

Influence of COVID-19 and its long-term effect in work productivity and sickness absence

Influencia de la COVID-19 y su efecto a largo plazo en la productividad laboral y el ausentismo por enfermedad

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Fechas · Dates

Recibido: 26/06/2026

Aceptado: 23/10/2026

Publicado: 27/10/2026

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Abstract

Background. Long-COVID is estimated to affect almost 400 million people globally, but its impact on the workforce is not fully understood. The aim of this study is to investigate the influence of COVID-19 and long-COVID on work productivity loss and sickness absence in employees from a large multinational corporation located in three countries from different geographical regions.

Methods. Cross-sectional study in which 1 955 employees completed a questionnaire covering sociodemographic, occupational, lifestyle and clinical characteristics. COVID status was the explanatory variable, and the outcomes were work productivity loss and sickness absence. Binomial Logistic regression models were used to determine the association between COVID status and both outcomes. The effects of covariates as potential confounders for the association of long-COVID with both outcomes were also assessed.

Results. Among 1 782 employees included, 58.8% reported COVID-19 of whom 50.4% reported long-COVID symptoms. Fatigue and brain fog were the main symptoms reported. Long-COVID was significantly associated with higher rates of work productivity loss and sickness absence. These associations were partially explained by pre-existing mental health

th conditions; additionally, participants' job roles and country partially accounted for the association with productivity loss.

Conclusion. Work productivity loss and sickness absence are more influenced by the persistence of the long-term effects of COVID-19 rather than COVID-19 per se, and this is partially driven by pre-existing mental health conditions, job roles, and participant's country. Workplace strategies and cost-effective interventions are needed to support affected employees and employers who are seeking to mitigate the impact of long-COVID in their organisations.

Keywords: Long-COVID; Work productivity loss; Sickness absence.

Resumen

Objetivo. Investigar la influencia de la COVID-19 y la COVID persistente en la pérdida de productividad laboral y el ausentismo por enfermedad en empleados de una corporación multinacional localizada en tres países de diferentes regiones geográficas.

Métodos. Estudio transversal con 1 955 empleados completaron un cuestionario sobre variables sociodemográficas, ocupacionales, clínicas y de estilo de vida. Se aplicaron modelos de regresión logística binomial para analizar la asociación entre el estado de infección por COVID y las variables dependientes (productividad y ausentismo), evaluando además los efectos de las covariables como posibles factores de confusión.

Resultados. Entre los 1 782 empleados incluidos, el 58.8% reportó haber tenido COVID-19, de ellos, el 50.4% presentó COVID persistente, siendo la fatiga y la niebla mental los síntomas principales. La COVID persistente se asoció significativamente con mayores tasas de pérdida de productividad y ausentismo laboral. Estas asociaciones se explicaron parcialmente por la presencia de condiciones de salud mental preexistentes. Asimismo, los roles laborales y los países de los empleados influyeron en la asociación con la pérdida de productividad.

Conclusión. La pérdida de productividad y el ausentismo laboral están provocados más por los efectos a largo plazo de la COVID persistente que por la infección inicial. Ello está impulsado parcialmente por condiciones de salud mental preexistentes, roles laborales y país de origen. Son necesarias estrategias en el lugar de trabajo e intervenciones costo-efectivas para apoyar a los empleados afectados y a los empleadores que buscan mitigar el impacto de la COVID persistente en sus organizaciones.

Palabras clave: COVID persistente; Pérdida de productividad laboral; Ausentismo por enfermedad.

Introduction

The COVID-19 pandemic has been the most significant healthcare crisis of modern times, impacting global health and economies^(1,2). COVID-19 is an infectious disease caused by the SARS-CoV-2 virus, typically presenting as mild to moderate respiratory illness, though some cases result in severe illness or fatality^(3,4). Glo-

bally, an estimated 400 million individuals suffered long-term effects after SARS-CoV-2 infection through long-COVID⁽⁵⁾; an infection-associated chronic condition that is present for at least 3 months as a continuous, relapsing and remitting, or progressive disease state that affects one or more organ systems^(6,7). Symptoms of long-COVID are multidimensional and can include tiredness and fatigue, brain fog, breathlessness, and other physical, cognitive symptoms that impact daily life^(8,9). A systematic review and meta-analysis suggested a global estimated pooled prevalence of long-COVID of approximately 36%⁽¹⁰⁾.

