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DS 395

Project II

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Analyzing Trends: The Impact of Long COVID on Various Bodily Systems

1. **Introduction**

The COVID-19 pandemic dramatically affected the lives of billions of people around the globe. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a strain of coronavirus that causes acute respiratory illness (Akbarialiabad, H, et al.). The virus is of zoonotic origin, and epidemiologists estimate that a spillover event introduced SARS-CoV-2 to humans in late 2019 (V'kovski 2021). Human to human transmission of SARS-CoV-19 was confirmed on the 20th of January in 2020. Since then, there have been over one hundred million reported cases and 1.1 million deaths due to COVID-19 in the US alone (16). In addition to upper respiratory symptoms, COVID-19 infection has also been associated with a post-acute phase with lingering and late heterogeneous symptoms and events. The World Health Organization (WHO) acknowledges that patients with COVID-19 may continue to experience fatigue, cardiovascular, respiratory, and neurological symptoms, but our analysis found that there are a number of additional bodily symptoms impacted from the infection (15). Our analysis found that approximately one third of COVID-19 cases experienced persistent symptoms lasting several months after the resolution of the acute phase.

**Epidemiology**

Long COVID is generally recognized as the presence of one or more symptoms described as “unprecedented deterioration of the individual psycho-physical status,” and is diagnosed at least 12 weeks or 3 months after the onset of COVID-19 infection (di Toro, et al.). Although the mechanism and causes of Long COVID are not completely understood, the burden has led to the opening of Long COVID outpatient clinics in all countries affected by the pandemic, and thousands of longitudinal research studies on the causes and consequences of the virus. Our literature review evaluated eighteen pieces of literature available on Long-COVID to generate an understanding of the physiological impairments associated with COVID-19 infection, as well as the broader socio-structural and public health implications of a 21st century global pandemic.

1. **Methodology**

**Research Question**

What are the physiological, socio-economic, and health-related quality of life impacts of Long COVID, including its prevalence, burden, and implications on daily life?

**Inclusion Criteria**

* Those related to Long Covid or Long Haul Covid, with defining Long Covid/Long Haul Covid as the presence of one or more symptoms diagnosed at least 12 weeks or 3 months post COVID-19 infection
* Those related to symptoms, side-effects, complications/impairments of Long Covid in those over 18 years of age
* Types of reports included: Systematic reviews, comprehensive literature reviews, and original research studies
* All articles should have been published in a peer-reviewed journal

**Exclusion Criteria**

* Those irrelevant to Long Covid
* Those that included children in their studies
* Studies only looking at those who had been discharged from a hospital post infection
* Unavailable/redacted texts
* Reviews or non peer-reviewed studies

From our search, we identified 35 potential publications (Fig. 1). The publications were screened for relevance of the title and abstract, resulting in the exclusion of two. Then, the 33 publications were reviewed for full-text eligibility and being peer-reviewed and two were excluded. Finally, we screened the remaining full-text, peer-reviewed articles for eligibility and 14 were excluded based on exclusion criteria. Therefore, we were left with 17 papers for our review.

