandatory, so the concerned organization should try to improve the interrupted tests. In addition, the test menu of laboratories should have revised based on the number and types of tests expected to done from the federal ministry of health of Ethiopia. Further, to solve more the problem in the study area, government, managers, professionals and other stakeholders should undertake efforts to improve the major factors which affect the laboratory service interruption, and it’s better done additional investigation in this study area.

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Annex

Annex I: Information Sheet (English Version).

Addis Ababa University College o f health science, School of Medical Laboratory Sciences

Dear Participants,

My name is --------, Post graduate student of Addis Ababa University, College of health science, School of Medical Laboratory Sciences; I am going to conduct study and collect data on laboratory service interruption and affecting factors in public/ government hospitals Addis Ababa.

The objective of the study is to assess the status of laboratory service interruption and associated factors in public hospitals in Addis Ababa.

The information you provide will be used to improve test interruption system in the laboratory service and better quality service provision to the clients. The study will identify level of interruption and the major factors that cause service interruption and provide recommendations for proper interventions of government and logistic interventions for the future. If you decide to participate, we will guarantee that there is no any influence related to study but only request you that to provide all relevant information regarding the study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Your name will not be written on the questionnaire or be kept in any other records. Your participation is voluntary and you are free to withdraw your consent and to discontinue participation at any time without consequence. Your participation or not, do not have any influence for your position or responsibilities in your health facility.

For the successes of our study, you are kindly requested to respond genuinely and voluntary with patience. Your signature below indicates that you have read the information above and have decided to participate in the study. You have been identified as someone who can assist by responding to the questionnaire intend for the research. I wish to assure you of most confidentiality of any information you may provide and also that your responses are only for thepurpose of this research.

Thank you.

Annex II: Consent form in English

I _____ here by giving my consent for giving accurate information about the status of laboratory service interruption and associated factors. Health facility as recommended by the researcher/data collector and to answer those commodities questions. I understand there is no problem within my position in the health facility by participating in this assessment at the beginning as well as at the end of the study. I understand this study will be used not only for my health facility but also for other health facilities t hose provide medical laboratory services. I believe that at the end of study the result will not refer individual facilities but rather will describe the overall picture of all facilities.

Participants Name _____ Signature_____ Date_____

Researcher's Name_____ Signature _____Date_____

Thank you in helping with this important study

N.B: If you want to request additional information about the study, you will call by those phone numbers contact address of Principal investigator, 0989180270/0922298744.

Annex III: Code for name of hospitals

A=Armed Force Specialized Hospital

B= African Leprosy Research (ALERT) Hospital

C=Amanuel Mental Specialized Hospital

D=Tikur Anbessa Specialized Hospital

E= St. Paul's hospital Millennium Medical Collage

F= Federal Police Referral Hospital

G= Federal Prison Administration Hospital

H= Gandhi Memorial Hospital

I= Menelik-ll Referral Hospital

J= Ras desta Damtew Memorial Hospital

K=Tirunesh Beijing Memorial Hospital

L= Yekatit-12 Hospital Medical Collage

M= Zewditu Memorial Hospital

Annex IV: Questionnaires

Research title: Assessment of laboratory service interruption and associated factors in public hospitals in Addis Ababa, Ethiopia.

Please provide your assistance by giving your answers to the following questions

Date filled_____

1. Answers for part one and three should be ‘‘tick’’ by respondents.

2. The response of respondents on part two and three should be recorded by principal investigators and data collectors.

3. You are not expected to write your name.

I. Socio Demographic Characteristics would be filled by all respond ants

1. Level of your hospital

A, Tertiary, B, General C, Specialized

1.1.Sex/gender

A, male B, female

1.2.Age

A, 20-30 years B, 31-40years C, 41-50years D, 51-60 years

1.3. Educational status

A. Diploma B. first degree C. Masters & above

1.4. Work experience

A. 1-3 years B. 4-6 years C. 7-10 Years D. >10 years

1.5. What is Your position _____

A. Laboratory Head B. Laboratory Quality officer C. Other --------

1.6. What is your Monthly income?

A. 300-5000 B. 5500-7500 C. >7500

II. Status of Laboratory Service Interruption Part

The unstructured questioner combined with observation chike-list would be used for laboratory head/ quality officer to measure the status of laboratory service interruption. The response of respondents should record by principal investigator.

1. Do you provide all laboratory tests expected from your hospitals according to FMOH. ----------

   (Check by observation). ----------
2. Based on Q1 record, No of tests expected----------and No of tests listed on the hospital menu ----------
3. The percent of available hospitals test menu compared to excepted _____
4. If there is a test not included in the hospitals test menu, list those test that are not available._____(check by observation).
5. If there is interruption, how much test not provided _____
6. List test name which is not done according to the test menu _____and For how long _____(check observation)

III; Questions Related with Factor Affecting Laboratory Service

Structured self administered questioner used by laboratory professionals to measure factors affecting laboratory service interruption.

1. Are all requested laboratory tests done in your laboratory all the time?

A. Yes ☐ B. No. ☐

2. Infrastructure Part

2.1. Are there enough space allocated based on the number and the type of tests performed with in the hospital?

Yes ☐ B. No ☐ .

2.3. Is there continuous, functional electricity power available in the laboratory?

A. Y☐ B. N☐

2.4. Is there continuous, functional water available in the laboratory?

Yes ☐ B. No ☐

3. Communication part

.

