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FACTORS ASSOCIATED WITH ESSENTIAL WORKERS' WELLBEING DURING THE COVID-19 PANDEMIC

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1. Introduction

The COVID-19 pandemic profoundly altered labour markets and working conditions across the world, but its effects were especially intense for essential workers. While a large part of the workforce moved to remote work or experienced temporary interruptions, essential workers continued performing their jobs on-site in order to sustain basic services, often under conditions of higher exposure, greater work pressure, and increased uncertainty. In this context, concerns about workers' wellbeing became particularly relevant, as the pandemic intensified not only health risks but also psychological strain, job insecurity, and difficulties in balancing work and personal life.

Understanding the wellbeing of essential workers is therefore important both from a social and an analytical perspective. Essential workers were central to the functioning of society during the pandemic, yet their experiences were far from uniform. Some faced very high levels of anxiety and emotional strain, while others reported more limited effects on their wellbeing. This variation suggests that essential worker status alone is not enough to explain differences in mental wellbeing, and that it is necessary to examine the role of job demands, organizational conditions, work-family conflict, and socio-demographic characteristics.

This study investigates the factors associated with essential workers' wellbeing during the COVID-19 pandemic, with a specific focus on anxiety-related wellbeing. Drawing on the UCD Working in Ireland Survey 2021, the analysis examines whether work-related strain, perceived organizational support, work effort, work-family conflict, trade union presence, and socio-demographic factors are associated with lower mental wellbeing among essential workers in Ireland. To do so, the study combines Principal Component Analysis to construct a broader indicator of anxiety-based wellbeing with six weighted linear regression models that analyse both the overall anxiety component and its specific dimensions.

By adopting this approach, the thesis aims to contribute to a better understanding of how the pandemic affected essential workers beyond broad descriptive claims. More specifically, it seeks to identify which factors were most strongly associated with lower wellbeing and whether these patterns are consistent across different forms of employment-related anxiety. In this way, the study offers evidence that may be useful for both academic research and the design of future labour and organizational policies.

2. Literature Review and Theoretical Framework

2.1. Essential workers' wellbeing during COVID-19: An explanatory analytical perspective

The COVID-19 pandemic completely transformed labour markets and working conditions around the world. Essential workers especially had to face significant added risks and greater work pressure than most workers (Eurofound, 2021; Fasani & Mazza, 2020). In general, essential workers are those with jobs that were considered utterly necessary to keep basic services available during lockdown and travel restrictions. For example, this includes workers in the health and social sectors, food production and supermarkets, transport, security, cleaning and key public administration (Basso et al., 2020; Dingel & Neiman, 2020).

From the very beginning of the pandemic, essential workers encountered several sources of stress. The first and most obvious one is exposure to SARS-CoV-2, as they continued working on-site and had constant contact with the public and other co-workers (Blau et al., 2021). Second, some of the essential sectors, like health care and food retail, had to respond to higher demand, shortages of staff or self-isolation due to illness, and dynamic and quick changes in processes. This normally led to more intense work and longer hours (Eurofound, 2021; Geary & Belizón, 2022). Lastly, the majority of these essential workers couldn't virtually work from home, so they had substantial difficulties when it came to combining their job with extra care responsibilities that arose when schools closed and other support services were reduced (Alon et al., 2020; Collins et al., 2021).

Several studies show that these conditions had significant consequences for the workers' mental health. Research on health professionals and other workers in direct contact with the public, finds higher levels of stress, anxiety, depression and burnout compared to before the pandemic and to other workers (Pappa et al., 2020; Vindegaard & Benros, 2020). Population surveys also confirm that, in general, essential workers had worse mental wellbeing than non-essential workers, even after factoring in socio-demographic characteristics (Bell et al., 2021; Eurofound, 2021). Some studies also indicate that these negative effects did not disappear right after, which raises concerns regarding the long-term impacts of the pandemic on workers and organisations (Holmes et al., 2020). More recent evidence suggests that these psychological effects didn't disappear once the most critical phase of the pandemic had passed, as research that looked at hospital workers repeatedly over time still found high levels of distress in 2023 (Maunder et al., 2024; World Health Organization, 2024).

However, essential workers are not a differentiated and homogenous group. There are factors in which they differ, like risk of exposure, access to resources, workload, job quality and personal situations. For example, a nurse working in an intensive care unit during COVID-19 is exposed to different risks and pressures than a supermarket cashier or a bus driver. Not even within the same occupation do they face the same challenges, some workers might have more productive equipment or more supportive managers than others, resulting in a smaller workload. Due to the differing conditions, some essential workers report a major decline in their mental health, while others claim to not have noticed a consequent change in their wellbeing. This variation suggests that the mere classification of an essential worker is not enough to explain the effect of the pandemic on their wellbeing, but that it is important to take individual, job-related and organizational factors into account to therefore be able to explain why some were more negatively affected than others.

From a Business Analytics point of view, these differences lead to explanatory quantitative research with the aim of modeling how different factors are related to the wellbeing of essential workers. Regression analysis represents a structured way to measure the relationship between wellbeing, as the dependent variable, and a set of explanatory variables that represent exposure to COVID-19, work effort, job quality, organizational context and socio-demographic features. The objective is to show that essential workers usually have lower wellbeing and to study what factors and to what degree they provoke lower wellbeing, and if these factors are still important when other influences are controlled.

