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NEAR EAST UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

DEPARTMENT OF MEDICAL GENETICS

MASTER'S PROGRAM IN MEDICAL BIOLOGY AND GENETICS

COVID-19 PANDEMIC EFFECT ON PARASITIC INFECTIONS

M.Sc. THESIS

Samuel Chikezie EZE

Nicosia

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M.Sc. THESIS

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July 2023

Approval

We certify that we have read the thesis submitted by Samuel Chikezie Eze titled **"COVID-19 Pandemic Effect on INTESTINAL Parasitic Infections"** and that in our combined opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master's in Health Sciences.

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Declaration

I hereby declare that all information, documents, analysis, and results in this thesis have been collected and presented according to the academic rules and ethical guidelines of the Institute of Graduate Studies, Near East University. I also declare that as required by these rules and conduct, I have fully cited and referenced information and data that are not original to this study.

Samuel Chikezie Eze
03/09/2023

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Abstract

COVID-19 PANDEMIC EFFECT ON PARASITIC INFECTIONS

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The 2019 coronavirus illness (COVID-19) was discovered in Hubei Province, China, in the city of Wuhan at a facility. It belongs to a larger category of diseases known as coronaviruses (CoV), which includes everything from common colds and influenza to more serious ailments like the Ebola virus, acute respiratory syndrome with severe manifestations (SARS-CoV), and respiratory syndrome from the Middle East (MERS-CoV). The coronavirus epidemic was officially named coronavirus disease 2019 (COVID-19) on February 11, 2020, under the World Health Organisation [WHO].

This study employed a non-parametric, one-sample binomial statistical model to investigate the effect of the COVID-19 pandemic on parasitic diseases. Data collected from government hospitals and health agencies underwent testing via real-time PCR and analysis of estimates was performed in the SPSS software environment.

The findings indicated that while the pandemic didn't show a significant effect on the gender of those studied, it did demonstrate a positive influence on patients who were co-infected or super-infected.

Keywords: COVID-19**,** parasitic infection, SARS-CoV-2, intestinal parasite

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List of Abbreviations

KB:	Kilo Base
CDC:	Centre for Disease Control
COV:	Corona Virus
COVID-19:	Corona-virus disease 2019
DNA:	Deoxyribonucleic acid
ICTV:	International Committee of Taxation on Viruses
PARG:	Poly (ADP-ribose) glycohydrolase
RAS:	Renin-angiotensin System
RdRp:	Dependent RNA polymerase
RNA:	Ribonucleic acid
MERS-CoV:	Middle East Respiratory Syndrome
MNE:	Ministry of National Education
Nsp:	Nonstructural protein
SARS:	Severe Acute Respiratory Syndrome
SARS-CoV-2:	Severe Acute Respiratory Syndrome Corona Virus 2
SPSS:	Statistical Package for Social Science
TM2:	Trans-membrane domain 2
TRPM2:	Transient receptor potential melastatin type 2
TRNC:	Turkish Republic of North Cyprus
WHO:	World Health Organization

CHAPTER I

Introduction

1.1 Background:

Since the beginning of the human race, survival has been challenged by disease. Diseases have caused deaths, shortened life spans, and adversely impaired the physical and mental status of survivors. Most infant mortality and physical and mental challenges are due to the outcome of illness caused by diseases such as polio, measles, mumps, whooping cough etc. For adults, cancer (various types), Parkinson's disease, hypertension memory loss etc., are suffered due prevalence of diseases. One of the most devastating diseases of the 21st century is COVID-19 (Burns, 2023).

According to Viswanath, (2021), It was shown that the cause of this illness is a new coronavirus variation called severe acute respiratory coronavirus 2 (SARS-CoV-2), which had not been identified or reported to human populations before. Also, as per Anjorin's, 2020 findings, the COVID-19 outbreak had already reached 114 countries before its official declaration as a pandemic by the World Health Organization (WHO) on March 11, 2020. In addition to resulting in numerous fatal illnesses and millions of deaths upon its emergence, the pandemic also led to significant disruptions in the global economy. According to data from the WHO report had been approximately 170 million documented cases of COVID-19 and a staggering 3.5 million deaths worldwide (Tozan, 2021).

Abd Al-Khaliq et al., (2021), identify parasites as powerful immune modulators because they can stimulate the immune response in infected individuals. Parasitic infections are usually treated with antibiotics. Meanwhile, treatment may take a couple of weeks to months, and the infection can reoccur if not treated properly.

The advancement of antibiotics, anti-viral medicines and immunizations have appeared to speed up recuperation, moderate movement and in a few cases annihilate irresistible infections from the whole population. Antibiotics are endorsed for bacterial diseases and back the body's characteristics and defense framework to dispose of the disease-causing bacterial agent (Davies & Davies, 2010a). However, overuse of antibiotics, misuse of antibiotics, and the mutation of bacteria are some of the factors that often contribute to antibiotic resistance.

Immunizations are done to elevate immunity to a desired disease (Lee Ventola, 2015). This is however to the extent that complication does not arise from secondary effects. Such secondary effects may include variations in the body's defense system and immunity levels arising from COVID-19 consequences. Thus, if the COVID-19 pandemic's impact and ramifications on parasitic illnesses are not adequately researched and comprehended, they continue to pose a threat to global health.

The result of this study will significantly contribute to the enhancement of management and treatment strategies for individuals who are infected with parasites and are also exposed to COVID-19 both before and following the COVID-19 pandemic. The research aimed to explore whether the occurrence of the pandemic has any impact on infections caused by intestinal parasites. Ultimately, the findings will aid in improving the overall care and outcomes for people dealing with both parasitic infections and COVID-19.

1.2 Statement of the problem

With the emergence of COVID-19, different countries faced short- and long-term lockdowns. During and after the lockdown, other infections, such as parasitic infections, were still detected. There has not been any data on the rates of parasitic infections, more specifically as it affects different age grades and sex during the COVID-19 outbreak in Northern Cyprus. The understanding of the interaction of the virus with hosts is of most extreme significance within the treatment of infected victims.

The similarities between the symptoms displayed by COVID-19 and those seen in other viral infections along with the challenges associated with co-infection and super-infection, have posed obstacles in the timely diagnosis and management of COVID-19. Thus, the main goal of this research is to investigate the relationship between COVID-19 and parasitic illnesses as well as the determinants of this relationship. These factors include gender, age, place of residency, educational level, occupation, body mass index, and any pre-existing medical conditions. The importance of conducting this study cannot be overstated, especially considering the global recovery from the distressing phase of the pandemic.