Long-COVID is estimated to have an annual global economic impact of approximately \$1 trillion, equivalent to 1% of the global economy⁽⁵⁾. Sickness absence, reduced work ability, absenteeism and subsequent job loss are key contributors to this economic burden, which affects workers, employers and labour markets. A systematic review and meta-analysis found that 14% of individuals with long-COVID were unable to return to work two years after COVID-19⁽⁹⁾. In addition, a study of 366 patients attending UK long-COVID clinics, showed that approximately 52% of participants had reduced their paid working hours or were no longer in paid work compared to pre-infection period⁽¹¹⁾.

Understanding the global impact of both COVID-19 and long-COVID on work productivity and sickness absence is vital for supporting global workforce health and economies to prepare for future pandemics. It also remains unclear how pre-existing medical conditions, lifestyle factors, job category and country differences affect the association of long COVID with these outcomes.

The aim of this study was to examine the association of COVID-19 and long-COVID on work productivity and sickness absence in employees from a large multinational corporation across three countries from geographically diverse regions.

Methods

Between April 2023 and July 2023, employees from a large multinational corporation across three countries - the United Kingdom (UK), India, and Brazil - were interviewed and invited to take part in this cross-sectional study. The study had no exclusion criteria and was open to everyone in the organization.

Data were collected by self-response questionnaires in Brazil, UK, and India. The questionnaires were administered online in Brazil and the UK, and face-to-face in India due to operational issues. The online questionnaire (accessible as supplementary material) was available through the organisation intranet and was open for a six-to-eight-week period to allow employees to complete it. The face-to-face questionnaire was also delivered across a period of six-to-eight weeks. The same structured self-response questionnaires were used across all countries and 1 955 employees provided informed consent to participate between the three countries. Each country required slightly variations in the structured questionnaire to fit local language requirements. Ethical approval was obtained from the University of Glasgow's Research Ethics Committee.

Participants who did not report COVID-19 and/or long-COVID symptoms and participants who reported COVID-19 (independently of whether this was confirmed by a healthcare professional or covid test) with or without long-COVID symptoms were included in this study.

Participants were asked to select 'yes' or 'no' to whether they had any of the following 16 symptoms: i) tiredness or fatigue that interferes with daily life, ii) symptoms that get worse after physical or mental effort (also known as 'post-exertional malaise'), iii) problems with memory and concentration ('brain fog'), iv) chest pain or tightness, v) difficulty sleeping ("insomnia"), vi) heart feels like it's beating too fast or skipping beats ("heart palpitations"), vii) light-headedness, unsteadiness, or a sensation that the surroundings are spinning ('dizziness'), viii) pins and needles, ix) joint or muscle pain, x) depression and anxiety, xi) perception of ringing, buzzing, or other sounds in the ears ('tinnitus')/earaches, xii) feeling sick, diarrhoea, stomach aches, loss of appetite, xiii) high temperature, cough, headaches, sore throat, changes to sense of smell or taste, xiv) rashes, xv) hair loss or xvi) hyperthyroidism. Participants who selected at least 1 symptom were grouped as 'long-COVID symptoms'. Participants who did not select any symptom were grouped as 'no long-COVID symptoms'. Participants (n=173) who reported long-COVID symptoms but did not have a previous diagnosis of COVID-19, were excluded.

To establish COVID status, participants who reported having neither COVID-19 nor long-COVID symptoms were grouped as 'neither'. Participants who reported having COVID-19, but no long-COVID symptoms were grouped as 'COVID', and participants who reported having COVID-19 and long-COVID symptoms were grouped as 'long-COVID'.

Participants were asked to indicate the extent to which health problems affect their productivity while they were working during the past 7 days. Participants gave a score between 0-10 with 10 indicating greater impact. For the purpose of this analysis, participants were split into two groups. 'Work productivity loss' was considered if participants reported an impact of 1 or above, whilst those who reported a score of 0 were classified as 'No productivity loss'.

Participants were also asked about sickness absence. Specifically, they were asked how many work hours they had missed due to health in the last 7 days. The responses were free text, and participants could put in any number of hours they chose. Participants who reported missing at least 1 hour of work were classed as 'sickness absence' and those who did not report working hours lost, were classified as 'no sickness absence'.