The theoretical framework of this thesis has two main objectives. The first one is to explain the key concepts related to essential workers' wellbeing and to translate them into variables that are measurable. The second one is to summarize the main theoretical and empirical arguments about how these variables are expected to correlate, so that it is possible to justify the specification of the regression model and the hypotheses that will be tested.

2.2.Conceptualising essential workers and wellbeing

2.2.1. Essential worker status

The concept of "essential worker" is at the centre of this study, as it defines the main group of interest and is also an explanatory variable by itself. To accurately define essential work, governments lists are usually used, as they contain the critical sectors that had to keep operating

on-site during lockdowns (Fana et al., 2020; Blau et al., 2021). These lists tend to include sectors like health care, long-term care, emergency services, transportation, food supply, utilities, security, cleaning and certain public sector activities (Dingel & Neiman, 2020). However, the content is different for each country and changes over time, as it depends heavily on policies and institutions (Eurofound, 2022).

Empirical studies normally use two methods to identify essential workers. One method consists in matching occupations and industries to the essential sectors defined by the government using standard classification codes (Fana et al., 2020), which allows researchers to use large administrative or labour force datasets. The second method is completely different, as it uses the answers of the workers themselves when being questioned if their job was considered essential during the pandemic (Tropiceanu et al., 2021; Wielgoszewska et al., 2022). This second approach has the advantage of capturing the social and personal meaning of essential work, but it can also lead to ambiguity, as people might understand the term differently.

The UCD Working in Ireland Survey 2021 used this second method, as they ask workers whether they thought of themselves essential during the COVID-19 pandemic (Geary & Belizón, 2022). Normally, in regression models, essential worker status is studied as a binary variable, meaning having a value of 1 if essential and of 0 if non-essential. Recent research argues that during COVID-essential workers had on average worse mental health than non-essential workers (Bell et al., 2021; Eurofound, 2021). Because of this, when wellbeing is the dependent variable, a negative coefficient is expected for essential worker status, even though this effect can partly be explained by other variables, like exposure or work intensity. Recent international evidence also has highlighted that essential work isn't just socially necessary but often undervalued by the system in terms of salary, protection and recognition (Woods et al., 2023).

2.2.2. Wellbeing

Wellbeing is a multidimensional idea and in fields like psychology, public health and economics it's usually interpreted as a combination of life satisfaction, absence of negative emotions, positive emotions and good psychological functioning (Diener, 2000; Ryff & Keyes, 1995). In the work context, researchers usually differentiate between work engagement, job satisfaction, burnout and mental health, as they are related but not quite identical aspects of wellbeing (van Horn et al., 2004; Maslach & Leiter, 2016).

In this study, the focus will be on mental wellbeing related to work during the pandemic, including self-evaluations of anxiety levels, mental health and emotional strain. This focus is the result of studying most of the COVID-19 literature, which primarily analyses mental health conditions like depression, anxiety and stress among workers (Pappa et al., 2020; Vindegaard & Benros, 2020). It's particularly important for essential workers under extreme conditions to look at their mental health, as constant stress and anxiety can lead to long-term consequences for their productivity, their health and their careers (Benach et al., 2014).

Some surveys tend to use validated scales like the GHQ-12[1] or the HADS[2] or simple self-reported questions on mental health or anxiety to be able to measure mental wellbeing (Bell et al., 2021; Eurofound, 2021). In the UCD Working in Ireland Survey, wellbeing is measured with questions about mental health problems and anxiety related to work during COVID-19 (Geary & Belizón, 2022). These answers can be combined to create a continuous indicator of mental wellbeing, or they can also be treated as ordered categories. This depends on the empirical strategy and the distribution of the data.

In this study, mental wellbeing will be treated as the main dependent variable that the regression model tries to explain. This way, the theoretical framework should take existing theories and empirical evidence to identify explanatory variables and explain how they are expected to influence wellbeing.

2.3.Theoretical frameworks for explaining wellbeing: JD-R and ERI

To explain the choice of explanatory variables and the expected behavior of their effects on wellbeing, this study takes into account two famous frameworks from research of occupational health: the Job Demands-Resources (JD-R) model and the Effort-Reward Imbalance (ERI) model. Both have been used in various contexts and provide information on how working conditions can affect mental health.

[1] Self-reported 12-item questionnaire to detect psychological distress and potential mental health issues.
[2] Self-reported 14-item questionnaire to measure the severity of anxiety and depression on patients with physical health conditions.

2.3.1. Job Demands-Resources (JD-R) model

The JD-R model is used to study the way different job characteristics can affect both health and wellbeing (Bakker & Demerouti, 2007, 2017). It differentiates between job demands and job resources.

The first one consists of aspects of the job that demand constant physical and/or psychological effort and therefore have physical or psychological costs. Some examples include time pressure, heavy workload, interactions that are emotionally difficult, role conflicts and, when talking about COVID-19, exposure to infection and fear of contagion.

The latter includes aspects of the job that make workers able to achieve their goals, reduce job demands and their costs, or support personal growth and development. Some examples are autonomy, supervisor support, opportunities for learning, clear communication, fair treatment and organizational safety measures.

This model also identifies two processes: the health impairment process and the motivational process. The first one implies that high job demands have a negative effect on employees' mental and physical resources and can cause lower wellbeing and health problems. Meanwhile, the motivational process suggests that job resources boost motivation, work engagement and resilience and can also reduce the negative impact of demands on wellbeing (Bakker & Demerouti, 2017).