1.3 The Goal of the Research

Extending the research problem logically is the main goal of the study. The purpose of this research is to look at how the COVID-19 pandemic has affected intestinal parasite infections.

The specific objectives are to:

I was given a surveyed population stool sample from the Near East University Hospital, Nicosia and examined it. The Source for secondary data was generated and released by various agencies including Laboratory tests for the population sample, I then analyzed the generated survey data using SPSS Software and, after that carried out a comparative evaluation of the result with existing record(s).

1.4 Research Hypotheses

The following theories serve as the basis for the research:

Ho1: The patient's gender and the rate of COVID-19 infection are positively and significantly correlated.

Ha1: There is no statistically significant positive correlation found between the patient's gender and the risk of COVID-19 infection.

Ho2: Intestinal parasite infection and COVID-19 infection are positively and significantly correlated.

Ha2: Intestinal parasite infection and COVID-19 infection do not positively correlate significantly.

1.5 Significance of the Study

Given the current global studies being conducted on the impacts of COVID-19, an investigation of this kind is much needed. Furthermore, politicians and international health authorities' decision-making processes are anticipated to be significantly impacted by this study. These lessen the shock that is experienced whenever such an outbreak happens by greatly contributing to reform efforts. The findings of this study will help treat and care for those exposed to the COVID-19 pandemic who have intestinal parasite infections. Additionally, it will guarantee that medical personnel are up to date on the most effective ways to contain the COVID-19 epidemic.

1.6 Scope of Work

The purpose of this study is to investigate how the COVID-19 pandemic has affected the dynamics and prevalence of intestinal parasite infections. The five-year historical period from 2018 to 2022 is the subject of the study. It is crucial to remember that the study's breadth is constrained by several factors, such as limited access to resources and tools, as well as budgetary and scheduling restrictions.

CHAPTER II

Literature Review

2.1.1 Overview of COVID–19

The coronavirus disease 2019, or COVID-19, was discovered at a Hubei Province, China, Wuhan city facility. It falls under the larger category of coronaviruses (CoV), which includes a range of diseases from mild respiratory infections such as the common cold and influenza to more serious ailments like the Ebola virus, severe acute respiratory syndrome (the SARS-related), and Middle East respiratory syndrome. (Sun et al., 2020). The coronavirus-caused outbreak has been officially named as coronavirus disease 2019 (COVID-19)(Wu et al., 2020).

The most common ways of transmission are direct contact with infected people. When a person with the virus talks, sings, sneezes, breathes, or wheezes, tiny fluid particles from their mouth or nostrils might transmit the infection. These particles extend from bigger droplets in the respiratory tracts to little aerosols. The virus that caused COVID-19, SARS-CoV, primarily spreads through fomites (inanimate objects) and respiratory droplets when there is close and prolonged contact between infected and uninfected individuals, both asymptomatic and symptomatic patients can serve as sources of infection. (Wang et al., 2021). Additionally, indirect contact with contaminated surfaces can lead to transmission. The virus-laden droplets can contaminate hands, and when people touch their mouth, nose, or eyes, they can become infected according to WHO (WHO, 2020).

2.1.1.1 Diagnosis of COVID-19

In accordance to the World Health Organization (WHO), the diagnosis of COVID-19 is established by the combination of fever and the presence of at least one symptom, such as cough or dyspnea (difficulty in breathing). This diagnosis applies to individuals who exhibit these symptoms and do not have any other underlying factors that could explain the presence of these symptoms. Additionally, this pertains to individuals who have recently visited an area with documented cases of COVID-19 transmission within a 14-day timeframe before exhibiting symptoms or those who have been hospitalized due to severe acute respiratory illness without any other identifiable clinical explanation (WHO, 2020).

Anjorin's, (2020) report emphasized the diverse laboratory protocols implemented in the diagnosis of COVID-19. These protocols entail the acquisition of respiratory specimens such as oropharyngeal or nasopharyngeal aspirates or lavages, oropharyngeal or nasopharyngeal swabs, bronchoalveolar lavage, tracheal suction, and sputum. To identify and examine COVID-19, it is usually necessary to employ the following methods: isolating the virus in tissue culture or cell lines, conducting serological tests to quantify antibody levels, using electron microscopy to examine viral particles closely, and utilizing conventional and real-time reverse transcriptase polymerase chain reaction (PCR) technique (Anjorin's, 2020).

2.1.2 SARS-CoV-2

The pathogen known as SARS-CoV-2, or severe acute respiratory syndrome coronavirus 2, first appeared in December 2019 and posed a serious risk to human health. In 2020, Hu B. et al. reported a pneumonia outbreak in the Chinese city of Wuhan, Hubei Province, for which the precise source of the sickness was first unknown. Subsequently, the International Committee on Taxonomy of Viruses (ICTV) named it SARS-CoV-2 and recognised it as a novel beta coronavirus capable of human infection. (Zhou et al., 2020).

2.1.2.1 SARS-CoV-2 Diagnosis

The virus that caused the COVID-19 pandemic, SARS-CoV-2, mainly transmits by respiratory droplets and fomites, or inanimate items, when infected and uninfected people come into close, continuous contact with one another (WHO, 2020). Both asymptomatic and symptomatic patients can serve as sources of infection. Additionally, indirect contact with contaminated surfaces can lead to transmission. The virus-laden droplets can contaminate hands, and when people touch their mouth, nose, or eyes, they can become infected (Dhand & Li, 2020). Using swabs from the throat and mouth cavity, an RT-PCR test is run to detect the virus and diagnose the infection. Although SARS-CoV-2 may additionally be found in respiratory specimens, blood, and faeces, the chances of discovering the infectious agent in these samples are minimal (Moreira et al., 2021). According to research by Du et al., (2020), the transmission of acute virus may extend beyond

the respiratory tract, as aerosols produced during medical procedures can spread within healthcare facilities.