Identification

**35** identified by database search

Screening

**33** studies focused on symptoms/side effects of Long COVID

Eligibility

**31** assessed for eligibility

**1** not peer reviewed

**1** redacted

Inclusion

**17** Included in review

**Excluded**

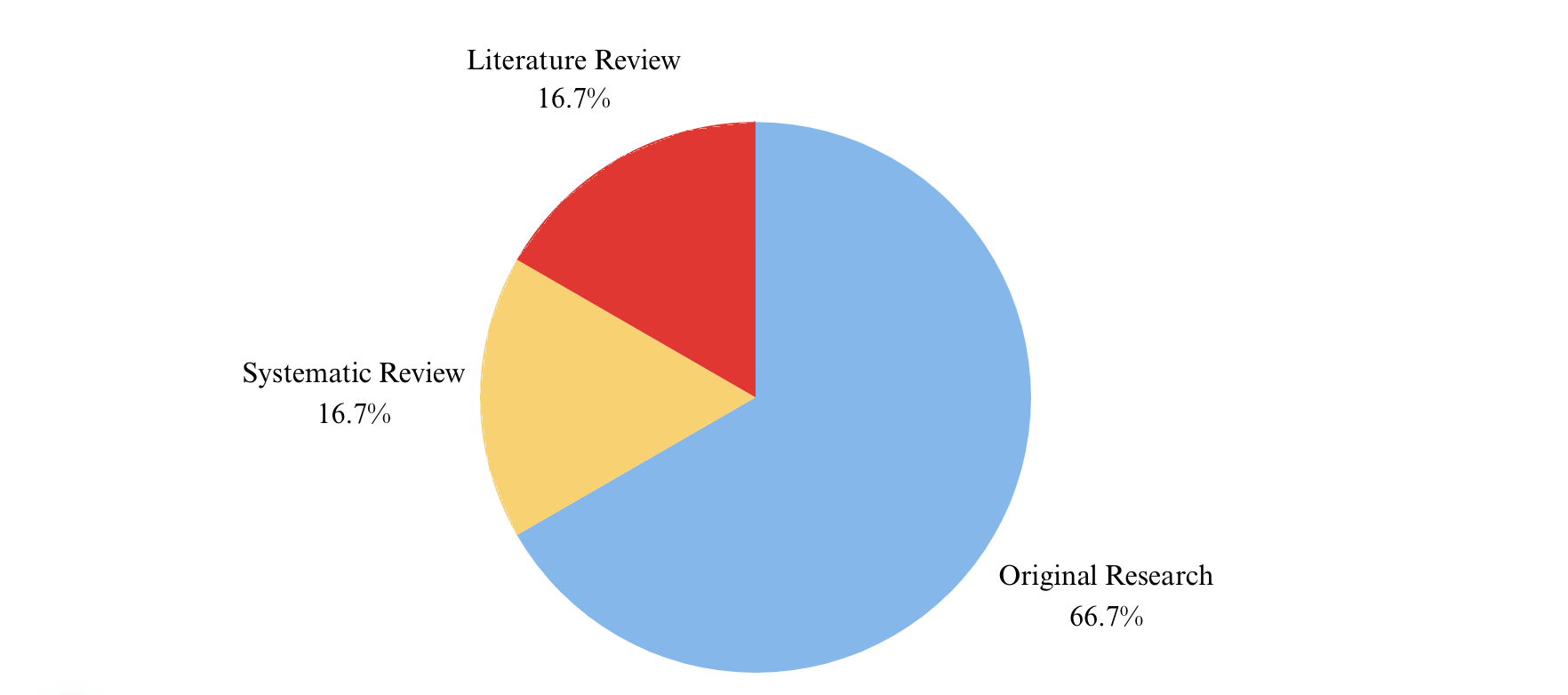
**5** for not meeting Long COVID definition

**2** for children being the subject of study

**7** for only looking at those discharged from a hospital post infection

*Figure 1 Literature Selection Process*

The distribution of publications based on type is shown in Figure 2 (of the 17 selected)

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*Figure 2. Distribution of included papers based on publication type.*

**Search Strategy**

First, a preliminary search was done on databases such as Google Scholar and PubMed to identify appropriate keywords. Next, we searched the databases for papers with the keywords and added them to a shared list. Titles and abstracts of the papers were then checked and irrelevant studies were removed based on exclusion criteria. The following keywords were used in the search: “Long Covid” or “Long Covid Symptoms” or “Long Covid Side Effects” or “Long Covid Health Impacts”.

|  |  |  |
| --- | --- | --- |
| **Database** | **Search Strategy** | **Keywords** |
| PubMed | Title and abstract | “Long Covid” or “Long Covid Symptoms” or “Long Covid Side Effects” or “Long Covid Health Impacts” |
| Google Scholar | Title and abstract | “Long Covid” or “Long Covid Symptoms” or “Long Covid Side Effects” or “Long Covid Health Impacts”. |

*Table 1 Keywords and search strategy*

**Data Extraction and Synthesis**

The following were extracted from included papers: first author of the study, number of participants, type of study, investigative strategy/diagnostic technique (questionnaire, interview, examine, ect.), time of assessment (how long post COVID-19 infection), and symptoms.

1. **Results:**
2. ***Multisystem Effects:***

While much research has focused on the acute phase of infection, public health officials and providers' concern has been shifted towards the long-term effects of the COVID-19 virus. Long COVID is a condition characterized by persistent symptoms that encompass a wide range of organ systems, inflicting harm beyond the respiratory system. Though the literature encompassed a wide range of multisystemic effects, our research found that Long COVID impacts the thrombotic, cardiovascular, respiratory, neurological, olfactory, orthostatic systems, in addition to psychiatric symptomatology that manifest across all bodily systems and overall wellness. Beyond bodily systems, Long COVID has placed strain on clinical and public health professionals, global and national economies, and activities of daily life.