When it comes to essential workers during COVID-19, job demands refer to traditional elements, such as work intensity and workload, and other factors that are pandemic specific, like higher exposure risk to infection due to contact with patients, customers or colleagues (Blau et al., 2021; Geary & Belizón, 2022); greater psychological demands like fear of contagion, worry about infecting family members and dealing with distressed service users or patients (Brooks et al., 2020; Porceli, 2020).; and increased work-family conflict because of school closures and a reduced external support (Alon et al., 2020; Collins et al., 2021).

In this context, job resources include perceived organizational support and collective representation. The first refers to clear information about safety procedures, access to PPE[3], realistic workload adjustments and mental health support (Eisenberg et al., 1986; Holmes et al., 2020; Xiao et al., 2020). Meanwhile, an example of collective representation is a union

[3] Personal Protective Equipment used at the workplace for essential workers during the pandemic.

presence that can help guarantee safer working conditions, negotiate COVID-19 measures and give worker's a channel for their voice (Bryson et al., 2019; Eurofound, 2021).

In a regression model, the JD-R framework suggests that job demands should show negative effects in wellbeing and job resources should show positive effects. Also, resources can reduce the negative effect of demands, therefore making an important point to consider, which is that there can be interaction terms. Recent evidence keeps supporting this logic, showing that staffing shortages, highly stressful work environments and limited organizational support are linked to worse mental health, while measures introduced by the employer can reduce some of this negative impact (World Health Organization, 2024; Belita et al., 2025).

Hypothesis 1 (H1). Higher work-related strain, particularly stressful work and difficulty unwinding after work, is negatively associated with mental wellbeing among essential workers.

2.3.2. Effort-Reward Imbalance (ERI) model

The ERI model provides another point of view, as it focuses on the balance between effort and rewards at work (Siegrist, 1996). It states that work-related stress and bad health can result both from high effort and an imbalance between low reward and high effort. Effort applies to workload, time pressure, responsibilities and obligations, while rewards regard financial compensation, job security, career opportunities and esteem (respect and recognition).

During COVID-19, a lot of essential workers noticed a strong imbalance, as they put considerable effort into their work under risky conditions, but still received a low salary and job security and not enough recognition (Burström & Tao, 2020; Sarti & Torre, 2021). For example, care workers and cleaners were praised as "heroes", but in most cases their wages and employment conditions didn't change or even became less secure (Blundell et al., 2020). This theory argues that the imbalance between high effort and insufficient rewards is a powerful element that can deteriorate mental and physical health.

In empirical models, effort is measured with variables like hours worked, work intensity and responsibilities. Rewards are measured with income level, contract type (permanent or temporary), job security and recognition. The ERI theory states that, having a constant effort, lower rewards will mean lower wellbeing. Therefore, regression coefficients for variables that indicate low income or insecure contracts are expected to be negative, mostly in essential workers facing high demands (Benach et al., 2014; Adams-Prassl et al., 2020).

2.4.Exposure risk and mental wellbeing

2.4.1. Occupational exposure as a key demand

Exposure to COVID-19 is one of the most distinctive job demands for essential workers. Empirical work proves that jobs that involve being physically close to others and having frequent face-to-face contact with the public usually have a higher risk of infection (Blau et al., 2021; Dingel & Neiman, 2020). In Ireland, the UCD Working in Ireland Survey states that for every ten essential workers, around six of them thought of they had a moderate or high risk of contracting COVID-19, with particularly high levels in human health, defence and public administration (Geary & Belizón, 2022).

Exposure can be measured subjectively, with self-reported risk level, or objectively, based on sector and occupation. In this study, perceived exposure risk is considered a job demand that's expected to affect wellbeing in a negative way, as it has been proven in previous epidemics that health workers exposed to SARS or Ebola had an increased risk of having PTSD, depression and anxiety (Maunder et al., 2003; Kisely et al., 2020). Similarly, during COVID-19, meta analyses[4] showed that frontline workers working in high-exposure environments had higher levels of anxiety and depression (Pappa et al., 2020; Vindegaard & Benros, 2020).

2.4.2. Risk mitigation and organizational support

Health risk mitigation measures are an important job resource. Having enough PPE, keeping distance at work, testing and vaccination, and clear safety protocols can reduce actual risk and perceived fear (Brooks et al., 2020; Eurofound, 2021). From the point of view of the JD-R model, these measures should mitigate the negative relationship between exposure and wellbeing (Bakker & Demerouti, 2017).

In this context, perceived organizational support is closely related to risk mitigation, as workers that feel that their organization prioritizes their safety while providing the needed resources usually report better mental health and are more able to cope with high job demands (Eisenberger et al., 1986; Xiao et al., 2020). Regression models are able to capture this by including variables for PPE access, satisfaction with safety measures or general organizational

[4] A statistical method that combines quantitative data from numerous independent studies to develop one conclusion with higher statistical power.

support and by testing interactions with exposure risk, investigating if support cancels out the negative impact of high exposure.

Hypothesis 2 (H2). Higher perceived organizational support is positively associated with mental wellbeing among essential workers.

2.5.Work effort, work-family conflict and wellbeing

2.5.1. Extensive and intensive work effort

Another important group of explanatory variables are related to work effort. There are two types of effort: extensive and intensive. The first one refers to the number of hours worked, including overtime, while the latter refers to how hard or fast the work is within those hours (Green, 2001). During the COVID-19 pandemic, many essential workers experienced both extra hours and work intensification due to shortage of staff, higher demand or implementation of new processes (Eurofound, 2021; Geary & Belizón, 2022).