2.1.2.2 Morphology of the SARS-CoV-2

In the findings conducted by (Du et al., 2020), It was discovered that the coronavirus SARS-CoV-2 has a genome that is roughly 29.9 kb in size. Four structural protein types (S, E, M, and N) and sixteen non-structural proteins (Nsp1-16) comprise the virus. While Nsp2 controls the signalling pathway essential for maintaining host cell viability, Nsp1 participates in RNA processing and replication. Nsp3 is thought to be responsible for the breakdown of translated proteins, whereas Nsp4—which has a unique region called transmembrane domain 2 (TM2)—modifies the endoplasmic reticulum, also known as the wall structures. Nsp13 binds to ATP and its zinc-binding domain contributes to replication and transcription. Enzyme activity dependent on endoribonuclease is demonstrated by Nsp14, whereas Nsp16 acts as a 2'-O-ribose methyltransferase, modifying ribose molecules on RNA strands (Naqvi et al., 2020).

2.1.3 Overview of Intestinal Parasitic Infections

A parasite is any living entity that either inhabits or feeds on its host and obtains its food from it at the expense of the host. The parasite can spread parasitic infections, which can result in sepsis, and it can be tiny or large enough to be seen with the naked eyes (Samuel Baron, 1996). Helminths, parasitic organisms, and protozoa are the three main parasite species that can infect people.

Intestinal parasitic infections are the leading causes of global diarrhoea, and while they are generally associated with low death rates, complications frequently arise, necessitating hospitalization in certain cases (Di Genova & Tonelli, 2016).

Diarrhoea is the medical term for an upsurge in the quantity or fluidity of faeces. The frequency of bowel movements may or may not accompany this condition, as indicated by the findings of (Visvanathan & Chapman, 2009). Also, Guerrant proposes a classification system for diarrhoea based on its duration, encompassing three categories: acute diarrhoea (enduring for no more than 14 days), persistent diarrhoea (persisting between 15 and 29 days), and chronic diarrhoea (persisting for 30 days or longer). This classification is of great

importance in clinical settings as it aids in the identification of the underlying cause for diagnosis and treatment, as emphasized by (Guerrant et al., 2001).

Multicellular worms called helminths are frequently discovered in the gastrointestinal system of humans. It is important to note that helminths generally cannot reproduce within the human body. On the other hand, protozoan parasites, consisting of a single cell, can multiply inside the human body (Al Amin & Wadhwa, 2024).

2.1.4 Types of Intestinal Parasitic Infection

2.1.4.1 Blastocystis hominis

This is a microscopic parasite that can live in the digestive tract. Normally they live in the digestive tract without causing harm. Usually, this parasite is spread through contact with contaminated food, water, and faeces.

Its ability to cause infection could depend on these main factors: The existence of a classified type of *Blastocystis hominis*, the Presence of preexisting gastric conditions, presence of co-existing bacteria in the gastric tract. This can be diagnosed through Microscopy, colonoscopy, and PCR-based tests (Stenzel & Boreham, 1996).

2.1.4.2 Entamoeba histolytica

The bacterium *Entamoeba histolytica* is the cause of amebiasis. The parasite can be found in the gastric tract, liver, respiratory tract and brain. It is difficult to diagnose because many gastric infections present in a similar manner. Symptoms include abdominal pain and bloody diarrhoea. This disease is often treated using Metronidazole. This can be diagnosed through Microscopy, antigen detection test, colonoscopy, and PCR-based test (Tanyuksel & Petri, 2003).

2.1.4.3 Giardia intestinalis

The parasite *Giardia intestinalis/duodinalis* causes the disease Giardiasis, a gastric infection. It is often transmitted, like other gastric infections, through contaminated food, water and faeces. Again, treatment can be done using Metronidazole. The disease can be diagnosed through microscopy, antigen detection test, colonoscopy, and PCR based test (Smith & Evans, 2009).

2.1.5 Infection:

The concept of "infection" describes the successful spread of pathogenic microorganisms, such as microbes, parasites, viruses, or fungi. This transmission can occur through direct person-to-person contact or indirect means, such as through respiratory droplets expelled during a sneeze or through contact with contaminated body fluids or objects housing infectious agents in the environment. Specifically, two types of infections commonly observed in respiratory viral illnesses are co-infection and super-infection (van Seventer & Hochberg, 2017a).

2.1.5.1 Co-infection

Can be described as the presence of at least two distinct pathogens with different genetic characteristics within the same individual. These pathogens may be distinct genetic variations of an identical infectious agent or they may belong to separate taxonomic groups, such as viruses and bacteria. In scientific literature, co-infection is also known as polyparasitic, polyinfection, multiple parasitism, mixed infection, multiple sickness, simultaneous infection, and polyparasitic (Rigaud et al., 2010). According to (Hoarau et al., 2020), when infectious agents communicate and exploit the same vertebrate host simultaneously (co-infections), it can influence the outcomes of the diseases.

2.1.5.2 Super-infection

On the other hand, according to Davies & Davies, (2010b), superinfection is an infection following a previous infection not precisely similar, especially if it is caused by a microorganism that is resistant or has become resistant to previously used antibiotics (Davies & Davies, 2010b).

2.2 Review of related literature

Wolday and colleauges (2021) performed a study to evaluate the impact of intestinal parasite co-infection on the extent of COVID-19 in an ensemble of patients from Ethiopia. The study, which took place between July 2020 and March 2021, involves screening individuals for intestinal parasites. Using standard logistic regression models, variables like body mass index, comorbidity, education, sex, age, and place of residence were adjusted for. 284 people (38%) out of the 751 patients with a SARS-CoV-2 diagnosis had intestinal parasite infections.

Remarkably, 257 out of 496 people (52%) with non-severe COVID-19 showed positive findings for parasitic infections, but only 27 out of 255 people (11%) with severe COVID-19 were also co-infected with intestinal parasites (Wolday et al., 2021).

Abd Al- Khaliq and colleagues (2021) conducted a study in Baghdad with a specific focus on intestinal parasitic infections in individuals affected by COVID-19. From October 2020 to April 2021, the researchers investigated a group of 90 patients, all of whom tested positive for COVID-19 through PCR testing. The results of this research showed a divergent relationship between parasitic infection and COVID-19, highlighting the need to understand the complex interplay between parasites and the microbiome and how it affects COVID-19's pathogenicity (Abd Al-Khaliq et al., 2021).