Sociodemographic and occupational characteristics were ascertained by asking participants to select their country (UK, India or Brazil), gender (male, female, non-binary or prefer not to say) aged grouped in 5 categories (18-25, 26-35, 36-45, 46-55 or ≥ 56) and job category from 7 groups (1HR, general management, and admin support, 2. Finance, audit and legal, 3. Operations and project management, 4. Information technology and analytics, 5. Marketing, communications, customer development, 6. Research and development, 7. Factory worker, manufacturing, and supply chain).

Regarding clinical and lifestyle factors, underlying pre-existing health conditions were captured by asking participant to select 'yes' or 'no' to whether they had any of the following conditions: mental health, obesity, chronic lung disease, musculoskeletal, heart conditions, diabetes, immunodeficiency, chronic liver disease, cancer, cystic fibrosis, cerebrovascular disease, chronic kidney disease. Also, the number of positive responses were summed to give a total number of pre-existing health conditions, grouping the participants into three groups: 'no underlying health conditions', 'one underlying health condition' and 'two or more underlying health conditions'. Participants were also asked to select 'yes' or 'no' to whether they were physically inactive or smokers, and how satisfied with life as a whole are they, using a scale from 0-10 with higher scores indicating higher satisfaction. For life satisfaction, participants' responses were grouped into tertiles: high satisfaction (highest 33% of scores), medium satisfaction and low satisfaction (lowest 33% of scores)

Statistical analysis was carried out using IBM SPSS Statistics for Windows (v29)⁽¹²⁾ and R Statistical Software (v4.5.0)⁽¹³⁾. We used descriptive statistics to summarize the sample's background, occupational, lifestyle, and health characteristics across three countries. Our analysis focused on how COVID-19 status (the main explanatory variable) affected work productivity loss and sickness absence (the outcome variables). We considered all other background characteristics as potential confounding factors. Prevalence of work productivity loss and sickness absence was estimated according to COVID status.

Binomial logistic regression models were used to evaluate how COVID status relates to work productivity loss and sickness absence. Associations were summarised by odds ratios (ORs) with their 95% confidence intervals (95% CIs). Three types of models were fitted.

Finally, to analyse the covariates' effects as potential confounders for the association of long-COVID with both work productivity loss and sickness absence, three types of model were fitted: A) a crude model with COVID status as independent variable, B) different separate models including COVID status and each one of the covariates individually: country, gender, age, job category, physical inactivity, smoking, life satisfaction and each of the underlying pre-existing health conditions, and C) a model with COVID status and all covariates together in a single model. Comparing Model A to Model B revealed how much each specific covariate individually distorted the main associations, while comparing Model A to Model C revealed the collective confounding impact of all variables combined.

Results

Our sample comprised 1 782 employees (figure 1). Of those, 104 (5.8%) were from the UK, 947 (53.1%) were from India and 731 (41.0%) were from Brazil. In the UK, most participants were female (84.6%) whereas most were male in India (83.0%) and Brazil (53.6%). The greatest proportion of participants in the UK were aged 46-55 years old (36.5%) whereas the greatest proportion of participants were aged

36-45 in India (48.4%) and Brazil (35.8%). In the UK the majority of participants worked in research and development (46.2%), whereas the greatest proportion in India (74.2%) and Brazil (59.0%) worked in factory, manufacturing and supply chain. Overall, 24.6% of participants reported having at least one underlying health condition. The UK had the greatest proportion of participants with one or more underlying health conditions (45.2%) compared to in India (17.4%) and Brazil (31.1%). Obesity was highly prevalent among participants with an underlying health condition across all three areas, affecting 40.4% in the UK, 34.5% in India, and 29.5% in Brazil. Other conditions varied by region: the highest proportion of respondents with an underlying health condition in the UK and Brazil reported having a mental health condition (42.6% and 36.1% respectively), whereas in India, diabetes was the most frequent (44.2%) (Table 1).

Table 1. Participants' sociodemographic, occupational, clinical and lifestyle characteristics across the three countries.

