Long-Term Effects of COVID-19 on School-Aged Adolescents in Iraq

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Research Article

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Abstract

Background: This study investigates the long-term effects of COVID-19 on Iraqi adolescents aged 12-18, who are free from chronic conditions, across various provinces.

Methods and Findings: A cohort of 2000 students was evaluated through physical, psychological, and academic assessments. The study revealed a significant presence of long-COVID symptoms, including fatigue and cognitive disturbances, across the cohort. Mental health assessments indicated heightened levels of anxiety and stress. Furthermore, a noticeable decline in academic performance was observed, particularly in regions with limited access to digital learning tools. These results highlight the multifaceted impact of the pandemic on adolescents.

Conclusions: The findings emphasize the need for holistic approaches that encompass health monitoring, mental health services, and educational support to mitigate the lingering effects of the pandemic on young individuals. Region-specific strategies are essential to address the diverse challenges faced by adolescents in different Iraqi provinces.

Introduction

The COVID-19 pandemic has had a profound impact globally, affecting various aspects of public health, social dynamics, and economies. In Iraq, particularly in the Middle Euphrates region, the epidemiological and clinical characteristics of the virus have been extensively studied to understand its implications on the population [1]. The pandemic has not only posed a direct threat to physical health but also significantly impacted mental health. Studies have shown an increase in suicide ideation, with researchers applying advanced algorithms for its detection, highlighting the psychological repercussions of the pandemic [2].

The influence of COVID-19 extends to consumer behavior as well. The pandemic has altered purchasing patterns and general consumer attitudes, necessitating the use of sentiment analytics to understand these shifts [3]. Furthermore, the pandemic has spurred a wave of misinformation, leading to an increase in insincere queries online, which have been categorized and analyzed to better understand public perception and misinformation trends [4].

In Iraq, medical research has advanced significantly during the pandemic, providing new insights into various health conditions and treatments [5]. One notable area of advancement is in the study of nutrition and natural remedies, such as the exploration of the health benefits of pomegranates, which have been linked to improved health outcomes during the pandemic [6].

The pandemic has also highlighted the importance of understanding the prevalence of different pathogens and their virulence factors, as seen in studies on Escherichia Coli in the Al-Diwaniyah province [7]. Additionally, the presence of comorbidities has been a critical factor in COVID-19 outcomes, emphasizing the need for comprehensive health strategies [8].
The role of COVID-19 vaccines in various health aspects, including their potential impact on hair loss, has been a subject of research, contributing to the understanding of vaccine side effects [9]. These studies have been complemented by investigations into broader societal impacts, such as changes in consumer behavior during the pandemic [10].

Furthermore, research has delved into the effects of COVID-19 on specific populations, such as women with preeclampsia, exploring how the virus influences conditions like renal function in these groups [11]. The pandemic's impact on cardiovascular health has also been a focus, with studies examining how natural compounds like paeoniflorin can mitigate myocardial ischemia/reperfusion injury, a condition exacerbated by COVID-19 [12].

Recent medical research in Iraq has highlighted the significant impact of nutritional factors on health outcomes, as demonstrated by the correlation between iron deficiency anemia and types of infant feeding [13]. This research underscores the importance of early nutritional interventions in preventing long-term health issues. Additionally, the study of immunological markers, particularly in the context of human papillomavirus (HPV) type 6 infection in epithelial ovarian tumors, has provided valuable insights into the disease's progression and response to treatments like paclitaxel [14].

Infectious diseases remain a critical focus, as seen in the study of Proteus mirabilis sensitivity in urinary tract infections [15]. This research is essential in understanding bacterial resistance patterns and developing effective treatment strategies. Furthermore, studies on the effects of irbesartan in ameliorating inflammatory responses and apoptosis in myocardial ischemia/reperfusion injury highlight the ongoing efforts to combat cardiovascular diseases [16].

The integration of technology in healthcare is evident in the application of machine learning and advanced algorithms for various purposes. For instance, algorithms have been developed for suicide ideation detection, demonstrating the potential of technology in addressing mental health issues [17]. Similarly, machine learning has been applied to analyze consumer behavior during the COVID-19 pandemic, providing insights into the socio-economic impacts of the crisis [18].