Omoush and Alzyoud performed a comprehensive literature review to provide an up-to-date examination of the occurrence and consequences of coinfections and superinfections on the outcomes of COVID-19. The authors discovered that individuals diagnosed with COVID-19 face an increased susceptibility to acquiring secondary infections, potentially exacerbating the prognosis of the disease. However, subsequent investigations have yielded contradictory findings regarding the significance of coinfection on the observed COVID-19. This highlights the need for further research to ascertain the true relationship between coinfections and COVID-19 progression (Omoush & Alzyoud, 2022).

An investigation was carried out to assess the impact of co-infection with pathogens on the magnitude of COVID-19. Evaluating COVID-19 patients for intestinal parasite infections was part of the investigation. The findings suggested a possible relationship between mutual infection with a parasite infection and a reduction in COVID-19 severity. This study clarifies the relationship between COVID-19 results and parasitic infections, pointing to a possible protective benefit of co-infections with parasites (Gebrecherkos et al., 2023).

Anjorin, (2020) carried out a comprehensive investigation and offered a revised assessment of the COVID-19 cases in Africa. The researcher talked at length on past epidemics that posed serious threats to public health around the world. These include the current COVID-19 pandemic, the Middle East respiratory disease (MERS), the spread of Ebola, the H1N1 pandemic, and instances of acute

respiratory syndrome with severe consequences (SARS). This review emphasises how critical it is to comprehend the lessons learned from the past and how they apply to handling the COVID-19 situation that exists in Africa today (Anjorin, 2020).

2.3 Research Gap

Nearly all the studies examined played a part in enhancing our comprehension of how the COVID-19 outbreak has impacted the occurrence and consequences of parasitic infections. However, in Lefkosa North Cyprus there have not been any studies carried out. Hence, this research is undertaken to cover this gap.

CHAPTER III

Methodology

3.1 Research Design

The study modelling and application in medical biology and genetics cover a wide range of methods and techniques. However, in the biomedical field, two basic methods usually employed are observational and experimental. The design of the problem under investigation and the goal of the research will determine which of the alternatives is chosen. They can be chosen individually or in groups (Röhrig et al., 2009).

In cases where investigations are targeted, prevalence studies, specifically cross-sectional studies, are most appropriate for inquiries focused on understanding the distribution of disease, identifying affected and unaffected populations, assessing its geographic spread, and tracking variations in disease frequency over time. Such investigations are specifically tailored to address these aspects (Setia, 2016).

Among the various statistical software systems that are available for sample size calculation and analysis of the Statistical Package for the Social Sciences (SPSS) This system utilizes a computer program called 'Sample Power'. One sample binomial test model is used because it allows us to take accountabilities for all the inter-relationships between a set of variables (Allen & Wayne, 2016).

The following hypotheses drive the research:

HO1: The prevalence of COVID-19 infection and patient gender are positively and significantly correlated.

Ha1: The degree of COVID-19 infection and patient gender do not positively or significantly correlate.

HO2: Intestinal parasite infection and COVID-19 infection are positively and significantly correlated.

Ha2: Intestinal parasite infection and COVID-19 infection do not positively or significantly correlate.

These hypotheses set the framework for investigating and determining whether there is a statistical potency correlation between infection rates and variables such as patient gender and intestinal parasitic infection.

3.2 Participants/Population and Sample

The NEU Institutional Review Board granted ethical approval (YDU/2023/115-1750). The study population consisted of a cohort of people who visited the lab at Near East Hospital for medical attention between 2018 and 2022 and had tests for COVID-19 and intestinal parasite infections. A cross-sectional study design was used. The study, which focused on the incidence of parasitic illnesses in reaction to COVID-19 both before and after the pandemic, was conducted in Lefkosa, North Cyprus.

In this study, stool samples from 5981 individuals who sought treatment at our hospital due to gastrointestinal issues were assessed after the fact. In the Microbiology Laboratory, stool samples were first analysed macroscopically for the presence of parasites by looking at factors including colour, consistency, mucus, and blood present. Following this, microscopic examinations were conducted. When the stool samples were concentrated using native Lugol and formol ethyl acetate, they were inspected under a light microscope using 10x and 40x lenses. (Doğan et al., 2023). Antigen tests were performed with the commercially available Crypt-Giardia-Entamoeba (Monlab S.L., Barcelona, Spain) triple antigen kit, by the manufacturer's recommendations (Monlab, 2017). Equation 1 was used to estimate the number of samples needed for predicting the disease prevalence rate, and a total of 5981 participants participated in this investigation.

Equation 1: $n=4pqL_2$……

Table 1.

Study population of the participants.

S. No	Description	Result
1	Total Numbers	326
2	Test Statistic	165,000
3	Standard Error	9.028

Where “n” represents the sample size needed for the study, “p” refers to the estimated prevalence rate of the disease being studied, “q” represents the

complement of “p,” which is equal to 1 minus the prevalence rate and “L” denotes the permissible error in estimating “p,” and it can be based on previous studies or a pilot study.

It is crucial to remember that the formula is intended for a level of likelihood of 0.05, which is typical for statistical analysis. Additionally, the prevalence ratio “p” calculated from the determined sample size will have an error within the range of “L.” This statement asserts that this holds in 95 out of 100 samples.

3.3 Data Collection Tools/Materials

Materials used in this survey are mainly secondary data generated by government agencies such as Near East University Hospital Nicosia and laboratories specifically for intestinal parasites between 2018 -2022.

We conducted a retrospective evaluation of stool samples from 5981 individuals who sought treatment at our hospital between 2018 and 2022 due to gastrointestinal problems. Information on patient consent was not gathered because our study was retrospective. In our hospital's Microbiology Laboratory, stool samples were initially inspected macroscopically for parasites; colour, consistency, fluid, and blood presence were noted. Following this, microscopic exams were carried out (Doğan et al., 2023). The stool samples were examined under a light microscope with 10x and 40x objectives after native-lugol and formal ethyl acetate concentration methods. Antigen tests were performed with the commercially available Crypt-Giardia-Entamoeba (Monlab S.L., Barcelona, Spain) triple antigen kit, following the manufacturer's recommendations (Monlab, 2017).

3.4 Model Specification

One sample binomial test model is the assessment method chosen for the study. Along with other methods it has a simple computational procedure with optimal properties of estimators and those properties are linearity, unbiasedness and minimal variance between classes of unbiased estimators. The use of this model makes the following assumptions:

Assumption 1: The n samples are mutually independent.