Diagnosing and managing Long COVID poses significant challenges, given the lack of specific biomarkers and baseline imaging and screening for many patients. Additionally, the vagueness and variability of symptoms adds strain between providers and patients in the articulation and implementation of a treatment management plan.

1. ***Persistent Symptoms***

The diagnostic criteria for Long COVID specifies the condition is characterized by the presence of symptoms 12 weeks or 3 months post-acute COVID-19 infection. There is little known regarding the expected duration of these symptoms or the existence of chronic Long COVID. Multiple studies have confirmed the persistence of heterogeneous symptoms for up to one year following acute infection, with only 22.9% of patients being symptom free (Di Toro 2021). Among the seventeen selected pieces of literature, three contained information on the persistent symptoms of Long COVID.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Study Author** | **Study Type** | **Number of Participants\*** | **Time of Assessment** | **Investigative Strategy/**  **Diagnostic Technique\*** | **Most Commonly Reported Symptom** |
| Dennis et al. (2023) | ​​Prospective cohort study | 331 adults | 6 and 12 months post COVID-19 Infection | Multi-organ MRI and symptom report | 6 Months  Extreme breathlessness (38%) cognitive dysfunction (48%)  Poor health-related quality of life (57%)  Single-organ Impairment (69%)  Multi-organ impairment (23%)  12 Months  Extreme breathlessness (30%)  Cognitive dysfunction (38%)  Poor health-related quality of life (45%)  Single-organ Impairment (59%)  Multi-organ impairment (27%) |
| Holdsworth et al. (2022) | Comprehensive clinical assessment | 205 adults | 24 weeks post COVID-19 infection | Comprehensive clinical assessment (symptoms, WHO performance status, cognitive testing, CPET, lung function, high-resolution CT chest, CT pulmonary angiogram and cardiac  MRI) | Persistent symptoms (69%)  Shortness of breath (61%)  Fatigue (54%)  Cognitive Problems (47%) |
| Roca-Fernandez, et al. | Prospective longitudinal study | 6 months:  534 adults  12 months: 330 adults | 6 and 12 months post COVID-19 Infection | CMR (cardiac magnetic resonance imaging), multi-organ MRI, questionnaires, and blood samples | 6 Months  Cardiac impairment (19%)  12 months  58% presented with ongoing cardiac impairment at 12 months. |

*Table 2 Publications involving persistent symptoms*

\*if applicable

Common symptoms at 6 and 12 months included extreme breathlessness, cognitive dysfunction, ongoing cardiac impairments and poor health-related quality of life

1. ***Olfactory Effects:***

Among the seventeen selected pieces of literature, two contained information on the olfactory effects of Long COVID.

*Table 3 Publications involving olfactory effects*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Study Author** | **Study Type** | **Number of Participants\*** | **Time of Assessment** | **Investigative Strategy/**  **Diagnostic Technique\*** | **Most Commonly Reported Symptom** |
| Akbarialiabad H, et al. | Systematic Review | 120 studies reviewed ranging from 1 to 16, 234, 2113 adult participants | 12 weeks post infection | Literature search using electronic databases such as Cochrane Library, PsycINFO, Pub-  Med, Embase, Scopus, and the Web of Sciences | Loss of smell and taste sen-  sations (anosmia and ageusia) |
| Boscolo-Rizzo P, et al | Original Research | 183 adults subjects | 6 months post diagnosis | Olfactory testing, questionnaires | 18.0% reported long-lasting altered sense of taste and smell  60% of participants exhibited some smell dysfunction after psychophysical evaluation |

\*if applicable

Common symptoms include loss/alterations of taste and smell.

1. ***Neurological Effects:***

Among the seventeen selected pieces of literature, eight contained information regarding the neurological impairments of Long COVID. Among these original studies and systematic reviews, the most frequent symptom reported was cognitive impairment and fatigue.