	UK (n=104)	INDIA (n=947)	BRAZIL (n=731)	Total (n=1782)
	n (%)	n (%)	n (%)	n (%)
Gender				
Male	16 (15,4)	786 (83,0)	392 (53,6)	1194 (67,0)
Female	88 (84,6)	158 (16,7)	337 (46,1)	583 (32,7)
Non-Binary	0 (0)	2 (0,2)	1 (0,1)	3 (0,2)
Prefer not to say	0 (0)	1 (0,1)	1 (0,1)	2 (0,2)
Age group (years)				
18-25	2 (1.9)	65 (6.9)	59 (8.1)	126 (7.1)
26-35	18 (17.3)	168 (17.7)	209 (28.6)	395 (22.2)
36-45	31 (29.8)	458 (48.4)	262 (35.8)	751 (42.1)
46-55	38 (36.5)	191 (20.2)	165 (22.6)	394 (22.1)
56+	15 (14.4)	65 (6.9)	36 (4.9)	116 (6.5)
Job Category				
HR, Management and Admin	20 (19.2)	98 (10.3)	102 (14.0)	220 (12.3)
Finance, audit and legal	6 (5.8)	15 (1.6)	29 (4.0)	50 (2.8)
Operations and project management	6 (5.8)	21 (2.2)	46 (6.3)	73 (4.1)
Information technology and analytics	3 (2.9)	12 (1.3)	29 (4.0)	44 (2.5)
Marketing, communications & customer development	13 (12.5)	65 (6.9)	55 (7.5)	133 (7.5)
Research and development	48 (46.2)	33 (3.5)	39 (5.3)	120 (6.7)
Factory worker, manufacturing and supply chain	8 (7.7)	703 (74.2)	431 (59.0)	1142 (64.1)
Underlying pre-existing health conditions (yes)	47 (45.2)	165 (17.4)	227 (31.1)	439 (24.6)

	UK (n=104)	INDIA (n=947)	BRAZIL (n=731)	Total (n=1782)
Number of pre-existing health conditions				
1 condition	30 (28.8)	140 (14.8)	180 (24.6)	350 (19.6)
2 or more conditions	17 (16.3)	25 (2.6)	47 (6.4)	89 (5.0)
Pre-existing health conditions*				
Obesity	19 (40.4)	57 (34.5)	67 (29.5)	143 (32.6)
Mental Health	20 (42.6)	7 (4.2)	82 (36.1)	109 (24.8)
Heart Conditions	5 (10.6)	38 (23.0)	61 (26.9)	104 (23.7)
Diabetes	5 (10.6)	73 (44.2)	14 (6.2)	92 (21.0)
Musculoskeletal	5 (10.6)	15 (9.1)	23 (10.1)	43 (9.8)
Chronic lung Disease	10 (21.3)	1 (0.6)	16 (7.0)	27 (6.2)
Chronic Liver Disease	3 (6.4)	2 (1.2)	10 (4.4)	15 (3.4)
Immunodeficiency	4 (8.5)	0 (0.0)	11 (4.8)	15 (3.4)
Cerebrovascular Disease	0 (0.0)	4 (2.4)	3 (1.3)	7 (1.6)
Chronic Kidney Disease	0 (0.0)	1 (0.6)	4 (1.8)	5 (1.1)
Cancer	1 (2.1)	0 (0.0)	3 (1.3)	4 (0.9)
Cystic Fibrosis	1 (2.1)	1 (0.6)	1 (0.4)	3 (0.7)
Lifestyle				
Physical inactivity	17 (16.3)	19 (2.0)	111 (15.2)	147 (8.3)
Smoking	5 (4.8)	96 (10.1)	27 (3.7)	128 (7.2)
Life satisfaction (tertiles)				
Best	8 (7.7)	378 (39.9)	246 (33.7)	632 (20.3)
Intermediate	46 (44.2)	354 (37.4)	318 (43.5)	718 (40.3)
Worst	50 (48.1)	215 (22.7)	167 (22.8)	432 (24.2)

* Percentages are calculated based on those with an underlying pre-existing health condition (yes).