Assumption 2: The probability of a given outcome is the same for all the n samples.

Assumption 3: The only source of variation is simple random and binomial.

3.5 Data Analysis Procedures

The performance evaluation technique requires the use of the following criteria:

Null hypothesis: According to Ali & Bhaskar, (2016), the term "null hypothesis" ($H_{01, ----,}$ H_{0n}) in medical research refers to the absence of a relationship between specific variables within the population. On the other hand, the alternative hypothesis (H_{a1}, ------, H_an) suggests a positive relationship between the variables. The probability value, also known as the P value, is employed to assess the suitability of the estimated regression equation. It helps determine whether to accept or reject the null hypothesis.

The symbol "Sig" indicates the P-value. within the SPSS application. According to the statistical analysis, the regression model's p-value, which is below 0.05 (more precisely, $p < 0.0005$), suggests significant statistical conclusions. The interpretation of the P-value is shown in Table 2.

Chi-square (χ^2) statistic as a test of significance to measure how the model compared to actual observed data which was evaluated.

Finally, the a priori sign and magnitude of the coefficient are used to evaluate the results and the tests performed to ensure that the assumptions of the non-parametric, one-sample binomial model are fulfilled (Ali & Bhaskar, 2016).

Table 1.

P- values with interpretation

S.N	P	Result	Null hypothesis
1	<0.01	The outcome is really important.	Dismiss (zero hypothesis) H0
2	≥0.01 but <0.05	The outcome is really important.	Dismiss (zero hypothesis) H0
3	Value ≥ 0.05	The outcome is not important.	Do not dismiss (zero hypothesis) H0

CHAPTER IV

Findings and Discussion

Regression Results and Analysis

The results of one sample binomial regression using the SPSS program are presented in this chapter as shown in Tables 3 and 4. Estimates are subjected to various statistical tests. Based on the empirical results given by the results, the research hypotheses are evaluated.

Table 2.

Hypothesis Test Summary

Serial No	Null Hypothesis	Test	Sig level (500)	Decision
1	The gender categories, specifically "Female" and "Male," manifest with equal probabilities of 500 each.	Simple Binomial Test	868	Retain the Null Hypothesis
2	The categories associated with the pandemic, namely "Pre-pandemic" and "During pandemic," have equal probabilities of occurrence, both at 500.	Simple Binomial Test	203	Retain the Null Hypothesis
	The different classes of parasite names appear with equal likelihood and frequency.	One sample Chi-square Test	000	Reject the Null Hypothesis
4	The frequency and probability of the age groups are equal.	One sample Chi-square Test	000	Do not dismiss the Null Hypothesis

Note: The asymptotic impact is presented, indicating a significance level of 500.

4.1 Presentation of Regression Results

Table 4 presents the Hypothesis Test Summary of the estimates. The tests were conducted at a 94.9% degree of confidence or 5.1% degree of relevance. In the outcome displayed in Figure 1, out of a population of 5981 patients, there were a combined total of 2986 (49.9%) female and 2995 (51.1%) male individuals. The original null hypothesis, which states that there is no significant and positive correlation between the gender of the persons involved and the likelihood of COVID-19 infection, is supported by the test results shown in Table 4. By assessing the 5% and 1% level of significance thresholds with a P-value greater than 0.05, this confirmation is achieved.

Table 3.

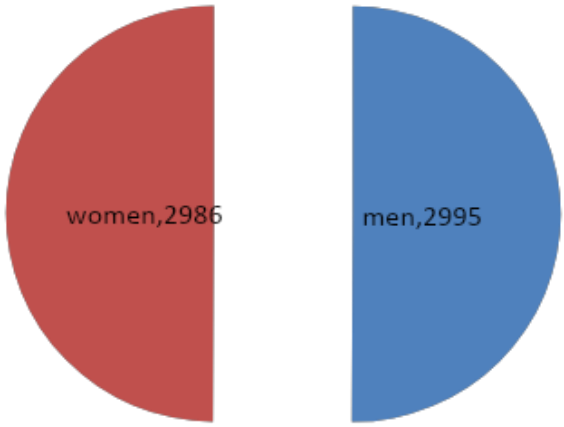
One Sample Binomial Test Summary

S.No	Description	Result
1	Total Numbers	326
2	Test Statistic	165,000
3	Standard Error	9.028

4.1.1 Evaluation of Number One Working Hypothesis

Figure 1.

Distribution of Screened Patients



4.1.2 Evaluation of Number Two Working Hypothesis

The data derived from the test results depicted in Figures 2 and 3 provides support for the second null hypothesis, suggesting a clinically significant and positive association between COVID-19 infection during the pandemic and pre-pandemic. This finding is affirmed by statistical significance levels at both 5% and 1%, whereby the P-value is lower than 0.05. The result showed that the total cases of parasitic infection recorded were 3552 (59.4%) during the pandemic while 2429 (40.6%) were recorded pre-pandemic. After the tests were conducted, a total of 326 (5.5%) patients tested positive for parasitic infections as shown in Figure 3. Of the 326 patients, 165 (50.1%) were female and 161 (49.4%) were male. It was also observed that 175(53.7%) cases of all parasitic infections were recorded during the pandemic and 151(46.3%) occurred pre-pandemic. This translates to 5665(95.5%) negative cases as shown in Figure 3. The outcome indicated a significant disparity between the quantities of individuals who tested negative and positive. As a result, we support the alternative hypothesis and reject the null hypothesis.

Figure 2.