*Table 4 Publications involving neurological effects*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Study Author** | **Study Type** | **Number of Participants\*** | **Time of Assessment** | **Investigative Strategy/**  **Diagnostic Technique\*** | **Most Commonly Reported Symptom** |
| Akbarialiabad H, et al. | Systematic Review | 120 studies reviewed ranging from 1 to 16, 234, 2113 adult participants | 12 weeks post infection | Literature search using electronic databases such as Cochrane Library, PsycINFO, Pub-  Med, Embase, Scopus, and the Web of Sciences | Headache, vertigo, “Brain fog”, and loss of smell and taste sen-  sations (anosmia and ageusia) |
| Boesl et al. | Original Research | 100 patients presented to PCS Neurology Outpatient Clinic at Department of Neurology, Charité – Universitätsmedizin Berlin | 12 weeks or more post infection | Self-questionnaire focusing on daytime sleepiness, mood, fatigue, and screening assessment for cognitive impairment. | Cognitive impairment (72%), Fatigue (67%) |
| Hampshire, et al. | Original research - observational study | 112,964 adults | >12 weeks with persistent symptoms following COVID-19 infection | Online assessment of cognitive function, scored across eight tasks | Cognitive deficits in working memory, reasoning, executive functioning and planning. |
| Holdsworth, et al. | Original research | 205 adults | 24 weeks post COVID-19 infection | Comprehensive clinical assessment (symptoms, WHO performance status, cognitive testing, CPET, lung function, high-resolution CT chest, CT pulmonary angiogram and cardiac  MRI) | Fatigue (54%), cognitive impairment (47%) |
| Meyer, et al. | Systematic Review | 116 participants across seven studies, ranging from ages 10-80 years old | At least 3 months from symptom onset | MEDLINE literature search to identify peer-reviewed original studies and case series  or case reports using PET or SPECT to investigate central nervous  system (CNS) manifestations of COVID-19. | Disturbance in smell/taste function (60-80%), myalgia (40%), encephalopathies (15-30%), fatigue (61%), cognitive fatigue (67%). |
| Okalander A, et al. | Original Research Study | 17 adults with Long Covid | At least 3 months post infection | Surveys and neuropathy examinations | 62.5% of lower leg skin biopsies pathologically conﬁrmed SFN (small fiber neuropathy) |
| Vernon S, et al. | Original Research Study | 88 adults ranging from 18-65; 42 with Long Covid, 26 with ME/CFS, and 20 healthy controls | >3 months with persistent symptoms following COVID-19 infection | Interview questions, NASA Lean test, symptom assessment, hemodynamic measurements, and cognitive testing | Overall decrease in cognitive efficiency in those with Long Covid |
| Zawilska and Kuczyńska | Systematic Review aiming to compile the psychiatric and neurologic manifestations of Long COVID | 823,470 across 31 studies | At least 3 months post infection | Varied across studies, including but not limited to: neurological assessments, self-questionnaires, interviews, mental health examinations, DSM-5 PTSD subscale, EST-Q2 Anxiety and Depression subscales. | Headache, fatigue, sleep disturbances, “brain fog”/cognitive deficit, anxiety, depression. |

\*if applicable

The most common symptoms found across the studies include brain fog, fatigue, and cognitive impairments/deficits.

1. ***Orthostatic Effects***

Among the seventeen selected pieces of literature, one contained information regarding the orthostatic effects of Long COVID.

*Table 5 Publications involving orthostatic effects*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Study Author** | **Study Type** | **Number of Participants\*** | **Time of Assessment** | **Investigative Strategy/**  **Diagnostic Technique\*** | **Most Commonly Reported Symptom** |
| Vernon S, et al. | Original Research Study | 88 adults ranging from 18-65; 42 with Long COVID, 26 with ME/CFS, and 20 healthy controls | >3 months with persistent symptoms following COVID-19 infection | Interview questions, NASA Lean test, symptom assessment, hemodynamic measurements, and cognitive testing | Increased diastolic BP and abnormally narrowed BP ratio in those with Long COVID |

\*if applicable

Common symptoms include increased diastolic blood pressure and abnormally narrowed blood pressure ratio.

1. ***Respiratory Effects***

Among the seventeen selected pieces of literature, four contained information regarding the respiratory effects of Long COVID.