Before COVID-19, research had already linked long hours and high intensity to higher stress and burnout and poorer health (Green, 2001; Kelliher et al., 2019; Mauno et al., 2019). In the context of COVID-19, these negative relations are likely to become stronger due to the combined impact of health risks and emotional stress. Data from the UCD survey confirms that a significant percentage of essential workers in Ireland reported working more than 40 hours per week and having high work intensity, and that intensity was strongly related to worse values in mental health indicators (Geary & Belizón, 2022). More recent evidence also shows that not being able to disconnect from work was an important reason why difficult conditions during the pandemic were linked to worse mental health (Trógolo et al., 2022; Woods et al., 2023).

From an analytical perspective, hours per week and work intensity scores can be used as continuous or categorical variables to predict in the regression model. Based on the literature review, their coefficients should be negative, as greater effort leads to lower wellbeing, particularly when there's also exposure risk and low organizational support.

Hypothesis 3 (H3). Higher work effort, measured with longer working hours and greater work intensity, is negatively associated with mental wellbeing in essential workers.

2.5.2. Work-family conflict and care responsibilities

The pandemic also made home life more demanding, as the closure of schools, daycare centres and other services meant families had to adopt those care responsibilities, often without working less hours. Essential workers, who normally couldn't work from home, faced significant challenges in balancing their jobs with these extra home responsibilities (Collins et al., 2021).

Conflicts between work and family have been known to cause stress and lower wellbeing for a long time (van Horn et al., 2004). During COVID-19, numerous studies proved these work-family were increasing and that they are associated with poorer mental health, mainly in mothers in frontline occupations (Hjálmsdóttir & Bjarnadóttir, 2021). This relationship has continued to receive support in more recent research, which shows that work-family conflict is still one of the main ways in which difficult working conditions harm employee wellbeing (Yang et al., 2024).

Moreover, these relationships tend to differ between men and women. As women usually do more unpaid care work, work-family conflicts might have a stronger effect on female essential workers (Alon et al., 2020; Collins et al., 2021).

Hypothesis 4 (H4). Higher work-family conflict and more care responsibilities are negatively associated with mental wellbeing in essential workers.

2.6.Organizational and institutional resources

2.6.1. Perceived organizational support

Perceived organizational support (POS) is a very important job resource that shows how employees feel that their organization values their contributions and cares about their wellbeing (Eisenberger et al., 1986). During the pandemic, POS also included clear communication of health and safety, concern showed by managers, reasonable changes to work organization, and access to mental health support (Holmes et al., 2020).

Research during COVID-19 shows that when workers feel supported by their organization and supervisors, they tend to have less stress and better mental health among healthcare workers and other frontline staff (Xiao et al., 2020). Within the JD-R model, this support can directly increase wellbeing and cancel out the negative effects of demands like exposure risk and work

intensity (Bakker & Demerouti, 2017). For example, workers that feel that their complaints are taken seriously and that their safety is prioritized, can deal with high workloads and fear of contagion in a better way than those that believe their organization in indifferent to these problems.

In a regression model, POS is usually measured with composite scales or items showing the extent to which employees feel supported and valued by their organization or managers. POS is expected to have a positive effect on wellbeing, and it can also act as a moderator, so that the negative effect of high job demands, like work intensity and exposure risk, is less when POS is high.

Recent post-pandemic evidence proposes that organizational support is still essential to protect worker wellbeing, particularly when it's translated into concrete measures, manageable workloads and access to psychological support (World Health Organization, 2024; Belita et al. 2025).

2.6.2. Trade union presence and worker representation

Collective representation through trade unions or similar bodies can also be interpreted as a resource at the workplace. Unions usually take part in negotiating safer working conditions, ensuring PPE, influencing how staff are hired and treated and providing a space for workers' voice (Bryson et al., 2019; Eurofound, 2021). In some countries, workplaces with unions put stronger COVID-19 safety measures and agreements regarding isolation, sick pay and flexibility around working hours, which can have a positive effect on workers' wellbeing.

The presence of a union in the workplace can be represented as a binary variable. Evidence based from an Ireland study suggests that the presence of a union is related to fairly better safety conditions and can be linked to better wellbeing results within essential workers, even though these effects depend on the context and sector they apply to (Geary & Belizón, 2022). Because of this, in a regression model, union presence is expected to have a positive relation with wellbeing, especially after controlling for sector, occupation and firm size.

Hypothesis 5 (H5). The presence of trade unions or worker representation at the workplace is positively associated with mental wellbeing within essential workers, after controlling for sector, occupation and firm size.

2.7.Socio-demographic and job quality determinants

2.7.1. Gender, age and family situation

Socio-demographic characteristics are important control variables, but they also have direct effects on wellbeing. Gender is especially relevant, as women are a great majority in many essential occupations (such as nursing, elder care, cleaning and retail) and they usually also do more unpaid care work at home (Burström & Tao, 2020; Blundell et al., 2020). Research done during COVID-19 shows that female essential workers tend to report higher stress levels, anxiety and depressive symptoms than men, even after controlling job-related factors (Tropiceanu et al., 2021; Wielgoszewska et al., 2022)

In the regression mode, gender is usually converted into a binary variable (female vs male), and on average female workers are expected to have lower wellbeing scores. Interaction terms with care responsibilities, essential status and work-family conflict help examine if women are more affected by high demands. Empirical and theoretical work about gender and unpaid care suggests that these interactions are likely to be relevant (Alon et al. 2020; Collins et al., 2021),

Age can also influence wellbeing. Younger workers can encounter more job insecurity and financial strain, while older workers might worry more about serious health consequences if infected (Eurofound, 2021). Some studies find a U-shaped relationship between age and wellbeing, with middle-aged workers reporting lower wellbeing (Diener, 2000). Despite this, the specific pattern during COVID-19 isn't fully clear and needs to have an empirical study.