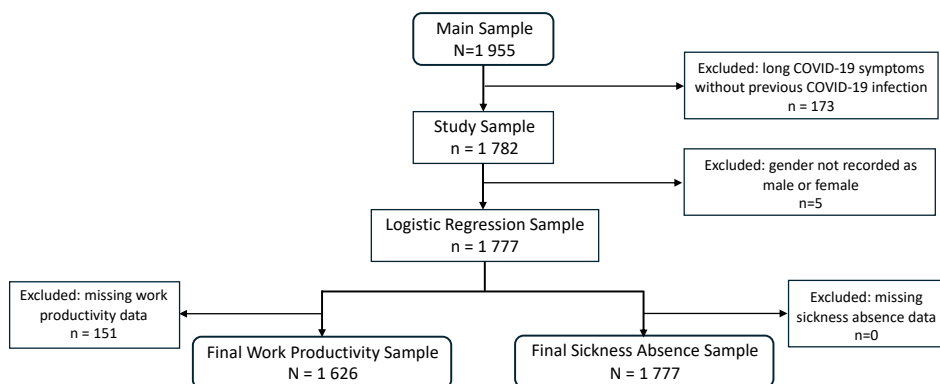


Figure 1. Participants Flow Chart.

Of the total sample, 41.2% (n=734) of participants had neither had COVID-19 nor long-COVID symptoms. Among the remaining 58.8% (n=1 048) who had COVID, 519 (49.5%) did not reported any long-COVID symptoms (data not shown), and 529 (50.4%) had reported at least one symptom of long-COVID symptoms. Table 2 displays the frequency of reported long-COVID symptoms, stratified by country. Across our sample, 'brain fog' was the most prevalent symptom (52.4%), followed by tiredness/fatigue (42.5%). This pattern remained consistent across all three countries. However, some variations emerged, such as hair loss was frequently reported in India and Brazil, mental health symptoms were prominent in Brazil, and joint/muscle pain was often reported in both the UK and India.

Table 2. Frequency of reported long-COVID symptoms among participants who had COVID-19 and reported at least one long-COVID symptom, stratified by country.

	UK n = 67	INDIA n = 77	BRAZIL n = 385	Total n = 529
	n (%)	n (%)	n (%)	n (%)
Tiredness or fatigue that interferes with daily life	36 (53.7)	39 (50.6)	150 (39.0)	225 (42.5)
Symptoms that get worse after physical or mental effort	20 (29.9)	12 (15.6)	74 (19.2)	106 (20.0)
Problems with your memory and concentration ("brain fog")	40 (59.7)	23 (29.9)	214 (55.6)	277 (52.4)
Chest pain or tightness	8 (11.9)	9 (11.7)	54 (14.0)	71 (13.4)
Difficulty sleeping ("insomnia")	26 (38.8)	15 (19.5)	133 (34.5)	174 (32.9)
Heart feels like it's beating too fast or skipping beats ("heart palpitations")	15 (22.4)	14 (18.2)	65 (16.9)	94 (17.8)
A feeling of lightheadedness, unsteadiness, or a sensation that the surroundings ("dizziness")	14 (20.9)	6 (7.8)	78 (20.3)	98 (18.5)
Pins and needles	12 (17.9)	4 (5.2)	64 (16.6)	80 (15.1)
Joint or muscle pain	28 (41.8)	36 (46.8)	104 (27.0)	168 (31.8)
Depression and anxiety	20 (29.9)	10 (13.0)	145 (37.7)	175 (33.1)
Perception of ringing, buzzing, or other sounds in the ears ("tinnitus")/earaches	23 (34.3)	11 (14.3)	62 (16.1)	96 (18.1)
Feeling sick, diarrhea, stomach aches, loss of appetite	9 (13.4)	8 (10.4)	55 (14.3)	72 (13.6)
A high temperature, cough, headaches, sore throat, changes to sense of smell or taste	8 (11.9)	5 (6.5)	48 (12.5)	61 (11.5)
Rashes	5 (7.5)	4 (5.2)	12 (3.1)	21 (4.0)
Hair loss	8 (11.9)	37 (48.1)	163 (42.3)	208 (39.3)
Hyperthyroidism	2 (3.0)	2 (2.6)	22 (5.7)	26 (4.9)

To improve the stability of the logistic regression models, two gender categories ("non-binary" and "prefer not to say") were excluded from the logistic regression analysis due to small counts. Therefore, the full sample for the analysis was 1 777 participants. Due to missing data on work productivity for 151 participants, the association between COVID-19 status and work productivity loss was analyzed using a sample of 1,626 participants. (Figure 1).