Screening Period

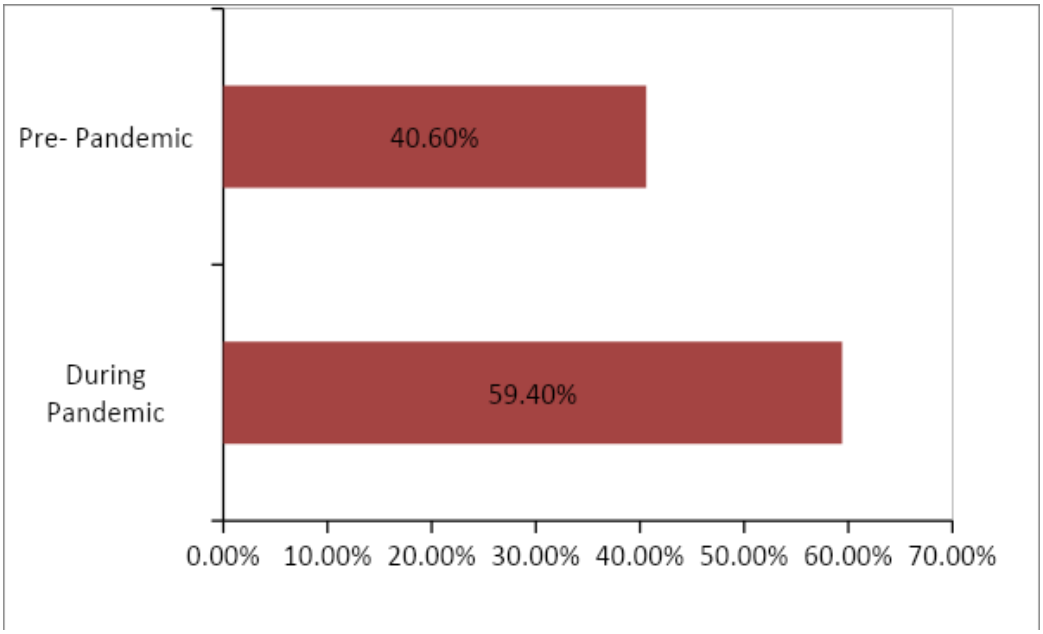
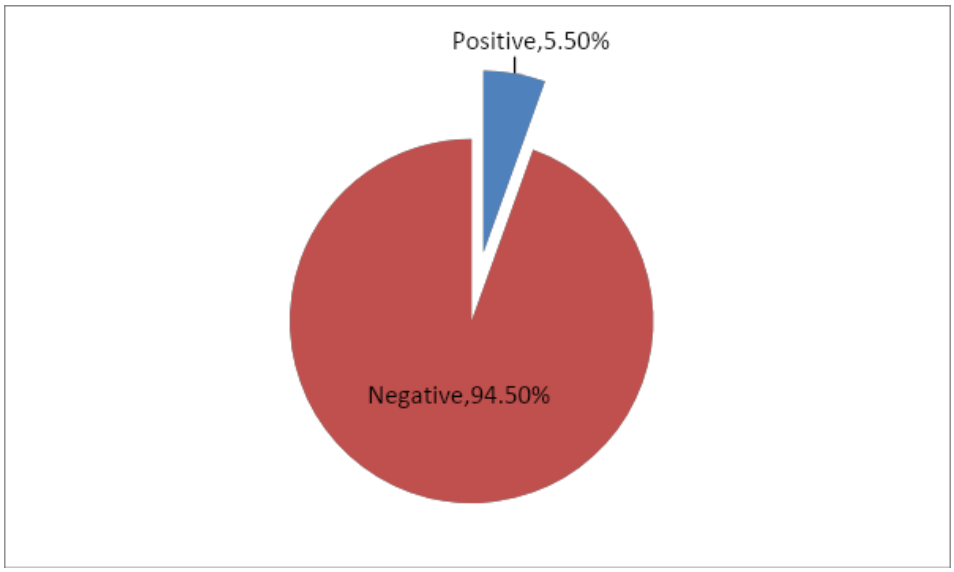


Figure 3.

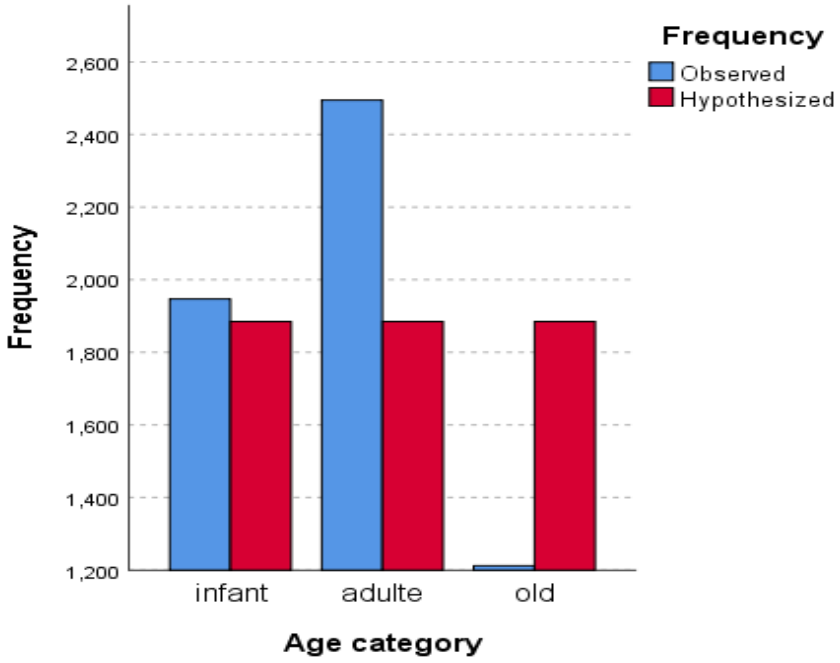
Test Result for Parasitic Infections



The depicted graph shows a notable disparity in the infection rate among children, adults, and elderly populations as shown in Figure 4. The elderly presented with the least number of positive cases whereas adults presented with the most positive cases. There are many possible reasons for this, the most prominent one being that elderly people rarely encounter faecal matter and other forms of transmission in comparison to the two younger age groups. One factor to consider is the ages of the people who tested positive for parasitic infections. In the initial analysis of the research topic, it was hypothesized that there would be little to no difference in the rate of infection between the ages as shown in the graph below. However, after the sample had been collected and categorized, there was a notably higher rate of infection in individuals between the ages of 18 and 45. The sample used contained individuals that have been categorized into three age groups: Infant (1- 17 years), Adult (18-45 years) and Old/Elderly (45+).

Figure 4.

Test Result for Age Category



4.1.3 Evaluation of Number Three Working Hypothesis

The third null hypothesis, which states that there is a strong correlation between COVID-19 and super-infection, is supported by the evidence of test findings shown in Table 5. This is confirmed by both 5% and 1% significance levels with a P-value of 0.05. The common parasitic infections identified as shown in Table 4.4 were *Blastocystis hominis* with 268 (4.5%) cases, *Entamoeba histolytica* with 26 (0.4%) cases and *Giardia intestinalis* 29 (0.5%) cases. Patients were also tested for *Gardia intestinalis* and *Blastocystis hominis*, *Hymenolepis nana* and *Taenia* spp. due to their frequency in the area.