Family situation, like having children, affects demands and resources. Parents might encounter high levels of work-family conflict, especially single parents and parents of young children, with negative consequences for wellbeing (Collins et al., 2021). Because of this, family-related variables are included as controls and examined as potential moderators in the regression model.

Hypothesis 6a (H6a). Female essential workers report on average, lower mental wellbeing than male essential workers, after controlling for job demands and job quality.

Hypothesis 6b (H6b). Essential workers with children have lower mental wellbeing, mainly due to higher work-family conflict.

3. Methodology

3.1.Description of the database

The empirical analysis in this study is based on the UCD Working in Ireland Survey from 2021, a cross-sectional survey carried out by University College Dublin to analyze working conditions and employment relations in Ireland during the COVID-19 pandemic. The survey was administered online to a sample of employees in different sectors and occupations, with special focus on changes in work organization, health and safety, and workers' experiences of the pandemic.

The dataset contains individual-level information on employees' socio-demographic characteristics, like household composition, age, education and gender; job characteristics like union presence, contract type, income, occupation and sector; and various dimensions of working conditions, including exposure to COVID-19, perceived organizational support, work-family conflict and work effort. It also includes different items on mental health and anxiety self-reported by workers and related to work during COVID-19, which are used in this study to construct the main indicator of mental wellbeing.

This study uses a quantitative research method, because it relies on structured numerical data and examines relationships between variables with a statistical analysis, with a goal of measuring patterns and relations numerically. More specifically, it follows a cross-sectional explanatory research design, as the objective is to identify the factors associated with mental wellbeing in essential workers during the COVID-19 pandemic. The analysis uses numerical variables resulting from survey responses, which are transformed into scales to be used for the analysis.

For this study, self-reported essential worker status is used to define the analytical sample, as respondents were asked if they considered their job as essential during the COVID-19 pandemic. For the analysis, only those that classified themselves as essential are used, which is consistent with the objective of identifying how work-related demands, exposure risks and organizational resourced affected wellbeing to a group that had especially stronger pressures during the pandemic. The final sample size (N=892) has enough variation to be able to estimate the regression models and test the hypothesis created.

Even though the UCD Working in Ireland Survey offers a lot of information on working conditions during COVID-19, it's also important to acknowledge its limitations. First, the data

is self-reported, so there might be some inaccuracy, and some might have responded in a more socially acceptable way. Second, as the survey is cross-sectional, meaning it was collected at one point in time, it can't show how changes over time. Third, while the survey includes workers from different sectors, there might be some groups that are more represented than others. These limitations should be kept into account when interpreting the statistical analysis.

3.2.Data processing

Before conducting the empirical analysis, different processing steps had to be carried out to make sure the dataset was suitable for descriptive statistics and regression modelling. These steps included data cleaning, recoding of variables, construction of composite indicators and handling of missing values.

The original dataset was the starting point, from which the analytical sample was restricted to workers classified as essential. All observations that didn't comply with this condition were excluded from the analysis, as the objective of the study is to examine the factors that affect essential workers' wellbeing during the COVID-19 pandemic. The way this filter was applied was through a question (Q44) regarding for how long a period the respondent worked from home, and those who responded that they hadn't at all, were considered as essential workers. In other words, the final analytical sample only contained those that had not worked from home, thus, essential workers. This restriction was made to be able to focus the analysis on a homogeneous group of essential workers that continued to work on site during the pandemic.

Regarding data cleaning, only the relevant variables were kept in the final working dataset, those unrelated to the explanatory framework were removed to make a simpler database and reduce analytical noise. As a result, the final dataset only included the recoded explanatory variables, the survey weight and the dependent variable resulting from the PCA process.

The dependent variable for one of the models resulted from principal component analysis (PCA) to combine five variables related to anxiety to a single variable. The items explained anxiety about pay reduction, inability to use skills, job loss, difficulties securing new employment and reduced working hours. PCA was used to reduce dimensionality and summarise the common variance across these related variables. First, these items were transformed into a numerical scale ranging from 0 ("Not at all anxious") to 4 ("Extremely anxious"). The five variables were then combined into the first principal component, which

was then used as the dependent variable in the regression analysis, as higher values of this component mean greater anxiety, which means lower levels of wellbeing.

As many survey responses were originally text categories, a systematic recoding process was required. Categorical and ordinal variables were transformed into numerical scales so that they could be incorporated in the regression analysis. This recoding applied to sector, occupation, long working hours, work-related disconnection, trade union membership, perceived union effectiveness, management support items, perceptions of fairness and trust, age group, marital status, parental status, education, country of origin, income level, and different indicators of job demands. In each case, the coding scale followed the ordering of the response categories, for the variables to be interpreted consistently in the quantitative analysis.

However, not all variables were transformed. Training effectiveness and Job autonomy were kept intact, as they were already in numerical form. Another variable that wasn't transformed was Weight, as it works as an adjustment factor to help correct the sample distribution in line with the structure of the Irish labor market.