*Table 6 Publications involving orthostatic effects*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Study Author** | **Study Type** | **Number of Participants\*** | **Time of Assessment** | **Investigative Strategy/**  **Diagnostic Technique\*** | **Most Commonly Reported Symptom** |
| Akbarialiabad H, et al. | Systematic Review | 120 studies reviewed ranging from 1 to 16, 234, 2113 adult participants | 12 weeks post infection | Literature search using electronic databases such as Cochrane Library, PsycINFO, Pub-  Med, Embase, Scopus, and the Web of Sciences | DLCO impairment, lung abnormalities, abnormal pulmonary function, and respiratory symptoms including  post-activity polypnea, etc. |
| Giurgi-Oncu C, et al. | Original Research | 143; 64 inpatient, 79 outpatients adults all under the age of 55 | 12 weeks post COVID-19 infection | Clinical examination, thorax computer tomography (TCT), daily O2 assessment, blood analysis | Inpatient: 10% to 37% had pulmonary injury  Outpatient: 37.97% had pulmonary injury |
| Yu J, et al | Prospective Cross-Sectional Study | 51 participants | 4-13 months after onset of disease | MRI, walking test, and self assessment of symptoms | Evidence of lung perfusion in those post-COVID |
| Zhao Y, et al. | Original Research | 55 adults | 3 months post COVID-19 infection | Clinical examination, chest CT scan, pulmonary function test, SARS-CoV-Ig2 test | The rate of radiological abnormalities was 74.55%  Lung function abnormalities rate was 25.45%  DLCO (Diffusion capacity of the lungs for carbon monoxide) detected in 16.36% and was the most common symptom reported day of discharge |

\*if applicable

Common symptoms include DLCO (diffusion capacity of the lungs) impairment and abnormalities in the lungs, lung function, and lung injury.

1. ***Cardiovascular Effects***

Among the seventeen selected pieces of literature, six contained information regarding the cardiovascular effects of Long COVID.

*Table 7 Publications involving cardiovascular effects*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Study Author** | **Study Type** | **Number of Participants\*** | **Time of Assessment** | **Investigative Strategy/**  **Diagnostic Technique\*** | **Most Commonly Reported Symptom** |
| Akbarialiabad H, et al. | Systematic Review | 120 studies reviewed ranging from 1 to 16, 234, 2113 adult participants | 12 weeks post infection | Literature search using electronic databases such as Cochrane Library, PsycINFO, Pub-  Med, Embase, Scopus, and the Web of Sciences | Myocardial inflammation, increased resting heart rate, subclinical myocarditis, and palpitations |
| Campen C, Visser F | Original Research | 29 adults | 3-28 months post onset of COVID-19 symptoms | Tilt-table test to measure cerebral blood flow, interview questions about orthostatic intolerance complaints | 71% of patients showed POTS in the first 12 months and none after 24 months |
| Di Toro A, et al. | Systematic Review | N/A | 12 weeks post infection | N/S | Palpitations, chest pain, POTS, thrombotic manifestations, arrhythmias, and cardiometabolic conditions |
| Giurgi-Oncu C, et al. | Original Research | 143; 64 inpatient, 79 outpatients adults all under the age of 55 | 12 weeks post COVID-19 infection | Personal medical history, clinical examination, electrocardiogram, and transthoracic echocardiogram | Inpatient: 28.12% had diastolic dysfunction and 34.37% had a reduced FAC (fractional area change)  Outpatient: 20.25% had diastolic dysfunction and 36.43% had a reduced FAC |
| Roca-Fernandez A, et al. | Original longitudinal study | 6 months: 534 adults  12 months: 330 adults | 6 months post-infection  12 months if abnormal findings were reported at baseline | CMR (cardiac magnetic resonance imaging), multi-organ MRI, questionnaires, and blood samples | 6 months: 19% cardiac impairment  12 months: 58% ongoing cardiac impairment |
| Xie Y, et al. | Original Research | 153,760 people with COVID-19, 5,637,647  contemporary controls and 5,859,411 historical controls | 12 months post COVID-19 infection | Use of electronic healthcare databases | Those with COVID have increased risk and burdens of cardiovascular disease such as cerebrovascular disorders,  dysrhythmias, inflammatory heart disease, ischemic heart disease,  heart failure, thromboembolic disease and other cardiac disorders. |

\*if applicable

The most common symptoms from all publications include POTS, palpitations, ongoing cardiac impairment, and other cardiac disorders/conditions. .