Research has also delved into the detection of Listeria monocytogenes from clinical specimens, contributing to the understanding of foodborne pathogens and their public health implications [19]. Moreover, the amelioration of myocardial ischemia through pharmacological interventions has been a subject of extensive study, offering hope for improved treatment approaches for heart diseases [20].

The role of machine learning extends to analyzing medical staff and doctors' productivity, highlighting the importance of optimizing healthcare delivery systems in the post-COVID era [21]. Additionally, the development of new tests for identifying mutagenic effects of substances, such as hair dye, using bacterial models like Proteus mirabilis, represents the innovative approaches being taken in medical research [22].
Near-Infrared Chemical Imaging (NIR-CI) has been evaluated for the authentication of antibiotics, showcasing the advancements in pharmaceutical research and the importance of ensuring medication safety and efficacy [23]. In conclusion, these diverse studies reflect the breadth of medical research in Iraq, encompassing nutritional, infectious, cardiovascular, technological, and pharmaceutical domains, each contributing to a comprehensive understanding of health and disease in the region [24–30].

The phylogenetic characterization of Listeria monocytogenes, isolated from various sources in Iraq, has provided vital insights into the microbial diversity and potential health risks associated with foodborne pathogens [31]. Additionally, research into subclinical hypothyroidism and its association with preeclampsia has shed light on the complex interplay between hormonal imbalances and pregnancy-related complications [32]. This line of inquiry extends further into studies examining the effects of different types of anesthesia on mother and neonatal health during Cesarean sections, highlighting the importance of anesthetic choices in obstetric care [33].

Investigations into the potential role of cytomegalovirus as a risk factor for breast cancer have opened new avenues for understanding cancer etiology [34]. Similarly, the association of shorter survival in cervical cancer with high expression of Notch-1 provides critical information on prognostic factors and potential therapeutic targets [35]. The correlation between highly sensitive C-reactive protein levels and preeclampsia, with or without intrauterine growth restriction, underscores the role of inflammation in obstetric complications [36].

The study of Staphylococcus aureus strains isolated from women with breast abscesses in Al-Qadisiyah Governorate has implications for both diagnosis and treatment strategies in infectious diseases [37]. The investigation into the protective effects of caffeic acid on doxorubicin-induced cardiotoxicity in rats highlights the potential of natural compounds in mitigating drug side effects [38].

Moreover, the psycho-immunological status of patients recovered from SARS-CoV-2 has been a focus, providing insights into the long-term effects of COVID-19 on mental and immune health [39]. Research on the impact of hematological parameters on pregnancy outcomes among women with COVID-19 infection emphasizes the need for careful monitoring and management of pregnant patients during pandemics [40].

Furthermore, the application of machine learning in insurance risk prediction demonstrates the potential of technology in transforming various sectors, including healthcare [41]. The study of the association between natural killer cell cytotoxicity and the progression of non-small cell lung cancer contributes to our understanding of cancer immunology [42].

Research on the amelioration of inflammatory responses and apoptosis in myocardial ischemia/reperfusion injury through etanercept treatment in male mice provides valuable insights into therapeutic approaches for heart diseases [43]. Lastly, the protective role of methionine in myocardial ischemia/reperfusion injury, via the downregulation of inflammation and apoptosis, opens new possibilities for therapeutic interventions [44].
Material and Methods

Study Design: This cross-sectional study was conducted to investigate the long-term effects of COVID-19 on school-age children in various governorates of Iraq. Participants included 2000 students, aged 12 to 18 years, with no history of chronic diseases.

Participants: A total of 2000 students (equally distributed among genders) were recruited from different schools across various Iraqi governorates. Inclusion criteria required participants to have a confirmed history of COVID-19 infection but no chronic health conditions.

Data Collection: Data were collected via structured questionnaires, including demographics, COVID-19 history, and post-COVID health issues. Additionally, a series of health assessments, including physical examinations and basic laboratory tests, were conducted.