In total, 395 (24.3) participants stated that their work productivity had been negatively impacted by their health, with the majority (n=262, 66.3%) residing in Brazil. This frequency was higher than those observed in the UK and India, where only 54 (13.7%) and 79 (20.0%) of participants, respectively, reported a negative impact on their productivity (data not shown). From those who reported work productivity loss (n=395), nearly three quarters (n=281, 71.1%) reported long-COVID symptoms. While a large majority in the neither (92.2%) and COVID (86.1%) groups maintained normal productivity, 55% of participants with long-COVID saw their productivity affected. Sickness absence was analysed using the full sample (n=1 777) as there was no missing data. In total, 195 (11.0%) participants stated they had lost hours due to sickness absence. From these individuals, 112 (57.4%) were from Brazil and 73 (37.4%) from India. In contrast, the frequency in the UK was notably lower, with only 10 (5.1%) participants reporting sickness absence (data not shown). From those who reported sickness absence, more than half (n=111, 56.9%) reported long-COVID symptoms (table 3).

The analysis of the association between work productivity loss and sickness absence with COVID status showed that after adjustment for gender, age and region (M1), the risk of work productivity loss was significantly associated with COVID-19 for those who did not report long-COVID symptoms (OR 1.8, 95% CI 1.2–2.6) and those who reported long-COVID symptoms (OR 8.7, 95% CI 6.0–12.8). For participants who reported long-COVID symptoms, these associations persisted and remained statistically significant after additional adjustment for job category, physical inactivity, smoking and life satisfaction (M2) and for all underlying health conditions reported (M3). Reporting long-COVID symptoms was again a significant predictor (OR 3.2, 95% CI 2.1–4.9) for sickness absence after adjustment for gender, age and region (M1). This risk estimate remained significant after additional adjustment for job category, physical inactivity, smoking and life satisfaction (M2) and for all underlying health conditions reported (M3). In contrast, no significant association was observed between sickness absence and having COVID-19 without reporting long-COVID symptoms (Table 3).

Table 3. Number of participants and percentages in which work productivity loss and sickness absence occurred according to COVID status and association between COVID status with work productivity loss and sickness absence.

Work Productivity Loss										Sickness Absence								
	N	n	%	M1		M2		M3		N	n	%	M1		M2		M3	
				OR	(95% CI)	OR	(95% CI)	OR	(95% CI)				OR	(95% CI)	OR	(95% CI)	OR	95% CI
Neither	669	52	7.8	1		1		1		730	52	7.1	1		1		1	
COVID	446	62	13.9	1.8	(1.2-2.6)**	1.4	(0.9-2.1)	1.4	(0.9-2.2)	518	32	6.2	0.9	(0.5-1.4)	0.8	(0.5-1.3)	0.8	(0.5-1.3)
Long-COVID	511	281	55.0	8.7	(6.0-12.8)**	5.5	(3.7-8.3)**	4.8	(3.2-7.3)**	529	111	21.0	3.2	(2.1-4.9)**	2.4	(1.5-3.8)**	2.2	(1.4-3.6)*

*Participants with missing data about work productivity: n=151.
**p<0.05
N: Number of “at risk” participants with exposure to the risk factor.
n: Number of participants “exposed” to the factor in which the outcome occurred
% Percentage of participants “exposed” to the factor in which the outcome occurred (prevalence)
M1: adjusted by Country, Gender, Age.
M2: adjusted by Country, Gender, Age, Job Category, Physical inactivity, Smoking, Life Satisfaction.
M3: adjusted by Country, Gender, Age, Job Category, Physical inactivity, Smoking, Life Satisfaction, Cancer, Cerebrovascular Disease, Chronic Kidney Disease, Chronic lung Disease, Chronic Liver Disease, Cystic Fibrosis, Diabetes, Heart Conditions, Mental Health, Immunodeficiencies, Musculoskeletal, Obesity.