1. ***Mental Health Effects***

Among the seventeen selected pieces of literature, three contained information regarding the mental health effects of Long COVID. The most common symptoms include depression and anxiety.

*Table 8 Publications involving mental health effects*

\*if applicable

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Study Author** | **Study Type** | **Number of Participants\*** | **Time of Assessment** | **Investigative Strategy/**  **Diagnostic Technique\*** | **Most Commonly Reported Symptom** |
| Akbarialiabad H, et al. | Systematic Review | 120 studies reviewed ranging from 1 to 16, 234, 2113 adult participants | 12 weeks post infection | Literature search using electronic databases such as Cochrane Library, PsycINFO, Pub-  Med, Embase, Scopus, and the Web of Sciences | Major mood swings, depression, the  feeling of loneliness and isolation, high levels of stress and  anxiety, and sleep–wake disorders |
| Giurgi-Oncu C, et al. | Original Research | 143; 64 inpatient, 79 outpatients adults all under the age of 55 | 12 weeks post COVID-19 infection | EQ-5D-5L QoL and HADS questionnaire | Inpatient: 46.87% had presence of depression, and 34.37% associated anxiety  Inpatient: 27.84% had presence of depression and 32.91% associated anxiety |
| Zawilska and Kuczyńska | Systematic Review aiming to compile the psychiatric and neurologic manifestations of Long COVID | 823,470 across 31 studies | 12 or more weeks post COVID-19 infection | Varied across studies, including but not limited to: neurological assessments, self-questionnaires, interviews, mental health examinations, DSM-5 PTSD subscale, EST-Q2 Anxiety and Depression subscales. | Anxiety and depression. |

1. **Discussion**

**Thrombotic and Cardiovascular Effects**

Numerous thrombotic and cardiovascular symptoms, such as palpitations, subclinical myocarditis, elevated resting heart rate, myocardial inflammation, and thrombotic events, are present in long-term COVID. A significant percentage of patients experienced a variety of cardiac abnormalities that persisted up to 12 months after infection, according to studies by Akbarialiabad et al. (2023) and Xie et al. (2022). These results highlight the necessity of continuous monitoring and specialist cardiac care for patients with long-term COVID.

**Respiratory Implications**

According to Akbarialiabad et al. (2023) and Zhao et al. (2022), the respiratory effects of long COVID include lung abnormalities, chronic respiratory symptoms, and impairment of DLCO. The long-term effects of infection on respiratory health are clearly shown by the frequency of radiological abnormalities and decreased lung function. This illustrates that patients with Long COVID may benefit from specialized respiratory rehabilitation programs and continuous monitoring of their lung function.

**Neurological and Olfactory Dysfunction**

According to research by Boesl et al. (2022) and Akbarialiabad et al. (2023), headache, vertigo, "brain fog," and loss of taste and smell are common neurological symptoms in long-term COVID-19 patients. Similarly, a considerable percentage of people continue to experience olfactory impairment post infection. Examples include anosmia and ageusia. (Akbarialiabad et al., 2023; Boscolo-Rizzo et al., 2022). These findings emphasize the significance of specific olfactory examinations and cognitive rehabilitation therapies in the long-term management of Long COVID.

**Orthostatic Challenges**

Vernon et al. (2022) notes that orthostatic intolerance—which can be observed by elevated diastolic blood pressure and aberrant blood pressure ratios—is an abnormality that Long COVID patients frequently exhibit. This implies that autonomic dysregulation has a major role in the symptomatology of long-term COVID-19, requiring specialized therapies such tilt-table tests and hemodynamic evaluations.

**Psychiatric Symptomatology**

Numerous mental health issues, such as mood fluctuations, despair, anxiety, loneliness, and stress are linked to long-term COVID-19 infection (Akbarialiabad et al., 2023; Giurgi-Oncu et al., 2022; Zawilska and Kuczyńska, 2022). Given the abnormally high frequency of these symptoms, early intervention techniques and mental health support services for viruses like long-term COVID-19 care are crucial in improving daily domestic and global life.