Missing data was kept whenever possible, instead of being removed. This was especially important in the creation of the dependent variable, as in the items related to anxiety used for PCA, there were responses like "I don't know". These were kept as missing values, but PCA was only calculated for those with complete information on the five anxiety items that were combined into one principal component. Observations with any missing information on any of these items were assigned a missing value on the first principal component, and once the component had been created, the temporary auxiliary variables generated for the PCA were removed from the final database.

There were also some variables that at first were kept in the dataset, but since they had a broad range of missing values or had very low explanatory power, had to be removed for the model to work better. These were the variables about union effectiveness, age of children, number of children, income, perceived fairness and marital status. When removing these variables, the model ran more smoothly, since the high number of missing values were interfering with the objective of the study.

Overall, this preprocessing procedure resulted in a clean and analytically focused dataset containing the explanatory variables required for the study, the survey weight, and the dependent variable measuring wellbeing related to anxiety. This final dataset was the basis for the descriptive and multivariable regression analyses.

3.3.Variables and sample's preliminary descriptive statistics

This section presents the variable used in the empirical analysis and summarizes their main descriptive characteristics in the final analytical sample. To be cohesive with the objective of the study and be able to examine the factors associated with wellbeing in essential workers during the COVID-19 pandemic, the following variables have been selected. For clarity, the variables are divided into the dependent variable, the control variables and the independent variables included in the regression models.

Dependent variable:

Before describing each outcome variable, it is important to clarify how mental wellbeing is measured in this study. Although wellbeing is a broad concept, its empirical measurement is constrained by the items available in the UCD Working in Ireland Survey (2021). The only consistent wellbeing-related indicators in the dataset are the five work-related anxiety items in question Q35. For this reason, mental wellbeing is operationalised exclusively through these anxiety variables, both individually and combined into a single principal component (PC1_anxiety), so that higher anxiety is interpreted as lower wellbeing. This approach is consistent with the COVID-19 literature, which has predominantly relied on anxiety measures to assess workers' mental health during the pandemic (Pappa et al., 2020; Vindegaard & Benros, 2020).

For Model 1 of this study, the outcome variable is PC1_anxiety, which is understood as an indicator of wellbeing. This variable was constructed with PCA using five variables related to anxiety about employment and job-related uncertainty. Instead of relying on a single question, with this process it's possible to capture a broader dimension of psychological strain. In a nutshell, higher values of PC1_anxiety reflect higher levels of anxiety, therefore lower levels of wellbeing. The remaining model will examine the independent variables for each of the anxiety items in order to determine if there is any variation across different sources of employee anxiety.

For Model 2, the outcome variable is Q35_LosingJob, which captures the anxiety of respondents' about losing their job. This variable reflects a specific aspect of insecurity related with employment and focuses on the fear of job loss during the pandemic context. Higher values indicate greater anxiety about losing their job, and therefore, lower levels of wellbeing in this field.

For Model 3, the outcome variable is Q35_DifficultToUseSkills, which measures respondents' anxiety about not being able to use their skills in the future. This variable represents concerns related to the possibility of not using their personal abilities and professional qualifications. Higher values mean more anxiety related to skill utilization, which can also be interpreted as a sign of lower wellbeing.

For Model 4, the outcome variable is Q35_ReducePay, which represents anxiety about a possible reduction in pay. This variable reflects financial insecurity as a type of anxiety related to employment. Higher values indicate greater concern about salary reduction and therefore mean lower levels of wellbeing in economic terms.

For Model 5, the outcome variable is Q35_Hours, which captures anxiety about a possible reduction in working hours. This variable captures uncertainty about job stability and unexpected changes to their hours of work. Higher values mean greater anxiety about losing working hours, and, as a result, lower levels of wellbeing.

For Model 6, the outcome variable is Q35_SecuringNewEmployment, which represents anxiety about difficulties in securing new employment. This variable represents how insecure workers feel about their chances of finding another job. Higher values then indicate greater anxiety about finding a new job, which leads to lower wellbeing in relation to employment prospects.

Control variables:

A set of control variables is included in the database to explain the background of the respondents and account for any differences related to it that might also be related to wellbeing. These variables describe the respondents' demographic, educational, household and labour-market position, like gender, age, parental situation, education, sector, occupation, sector, country of origin and income level. They are used to take into account basic differences between respondents, so that the results are more accurate.

Table 1. Control Variables' definition and descriptive values

Variable	Definition	Values	Descriptive (N = 891) in %	VIF
Q16_Sector	Sector of employment	Agriculture, forestry, fishing and mining [1]	4.5	1.31
		Energy & Construction [2]	8.4	
		Wholesale & retail [3]	15.3	
		Transport & hospitality [4]	15.6	
		ICT, professional, scientific, technical, admin & support, arts and other services [5]	12.7	
		Financial services & real estate [6]	2.7	
		Public administration & defence [7]	3.4	
		Education [8]	2.6	
		Human health [9]	23.5	
		Manufacturing [10]	11.4	
Q18_Occupation	Occupational group	Elementary occupations [1]	12.9	1.16
		Professional occupations [2]	15.2	
		Associate professional occupations [3]	8.8	
		Administrative and secretarial occupations [4]	4.7	
		Skilled trades occupations [5]	13.9	
		Caring, leisure and other service occupations [6]	10.3	
		Sales and customer service occupations [7]	11.6	
		Process, plant and machine operatives [8]	17.0	
		Managers, directors and senior officials [9]	5.6	
Q4_AgeClassification	Age group	15–24 [1]	16.9	1.49
		25–34 [2]	17.3	
		35–44 [3]	20.7	
		45+ [4]	45.1	
Q59_Gender	Gender	Male [1]	58.6	1.49
		Female [2]	41.4	
Q62_Children	Whether the respondent has children	Yes [1]	36.5	—
		No [2]	63.5	
Q66_Education	Educational attainment	Up to upper secondary [1]	38.2	1.27
		Non-tertiary & short-cycle tertiary [2]	26.5	
		College education [3]	35.4	
Q67_Country	Country/region of origin	Ireland [1]	71.1	1.04
		UK including NI [2]	6.0	
		EU [3]	10.4	
		North America [4]	1.0	
		Asia [5]	5.3	
		Africa [6]	2.9	
		Other [7]	3.3	
		Valid N = 886		