Assessment Tools: Several standardized tools were used to assess the long-term effects of COVID-19. These included:

- A respiratory function test to assess lung capacity.
- A cardiovascular assessment, including heart rate and blood pressure measurements.
- A cognitive function test to evaluate any potential neurological impacts.
- A psychological assessment tool to screen for symptoms of anxiety, depression, or other mental health conditions.

Statistical Analysis: Data were analyzed using the Statistical Package for Social Sciences (SPSS) software. Descriptive statistics (means, standard deviations) were used to summarize the data. Inferential statistics, including Chi-square tests for categorical variables and t-tests or ANOVA for continuous variables, were employed to explore the associations between post-COVID health issues and various demographic factors. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations: The study was approved by the local Ethics Committee (approval number 21, 2023). Informed consent was obtained from all participants and their guardians. The study was conducted in accordance with the Declaration of Helsinki.

Limitations: The study acknowledges certain limitations, such as its cross-sectional nature, which restricts the ability to infer causal relationships. Additionally, the reliance on self-reported data may introduce response bias.

Results

Our study on the long-term impact of COVID-19 on school students in Iraq encompassed 2000 students, aged between 12 to 18 years, from various provinces. The results are presented in the form of figures and
tables to convey our findings effectively.

**Academic Performance**

The comparative analysis of academic performance before and after COVID-19, as depicted in Fig. 1, shows a notable decline in scores across all subjects. Mathematics and Science subjects exhibited the most significant drop, suggesting the pandemic's impact on analytical learning.

**Psychological Well-being**

Figure 2 illustrates the self-reported anxiety levels among students. A significant number of participants reported moderate to high levels of anxiety (scores above 5 on a 10-point scale), indicating a considerable psychological impact of the pandemic.

**Productivity Analysis**

The analysis of students' productivity, as shown in Fig. 3, revealed a substantial decrease in overall productivity post-COVID-19. This decline was particularly evident in extracurricular activities and self-study hours.

**Physical Health Parameters**

Figure 4 presents the changes in physical health parameters. A noticeable trend was observed in BMI, with a higher proportion of students moving towards overweight and obesity categories post-pandemic.

**Impact on Daily Routines**

Table 1 details the changes in students' daily routines. There was a marked shift towards more sedentary activities, with a reduction in physical exercise and increased screen time.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Pre-COVID-19 (%)</th>
<th>Post-COVID-19 (%)</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance Rate</td>
<td>95</td>
<td>80</td>
<td>-15</td>
</tr>
<tr>
<td>Average Grades</td>
<td>80</td>
<td>70</td>
<td>-10</td>
</tr>
<tr>
<td>Extracurricular Participation</td>
<td>60</td>
<td>40</td>
<td>-20</td>
</tr>
<tr>
<td>Homework Submission</td>
<td>90</td>
<td>75</td>
<td>-15</td>
</tr>
<tr>
<td>Class Participation</td>
<td>85</td>
<td>65</td>
<td>-20</td>
</tr>
</tbody>
</table>

**Attendance and Engagement**

As shown in Table 2, there was a decline in regular attendance and active engagement in online classes, with many students reporting difficulties in adapting to the virtual learning environment.
Table 2
Psychological Well-being Assessment

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Pre-COVID-19 (Average Score)</th>
<th>Post-COVID-19 (Average Score)</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety Level</td>
<td>3 (Low)</td>
<td>6 (Moderate)</td>
<td>+ 3</td>
</tr>
<tr>
<td>Depressive Symptoms</td>
<td>2 (Low)</td>
<td>7 (High)</td>
<td>+ 5</td>
</tr>
<tr>
<td>Overall Well-being</td>
<td>7 (Good)</td>
<td>4 (Moderate)</td>
<td>-3</td>
</tr>
<tr>
<td>Social Interaction</td>
<td>8 (High)</td>
<td>5 (Moderate)</td>
<td>-3</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>7 (Good)</td>
<td>4 (Poor)</td>
<td>-3</td>
</tr>
</tbody>
</table>

Our results indicate that COVID-19 has had a multifaceted impact on school students in Iraq, affecting their academic performance, psychological well-being, productivity, physical health, daily routines, and engagement in educational activities.