**Management and Treatment**

Managing and treating Long COVID presents significant challenges and risks due to the varied nature of its symptoms. Given the unprecedented nature of the disease, expert scientists found difficulty in identifying specific COVID biomarkers, especially due to the lack of diagnostic technology during the pandemic. According to Xie’s original research, there were at least forty symptoms to account for, in clearly many different areas (as listed above). A key issue with managing and treating Long COVID is the extensive list of symptoms that come with the condition. Examples include fatigue, chest pain, and headaches. Many treatments are necessary. Thus, current management strategies mostly involve providing relief from symptoms and care, as opposed to addressing the larger overlying problem: one central cure. The lack of a universally accepted antidote begs more research to determine the effective strategies and therapies for Long COVID.

**Global Impact**

Global public health and economies are greatly impacted by Long COVID, which has a profound effect that goes beyond personal health. The demand for specialized care and continuous monitoring of Long COVID patients has resulted in a significant burden on healthcare systems. Allocating resources has proven to be a major challenge, with regard to both personnel and healthcare infrastructure.

Particularly during the pandemic, the workload for healthcare professionals increased. They made an effort to give patients with Long COVID comprehensive care. The creation of Long COVID outpatient clinics has been an essential step in offering specialized treatment to patients with chronic symptoms. Nonetheless, these clinics' scalability and sustainability continue to be crucial factors for global healthcare systems.

**Socio-economic Impact**

The public health effects of post-acute COVID are extensive and impact on societal functioning, healthcare resource allocation, and quality of life, especially and sadly in America. As Dennis et al. (2023) and Holdsworth et al. (2022) have argued, continued symptoms in many organs underscores the need for long-term healthcare planning processes. Furthermore, the connection between Long COVID and psychological conditions, like "stress, anxiety, or depression" (Akbarialiabad et al., 2023; Giurgi-Oncu et al., 2022) stresses the importance of integrated mental health care within the context of public health. To minimize long-term societal costs and to encourage a holistic recovery approach for patients with long-term COVID-19, there is a need for an approach that cares for the social-psychological-physical interactions. It is a challenging and expensive decision, but as Americans, scientists, students, businesspeople, and even friends & family, we're obligated to do so. Furthermore, the mental health toll of Long COVID cannot be understated. Many individuals report feelings of anxiety, depression, and isolation as they navigate the uncertainty and ongoing challenges associated with their condition. The need for comprehensive mental health support for Long COVID patients is clear, highlighting the importance of integrated care approaches that address both physical and psychological well-being.

1. **Conclusion**

**Public Health Implications**

Long COVID has significant effects on public health, influencing society. As healthcare resource allocation changes, so do people's quality of life. As noted by Dennis et al. (2023) and Holdsworth et al. (2022), the horrifying chronic impact of symptoms across multiple organ systems emphasizes the necessity of focused public health interventions and long-term healthcare planning. Moreover, the correlation between Long COVID and psychiatric symptoms such as stress, anxiety, and depression (Akbarialiabad et al., 2023; Giurgi-Oncu et al., 2022) highlights the significance of integrated mental health services in public health frameworks. A multidisciplinary strategy that takes into account the interactions between social, psychological, and physical aspects is needed to address long-term COVID-19 in order to minimize long-term societal costs and promote holistic recovery.

**Limitations of Existing Research**

Despite significant advances in understanding Long COVID, several limitations exist within the current body of literature. Firstly, the diversity of study designs, assessment tools, and participant cohorts complicates data interpretation and limits conclusions that can be taken away from these studies. Additionally, many studies have relatively small sample sizes. This limits our ability to analyze Long COVID observations over time, like longitudinal data. Furthermore, the lack of standardized diagnostic criteria and biomarkers hinders accurate diagnosis and characterization of Long COVID. Finally, potential biases, such as selection, recall, and even confirmation bias, may influence reported outcomes, as most experiments experience. This again highlights the need for rigorous study methodologies in future research.

**Future Directions**

Future research should address the aforementioned limitations and focus on several key areas to advance our understanding of Long COVID. Firstly, longitudinal studies and data with large, diverse cohorts are crucial to determine long-term outcomes of Long COVID. Additionally, larger regulatory organizations like the World Health Organization should encourage interdisciplinary collaborations between clinicians, researchers, and public health experts. Perhaps our government could get involved in mandating these efforts, both domestically and globally. We believe it is essential that the WHO broadens their COVID relief team to protect individuals with Long COVID. Soon enough in our ever-changing world, there will be another virus that infects our planet, ending thousands of innocent lives and harming millions. It is our job to learn from previous pandemics like the COVID-19 one and become prepared with teams for the “Long version” of the next virus.

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