The confounding effect of each covariate on the association between long-COVID symptoms with both outcomes showed that in those who reported long-COVID symptoms, the risk of productivity loss and sickness absence was approximately 14 times (OR 14.5, 95%CI 10.5-20.4) and 3 times (OR 3.5, 95%CI 2.5-5.0) higher, respectively, in comparison to those who had neither COVID-19 nor long-COVID symptoms. The crude estimates for both outcomes showed the highest decrease in magnitude after adjustment for pre-existing mental health condition (OR 11.5, 95%CI 8.2-16.3 and OR 2.9, 95%CI 2.0-4.3, respectively). The country where employees work (OR 8.8, 95%CI 6.1-12.7) and job category (OR 10.5, 95%CI 7.5-14.9) also influenced the association between long-COVID symptoms with productivity loss, but not for sickness absence (table 4). In spite of a further decrease in the magnitude of the risk estimates, the association of reporting long-COVID symptoms with both outcomes remained significant when all the characteristics of interest were included in a single regression model (OR 4.8, 95%CI 3.2-7.3 and OR 2.2, 95%CI 1.4-3.6, respectively) (Table 4).

Table 4. Confounding effect of each covariate in the estimate of the association between long-COVID status (reference category: neither) and work productivity loss and sickness absence.

	Work Productivity Loss n = 1 626		Sickness Absence n = 1 777	
	OR	95% CI	OR	95% CI
Crude (A)				
Long COVID	14.5	10.5-20.4*	3.5	2.5-5.0*
Adjusted individually by (B):				
Country	8.8	6.1-12.7*	3.4	2.3-5.2*
Gender	12.0	8.6-17.0*	3.3	2.3-4.8*
Age	14.9	10.7-21.1*	3.5	2.4-5.0*
Job Category	10.5	7.5-14.9*	3.1	2.1-4.6*
Physical Inactivity	13.0	9.3-18.3*	3.3	2.3-4.7*
Smoking	14.4	10.4-20.3*	3.5	2.5-5.0*
Life Satisfaction	13.4	9.7-19.0*	3.1	2.2-4.5*
Cancer	14.5	10.5-20.4*	3.5	2.4-4.9*
Cerebrovascular Disease	14.7	10.6-20.8*	3.5	2.5-5.0*
Chronic Kidney Disease	14.5	10.5-20.4*	3.5	2.5-5.0*
Chronic Lung Disease	14.1	10.2-19.8*	3.4	2.4-4.9*
Chronic Liver Disease	14.3	10.4-20.2*	3.4	2.4-4.9*
Cystic Fibrosis	14.7	10.6-20.8*	3.5	2.5-5.0*
Diabetes	14.5	10.5-20.4*	3.5	2.5-5.0*
Heart Conditions	14.6	10.5-20.6*	3.5	2.4-4.9*
Mental Health	11.5	8.2-16.3*	2.9	2.0-4.3*
Immunodeficiencies	14.3	10.3-20.1*	3.5	2.4-5.0*
Musculoskeletal	14.3	10.3-20.2*	3.4	2.4-4.9*

	Work Productivity Loss n = 1 626		Sickness Absence n = 1 777	
Obesity	14.0	10.1-19.8*	3.4	2.4-4.9*
Adjusted by all variables presented in the table (C)	4.8	3.2-7.3*	2.2	1.4-3.6*

*p<0.05

A) a crude model with COVID status as independent variable

B) different separate models including COVID status and each one of the covariates individually: country, gender, age, job category, physical inactivity, smoking, life satisfaction and each of the underlying pre-existing health conditions

C) a model with COVID status and all covariates together in a single model

Discussion

Employees from a large multinational corporation across three countries from geographically diverse regions who reported long-COVID symptoms showed stronger associations with work productivity loss and sickness absence. Our results suggest that work productivity loss and sickness absence are more influenced by the persistence of symptoms associated with the long-term effects of COVID-19 rather than COVID-19 per se. Our findings also suggest that the presence of pre-existing mental health conditions might explain, at least partially, the observed associations between long-COVID symptoms and both outcomes. The country where employees work and the nature of the role that they do might also partially explain the observed association between long-COVID symptoms and productivity loss.

Our results align with previous studies that have identified long-COVID as a significant factor affecting work productivity and sickness absence^(14,15,16,17). In our sample, brain fog and fatigue were the most common symptoms reported in those who had COVID-19 and long-COVID. This is also consistent with two systematic reviews and meta-analyses which found that a significant proportion of individuals experience persistent fatigue^(18,19) and/or cognitive impairment⁽¹⁸⁾ following resolution of acute COVID-19.