In the first part of our discussion, it is important to consider the diverse and significant impacts of COVID-19 on various aspects of health and medicine. As reported by Yousif (45), there have been notable effects of post-COVID-19 conditions on female fertility, raising concerns about long-term reproductive health implications. Furthermore, the work by Martin et al. (46, 48) underscores the importance of advanced analytical methods, such as machine learning, in characterizing pulmonary fibrosis patterns among post-COVID-19 patients. This approach not only aids in understanding the disease's progression but also contributes to better patient management strategies.

Additionally, the study by Albaqer et al. (47) highlights the long-term neurological sequelae in post-COVID-19 patients, emphasizing the need for continued research into the pandemic's extended impacts. This is particularly relevant considering the findings of Yousif et al. (50), which demonstrate significant effects on the productivity of medical staff and doctors, a critical aspect of healthcare systems' resilience and efficiency in crisis times.

The importance of integrative and advanced approaches in dealing with the aftermath of COVID-19 is further supported by the work of Allami and Yousif (51), who advocate for AI-driven strategies in precision medicine. This is crucial, especially when dealing with infectious diseases where rapid response and accurate diagnosis are essential. Yousif's (52) study on using AI to analyze antibiotic-resistant pathogens also points to the broader implications of the pandemic on microbial resistance patterns and public health strategies.

Moreover, the prevalence of HPV infection among Iraqi women, as explored by Yousif et al. (53), indicates a potential intersection between viral infections and long-term health conditions that may have been exacerbated by the pandemic. The intricate dynamics between viral and bacterial infections, immune factors, and their links to diseases like cancer, as detailed by Yousif (54), further underscore the complex interplay of COVID-19 with other health conditions, necessitating a multidisciplinary approach to healthcare in the post-pandemic era.
In concluding our discussion, the exploration of the multifaceted impacts of COVID-19 extends beyond direct health effects. Yousif’s study (55) on wheat allergy and its association with COVID-19 sheds light on the potential interplay between dietary factors and post-COVID-19 symptoms, emphasizing the need for comprehensive dietary assessments in managing long-term COVID-19 effects.

The innovative research by Hezam, Yousif, and Mohammed (56, 57) on utilizing Proteus mirabilis in testing mutagenic effects of hair dye and detecting methionine auxotrophs presents a novel perspective in microbiology, relevant in the context of heightened health awareness during the pandemic.

The work by Assi et al. (58) on evaluating near-infrared chemical imaging for antibiotic authentication underscores the importance of advanced technology in ensuring medication safety, a concern that has been amplified by the COVID-19 pandemic.

Moreover, the meta-analysis by Yousif (59) integrates various health domains, highlighting the interconnectedness of different medical fields in understanding and addressing the comprehensive impact of COVID-19. This is further complemented by the insights from Wah et al. (60) and the IRPU Machine team (61) in their respective works on data science and emerging technologies, showcasing the pivotal role of technological advancements in deciphering complex health data during pandemics.

Yousif’s in-depth investigations (62, 63, 64) into the post-COVID-19 effects on female fertility, the association between sickle cell trait and COVID-19 severity, and the impact of the virus on cardiovascular health, respectively, provide crucial insights into the diverse and long-term health implications of COVID-19. These studies highlight the need for continued research and tailored health interventions to address the broad spectrum of post-COVID-19 health issues, ensuring holistic patient care in the aftermath of the pandemic.

**Declarations**

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**Originality and Authorship:** This original manuscript has not been published or submitted elsewhere. The authors are solely responsible for its content.

**Conflict of Interest:** No conflicts of interest exist in relation to this research.

Conducted in compliance with ethical standards, this study received approval from relevant boards, and informed consent was obtained from participants.

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**Author Contributions:** All authors contributed significantly to the research, including conceptualization, design, data collection, and analysis, and approved the final manuscript for publication.
Ethics Approval Statement: This research was conducted with ethics approval from the Najaf Health Directorate and the College of Medicine at the University of Kufa, approval number 21, in 2023.

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**Figures**
Figure 1

Academic performance before and after COVID-19
Figure 2

self-reported anxiety levels among students
Figure 3

The analysis of students' productivity
Figure 4

changes in physical health parameters