Table 4

Identified parasitic infections.

S.No.	Description	Case No.	% of Sample
1	*Blastocystis hominis*	268	4.5
2	*Entamoeba histolytica*	26	0.4
3	*Giardia intestinalis*	29	0.5

CHAPTER V

Discussion

The purpose of this study was to investigate the impact of intestinal parasite infections on the COVID-19 pandemic. In previous studies, researchers have found that communities frequently come across cases of intestinal parasitic infections, demonstrating their ongoing significance. The occurrence of such infections shows variations based on factors like gender, level of education, hygiene practices, dietary habits, socioeconomic status, regional demographics, and geographical conditions. Scientists are actively investigating the consequences of the COVID-19 outbreak on parasitical illnesses in the literature (Seid et al., 2022). According to studies conducted in Saudi Arabia and Iran, the overall incidence of intestinal parasites was lower during the COVID-19 period than it was before (Hawash et al., 2021a; Teimouri et al., 2022). According to an Iranian study, health education and good personal hygiene can help lower the risk of parasite illnesses during the COVID-19 pandemic (Teimouri et al., 2022). According to a Saudi Arabian study, the government's quarantine policies for containing the pandemic may have contributed to a decrease in parasitic illnesses. (Hawash et al., 2021a).

In contrast to the previous two studies stated above, this study found that there was an increase in infections caused by parasites during the COVID-19 pandemic compared to the pre-pandemic period. Furthermore, it was noted that, when examined at the species level, the frequency of the parasites that are harmful *Giardia intestinalis* and *Entamoeba histolytica* decreased proportionately, despite an increase in the overall incidence rate during the pandemic process. The decrease in the frequency of the pathogenic parasites could be attributed to the actions made by the health authorities to inhibit the coronavirus's spread. Prohibitions against travel, frequent use of disinfectants, and daily hand washing can all help lower the incidence of parasite infections (Hawash et al., 2021b). These observations are also similar to the findings of (Aydemir et al., 2023; Hawash et al., 2021b), in which backdated research was done to determine the significance of COVID-19 on intestinal parasites. However, intestinal parasite infections maintain their importance in Northern Cyprus. Nonetheless, the study's findings are consistent with a rise in the general incidence of parasites. (Aydemir et al., 2023), where the occurrence of intestinal parasites was significantly reduced yet the incidence of

general parasites was elevated. The significant increase may be due to inconsistent hygiene. In research conducted in Baghdad City, (Abd Al-Khaliq et al., 2021) examined the relationship between COVID-19 and intestinal parasitic infections. Ninety patients were screened between October 2020 and April 2021 for the trial, and all of them tested positive for COVID-19 by PCR. The study's findings demonstrated the mutual association that exists between COVID-19 infection and parasite infection. It underlined how crucial it is to comprehend how parasites and the gut microbiome interact, especially in light of how they affect COVID-19's pathogenicity.

In this research, the study was done with the results acquired from Near East University Hospital Northern Cyprus. A total of 5981 patients, there was a total of 2986 (49.9%) women and 2995 (51.1%) men. Of the total cases recorded, 3552(59.4%) were recorded during the pandemic and 2429(40.6%) were recorded pre-pandemic. But these do not show patient status yet. After the tests were conducted, a total of 326 (5.5%) patients tested positive for parasitic infections of the 326 patients, 165 (50.1%) were female and 161 (49.4%) were male. It was also observed that 175 (53.7%) cases of parasitic infections were recorded during the pandemic and 151(46.3%) occurred pre-pandemic. The predominant parasitic infections increase in female to male patients may be as a result of hygienic meal intake (Taha et al., 2013).

This translates to 5665 (95.5%) negative cases. The common parasitic infections were identified to be *Blastocystis hominis* with 268 (4.5%) cases, *Entamoeba histolytica* with 26(.4%) cases and *Giardia intestinalis* (29.5%) cases, these observed infection parasites are similar to the detected infection parasites in Bakarman et al., (2019) study on the significance of parasitic infection on school children. Patients were subjected to testing for various parasites, namely *Giardia intestinalis*, *Blastocystis hominis*, *Hymenolepis nana*, and *Taenia spp*., as these species commonly occur in the given region. Among these, Blastocystis hominis exhibited the highest prevalence in the TRNC, followed by Entamoeba histolytica, while Giardia intestinalis was recorded to display the lowest incidence rate when compared to the studies. These outcomes are in agreement with the studies by (Bakarman et al., 2019; Hawash et al., 2021b) Since intestinal parasite infections are mostly related to dietary and hydration hygiene and because a significant

number of these parasites are transmitted from animals to people, there is undoubtedly no age at which an individual is immune from contracting the infection (Hawash et al., 2021b). Constrictions were present in the current investigation. First off, it was challenging for us to compare our results with those of other studies because this is the first study that looks into parasite infections among people during the Corona pandemic. Second, we utilised the patient data that was available for analysis because the focus of our investigation was medical records.

Primary clinical symptoms and sociodemographic details, like the patient's home, education level, employment status, income, and how they dispose of drinking water and wastewater, are not recorded in their medical records.

Third, since our study was conducted in a hospital, it is not representative of the actual prevalence in the nation. We have concluded that there is much similarity in other studies in patients testing positive during a pandemic, the number of cases is always higher than that of patients who tested positive pre-pandemic.

CHAPTER VI

Conclusion and Recommendations

6.1 Summary and Conclusion

This research was conducted with the results acquired from Near East University Hospital Northern Cyprus. Upon analysis of the generated survey data using SPSS software results showed that, of 5981 patients, there was a total of 2986 (49.9%) women and 2995 (51.1%) men. Of the total cases recorded, 3552 (59.4%) were recorded during the pandemic and 2429 (40.6%) were recorded pre-pandemic, but these do not show patient status yet. After the tests were conducted, a total of 326 (5.5%) patients tested positive for parasitic infections of COVID-19. Out of the 326 patients, 165 (50.1%) were female and 161 (49.4%) were male. It was also observed that 175 (53.7%) cases of the parasitic infections were recorded during the pandemic and 151 (46.3%) occurred pre-Pandemic. This translates to 5665 (95.5%) negative cases. The common parasitic infections were identified to be *Blastocystis hominis* with 268(4.5%) cases, *Entamoeba histolytica* with 26(.4%) cases and *Giardia intestinalis* 29 (.5%) cases. Patients were also tested for *Gardia intestinalis* and *Blastocystis hominis*, *Hymenolepis nana* and *Taenia* spp. due to their frequency in the area.