In our sample, the frequency of those who reported productivity loss and sickness absence was higher among Brazil employees, followed by India and UK. This variation by country may reflect differences in workplace policies, healthcare and social support access and/or cultural differences in how productivity or sickness absence is perceived and/or reported.

Our findings show that the association between long-COVID symptoms and productivity loss is partially explained by the country where employees work and the nature of the role that they do. It is possible that country and job category may act as independent proxies for socio-economic status, health disparities, healthcare accessibility, cultural differences and variations in labour conditions. For example, a prospective study carried out in 17 countries in Africa, Asia, Europe and South America found that the frequency of long-COVID was higher in high-income settings, but the impact on individuals may be higher in lower-resourced settings where the healthcare and socioeconomic support infrastructure may be more limited⁽²⁰⁾.

Our results suggest that the association of long-COVID with productivity loss and sickness absence are partially explained by pre-existing mental health conditions. This is not fully unexpected, as pre-existing mental health conditions (e.g. anxiety and depression) are commonly reported among individuals with long-COVID⁽²¹⁾ and they by itself could also contribute to both, difficulties in maintaining work productivity and attendance to work^(22,23).

Strengths and Limitations

Our study's primary strength is its large multinational sample, which includes three countries located in geographically and economically distinct regions. The study provides valuable cross-country insights into how long-COVID impacts workplace functioning across different settings. This diverse sample enhances the external validity of the findings. Another key strength is the consideration of multiple potential confounders, strengthening the internal validity of the associations observed.

Against these strengths, limitations which may influence the interpretation of our findings should be considered. Denoting a participant as having long-COVID if they have at least one symptom may overestimate the number of employees with long-COVID. Moreover, those symptoms are unspecific and may result from another condition other than long-COVID. We have mitigated this by including only participants with long-COVID symptoms who had COVID-19.

There were slightly different data collection methodologies across each country. Regional adaptations to the survey and translation, while necessary, may complicate cross-regional comparisons and induce response bias that may lead to an under reporting of some of the information collected e.g. mental health conditions or degree of productivity loss.

Our definitions of productivity loss and sickness absence were ascertained by self-report. It is possible that employees experiencing long-COVID symptoms may perceive their work as more challenging, influencing their responses regarding productivity loss. Also, classifying participants as having work productivity loss if they reported a score of 1 or more and as sickness absence when reported missing at least 1 hour of work may overestimate both outcomes. We cannot rule this out this possibility, but there is no reliable standard against which to assess the accuracy of reported productivity loss and sickness absence.

It is possible that employees with more severe COVID-19 were underrepresented in our sample due to healthy worker selection, which could have led to an underestimation of the prevalence of sickness absence and productivity loss. However, it is unlikely that this potential effect would have caused spurious associations of COVID status with both outcomes.

Conclusions and implications for practice

Identified barriers to the provision of support at workplace level include lack of understanding of long-COVID symptoms, insufficient workplace guidance and edu-

cational gaps among managers⁽²⁴⁾. Our findings highlight the need for workplace strategies to support employees with long-COVID. Interventions providing access to occupational health, mental health counselling, and rehabilitation can aid recovery and may contribute to stabilise symptoms. Additionally, managerial long-COVID training will foster a supportive environment where job modifications and flexible working may mitigate negative impacts on work performance and attendance.

Because long-COVID is not a temporary issue, future longitudinal studies must track its long-term impact on workplace productivity and attendance. Research should also explore sector-specific variations and investigate the cost-effectiveness of workplace interventions. This will guide employers seeking to reduce the negative impacts of long-COVID in their organisations.

Authors' contributions

All of the authors listed on the paper fulfil criteria for authorship and jointly participated in the study design and methodology. SW and EM were responsible for reception and storage of the data collected on each setting. SVP and EA performed the data analysis and drafting of the manuscript. All authors reviewed numerous drafts of the manuscript and are in agreement with the text and findings and have all approved this final version.

Funding

This research was supported by funding from the organisation. Key representatives were involved at the outset to support logistics and advise on the feasibility of the study design. The funders had no role in data analysis, the decision to publish, or the preparation of the manuscript. None of the researchers were employed by the organisation at any stage of the project.

Acknowledgements

We are grateful to members of the multinational organisation who were instrumental in facilitating data collection and coordination throughout the study. Their collaboration, support, and insight made this research possible.

Conflict of interest

The authors declare no conflict of interest.

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