3.1. Are there continuous communications with upper management about laboratory service?

A. Yes☐ B. No ☐

3.2. Are there continuous communications with physicians about laboratory services?

A. Yes ☐ B. No ☐

3.3. Are there continuous communications with patients about laboratory service?

A. Yes ☐ B. No ☐

3.4. Do you have regular staff meeting concerning laboratory service?

A. Yes ☐ B. No ☐

4. Motivation part

4.1. Are there systems for staff recognition?

A. Yes ☐ B. No ☐

4.2. Are there continuous education program for laboratory professionals?

Yes ☐ B. No ☐

4.3. Are there refreshment training on basic laboratory tests?

A. Yes ☐ B. No ☐

4.4. Are there enough orientations on laboratory equipments?

A. Yes ☐ B. No ☐

4.5. Do you satisfied in your salary?

A. Yes ☐ B. No ☐

5. Management Part

5.1. Does the hospital manager announce the laboratory budget at the beginning of the year?

A. Yes ☐ B. No ☐

5.2. Do the laboratory have annual plan?

A. Yes ☐ B. No ☐

5.3. Do laboratory manager request and follow essential supplies, reagents and equipments on time?

A. Yes ☐ B. No ☐

5.4. Do upper manager of the hospital give immediate feedback for questions related to laboratory service?

A. Yes ☐ B. No ☐

5.5. Do the laboratory managers follow your daily activity?

A. Yes ☐ B. No ☐

6. Resource part

6.1. Does the laboratory have sufficient budget?

A. Yes ☐ B. No ☐

Does the laboratory get sufficient reagents, supplies and equipments on time?

A. Yes ☐ B. No ☐

6.2. Are there enough laboratory equipments?

Yes ☐ B. No ☐

6.3 Do laboratory equipments get appropriate calibration and control on time?

Yes ☐ B. No ☐

6.4. Do laboratory equipments get appropriate maintenance on time?

A. Yes ☐ B. No ☐

6.5. If there is another cause list them_____?

7. Work load part

7.1 Are there sufficient human resources for laboratory work?

A. Yes ☐ B. No ☐

7.2. Are there trained and skilled laboratory professionals?

A. Yes ☐ B. No ☐

8. Back up and networking system part

8.1. Are there additional laboratory equipments used as backup?

A. Yes ☐ B. No ☐

8.2. Is there sample referral linkages system with other health facility laboratories?

A. Yes ☐ B. No ☐

IV. Structured cheke-list for laboratory service interruption filled by principal investigator/ data collectors.

Date ---------month -------- year----------

Hospital name (Specialized/ General Hospital) ----------

Please put tick mark if the test is done in the hospital if not put mark X mark

		Date of test done																														
S.No	Test name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total test no
	Clinical Chemistry:																															
1	Blood glucose																															
2 3	Cholesterol Triglyceride																															
4	LDL																															
5	HDL																															
	Serum Electrolyte:																															
6	Na+																															
7	K+																															
8	Cl-																															
	Liver function test:																															
9	ALKP																															
10	AST																															
11	ALT																															
12	δΤΓ																															
13	Total bilirubin																															
14	Direct bilirubin																															
15	Total protein																															
16	Albumin																															
	Renal function																															

	test:																														
17	Urea																														
18	Creatinine																														
19	Uric acid																														
	Cardiac function test:																														
20	LDH																														
21	CK-MB																														
22	Troponin																														
23	CPK																														
	Hormonal test:																														
24	T3																														
25	T4																														
26	TSH																														
27	FSH																														
28	LH																														
29	Testosterone																														
30	progestrone																														
31	Prolactin																														
	Parasitology:																														
32	Stool microscopy																														
33	Blood film for malaria and other hemoparasite/Malaria Rapid Test																														
34	Occult blood																														
	Urine and body fluid Analysis:																														
35	Urinalysis																														
36	CSF analysis																														
	Mycology:																														
37	KOH test																														

38	Fungal culture																														
	Hematology:																														
39	Haemoglobin																														
40	Total WBC count																														
41	Differential white cell count																														
42	Peripheral blood film																														
43	ESR																														
44	Hematocrit																														
45	Platelet count																														
46	Bleeding time																														
47	Reticulocyte count																														
48	prothrombin time																														
49	Hb electrophoresis																														
50	Lupus Erythematosus																														
	Serology :																														
51	H.Pylori																														
52	Troponin																														
53	HBs Ag																														
54	HCV																														
55	Toxoplasma latex																														
56	ASO																														
57	RF																														
58	RPR																														
59	TPHA																														
60	CRP																														
61	Salmonella Typhi-O																														

62	Salmonella Typhi-H																														
63	Proteus-OX19																														
64	CD4 count																														
65	HIV-test																														
66	Viral load																														
67	HIV-test																														
68	HCG																														
69	Anti-A																														
70	Anti-B																														
71	Anti-D																														
72	Compatibility testing																														
73	Cross match																														
	Bacteriology:																														
74	Gram stain																														
75	ZiehlNeelson stain																														
76	India Ink																														
77	Culture and sensitivity																														

1. Name of data collector ---------- Sign----------Date----------

2. Name of supervisor ---------- Sign----------Date----------

Declaration

I, the undersigned agree to accept responsibility for the scientific ethical and technical conduct of the research project and for provision of required progress reports as per terms and conditions of the research publications office.

M.Sc. candidate: **TilaneshMulu (B.S.C)**

Signature: _____

Date of submission: _____

This thesis has been submitted with our approval as advisors.

Advisor: **Fekadu Urgessa (MSC, PHD Fellow)**

Signature: _____

Date: _____

Place: Addis Ababa, Ethiopia.

Advisor: **AbaySisay (MSc, PhD Fellow)**

Signature: _____

Date: _____

Place: Addis Ababa, Ethiopia.