Upon further examination of the data, the null hypotheses were formulated through the utilization of the One Binominal Sample Test. The outcome suggests a notable discrepancy in the number of individuals testing negative and positive (P. value < 0.05). Conversely, there does not appear to be a significant variance between male and female patients (P. value > 0.05). An additional discovery was made, indicating a significant contrast in the rate of parasitic infection between the pre-pandemic and pandemic periods (P. value < 0.05). Furthermore, it was observed that there is no significant distinction between male and female patients who tested positive (P. value < 0.05). Additionally, there is no impactive difference in the rate of parasitic infection between the pre-pandemic and pandemic periods (P. value > 0.05). However, there is a noteworthy dissimilarity in the types of pandemic and pre-pandemic parasitic infections contracted (P. value < 0.05).

6.2 Recommendations

According to the findings of this research, the following recommendations were made:

i. It is beyond reasonable doubt that the COVID-19 outbreak had debilitating consequences on humanity in terms of well-being and economy. This was mainly because its arrival was not anticipated and that the risk anticipated was grossly underestimated. To this end, countries must begin to proactively prepare for quicker response to future outbreaks.

ii. Pandemic outbreaks are global in nature; therefore, countries should be encouraged to engage in such studies as this and to share research finding for the good of all. Unrestricted access to universal data and research outcomes should be encouraged especially health system management.

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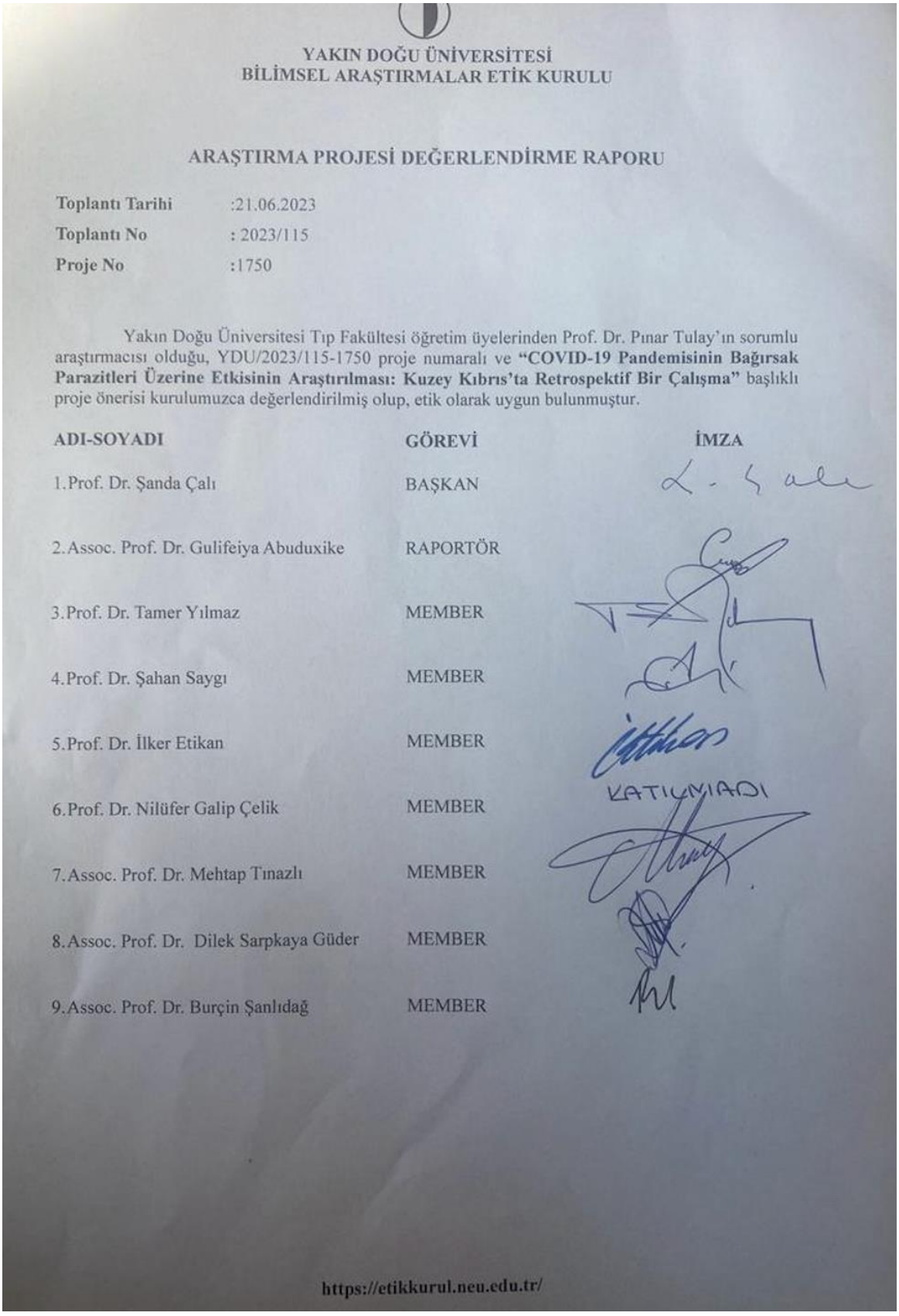
Appendix

Ethical Approval



YAKIN DOĞU ÜNİVERSİTESİ
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ARAŞTIRMA PROJESİ DEĞERLENDİRME RAPORU

Toplantı Tarihi :21.06.2023
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Yakın Doğu Üniversitesi Tıp Fakültesi öğretim üyelerinden Prof. Dr. Pınar Tulay'ın sorumlu araştırmacısı olduğu, YDU/2023/115-1750 proje numaralı ve **"COVID-19 Pandemisinin Bağırsak Parazitleri Üzerine Etkisinin Araştırılması: Kuzey Kıbrıs'ta Retrospektif Bir Çalışma"** başlıklı proje önerisi kurulumuzca değerlendirilmiş olup, etik olarak uygun bulunmuştur.

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