Independent variables:

The explanatory variables represent the main conditions related to work that might affect wellbeing in essential workers, according to the theoretical framework.

Table 2. Independent Variables' definition and descriptive values

Variable	Definition	Values	Descriptive (N = 891) in %	VIF
Q30_LongHours48H	Weekly working hours	Working up to 48 hours/week [1]	85.6	1.09
		Working over 48 hours/week [2]	14.4	
Q31_RightToDisconnect	Need to remain connected to work outside normal working hours	Always [1]	21.7	1.38
		Sometimes [2]	28.8	
		Rarely [3]	19.0	
		Never [4]	30.5	
Q37_TradeUnion	Trade union membership	Yes [1]	44.0	69.62
		No [2]	56.0	
		Valid N = 811		
Q40_UnionEffectiveness	Perceived effectiveness of the trade union	High effectiveness [1]	53.2	1.07
		Low effectiveness [2]	46.8	
		Valid N = 327		
Q41_Encourages	Management encourages and supports your development	Strongly agree [1]	33.2	2.43
		Agree [2]	42.0	
		Neither [3]	11.7	
		Disagree [4]	8.8	
		Strongly disagree [5]	4.3	
		Valid N = 811		
Q41_Praise	Management gives you praise and recognition when you do a good job	Strongly agree [1]	34.2	1.77
		Agree [2]	40.6	
		Neither [3]	10.7	
		Disagree [4]	10.1	
		Strongly disagree [5]	4.4	
		Valid N = 811		
Q41_Respects	Management respects you as a person	Strongly agree [1]	46.5	2.19
		Agree [2]	42.4	
		Neither [3]	6.4	
		Disagree [4]	3.3	
		Strongly disagree [5]	1.4	
		Valid N = 811		
Q41_Helpful	Management is helpful to you in getting the job done	Strongly agree [1]	36.7	2.63
		Agree [2]	43.4	
		Neither [3]	7.9	
		Disagree [4]	8.5	
		Strongly disagree [5]	3.5	
		Valid N = 811		
Q42_Trust	Employees trust management	Strongly agree [1]	23.2	1.69
		Agree [2]	43.2	
		Neither [3]	13.2	
		Disagree [4]	14.1	
		Strongly disagree [5]	6.4	
		Valid N = 811		
Q33_DifficultToUnwind	Difficult to unwind after work	All the time [1]	6.7	1.70
		Almost all of the time [2]	9.5	
		Some of the time [3]	27.7	
		Rarely [4]	21.4	
		Never [5]	34.6	
Q33_HighSpeeds	Working at very high speed	All the time [1]	15.6	1.58
		Almost all of the time [2]	19.9	
		Some of the time [3]	36.0	
		Rarely [4]	14.8	
		Never [5]	13.7	
Q33_InterfereWithLife	Work interferes with life	All the time [1]	4.4	1.56
		Almost all of the time [2]	7.2	
		Some of the time [3]	30.6	
		Rarely [4]	22.9	
		Never [5]	34.9	
Q33_Replaceable	Feeling replaceable at work	All the time [1]	23.0	1.09
		Almost all of the time [2]	7.7	
		Some of the time [3]	31.9	
		Rarely [4]	18.1	
		Never [5]	19.3	
Q33_Stressful	Work is stressful	All the time [1]	7.1	1.70
		Almost all of the time [2]	10.1	
		Some of the time [3]	45.6	
		Rarely [4]	21.1	
		Never [5]	16.2	
Q33_TightDeadlines	Working to tight deadlines	All the time [1]	20.2	1.46
		Almost all of the time [2]	18.0	
		Some of the time [3]	34.9	
		Rarely [4]	12.2	
		Never [5]	14.7	
Q33_WorryAfterWork	Worrying about work after work	All the time [1]	5.2	1.61
		Almost all of the time [2]	7.0	
		Some of the time [3]	32.2	
		Rarely [4]	27.8	
		Never [5]	27.8	

4. Results

This section shows and explains the main empirical results of the study. First, it explores the relationships between the dependent variable and the set of control and explanatory variables. Later, it presents the regression models used to examine which factors are more strongly associated with wellbeing within essential workers during the COVID-19 pandemic.

4.1.Spearman Correlation Analysis for the dependent variable

Before estimating the regression models, it's relevant to examine the bivariate relationships between the dependent variable and the other variables included in the analysis. The following figures present Spearman correlation matrices for the control variables and the independent variables in relation to PC1_anxiety. This step helps identify the variables that are more closely related with wellbeing before studying the regression results.

Figure 1. Control, independent & dependent variables

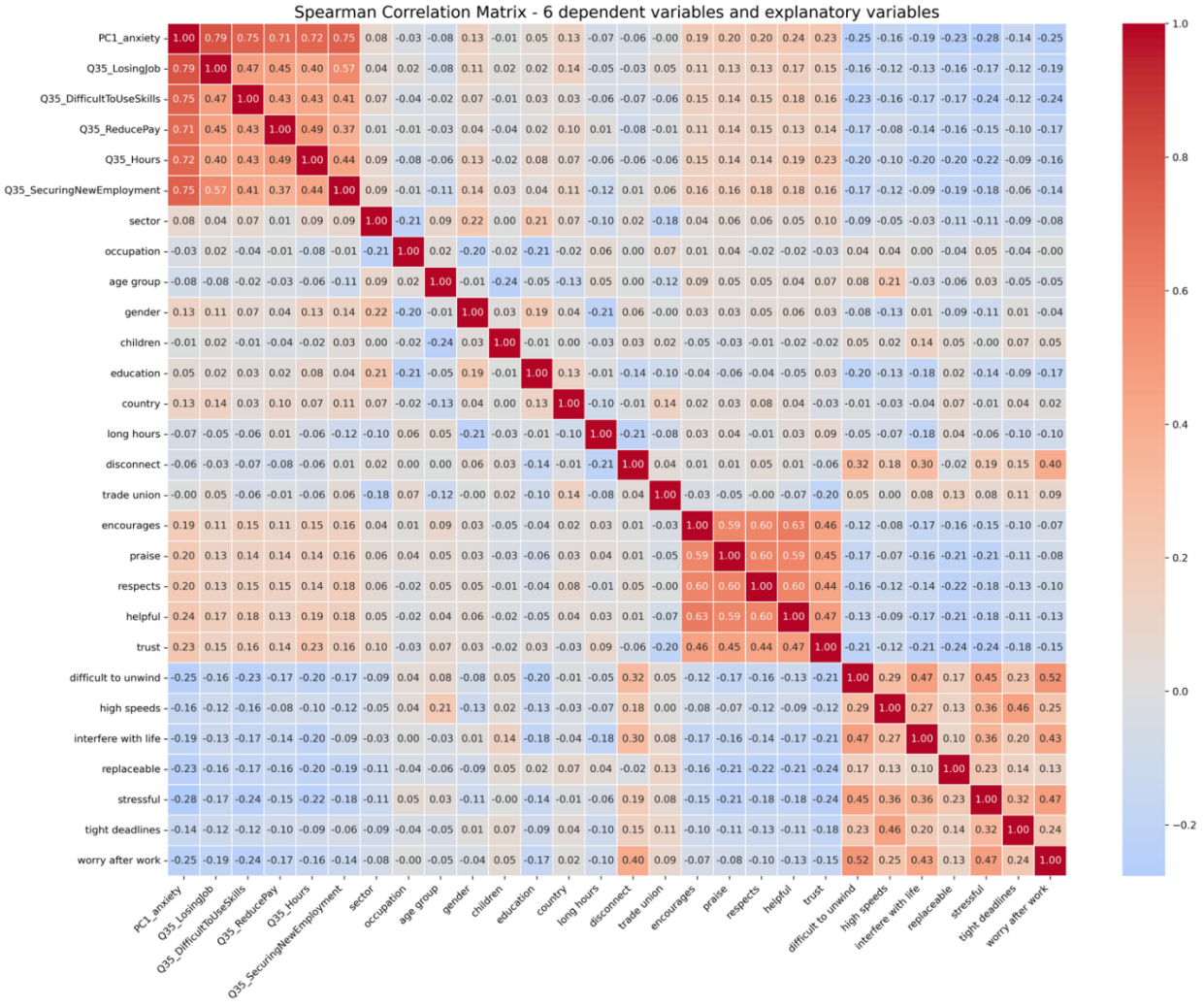

Figure 1 presents the Spearman correlation matrix, including the six dependent variables and the final set of explanatory variables. The most remarkable result is that the six outcome variables are positively and strongly correlated with each other. PC1_anxiety shows particularly high correlations with the five original Q35 items, going from around 0.71 to 0.79, and the correlations among the other five anxiety variables are also positive. This confirms that all six outcomes capture closely related dimensions of anxiety related to employment and supports the use of PC1_anxiety as a combination and summary indicator of anxiety-based wellbeing.

Regarding the explanatory variables, the strongest patterns are found as expected. The management-support variables (**encourages**, **praise**, **respects**, **helpful** and **trust**) are moderately to strongly correlated with one another, with coefficients mostly between 0.44 and 0.63, which suggests that they reflect related aspects of perceived organizational support. At the same time, the job-strain variables also have positive associations among themselves, for example **difficulty to unwind**, which is positively related to **worry after work** (0.52), **interfere with life** (0.47) and **stressful** (0.45), or **high speeds**, which is also positively associated with **stressful** and **tight deadlines**. This is consistent with the idea that these variables capture connected aspects of work pressure.

Regarding the dependent variables, their clearest bivariate associations are generally negative with the support variables and positive with the strain variables. Particularly, **PC1_anxiety** seems to positively associate with **stressful**, **tight deadlines** and **worry after work**, and the same general pattern is visible for the five individual Q35 outcomes. Overall, although many of these bivariate correlations are moderate, the matrix already suggests that lower wellbeing is mainly linked to weaker organizational support and higher job strain.

4.2.Predictive model: Weighted Linear Regression (WLS)

Weighted Linear Regression (WLS) is a statistical method used to analyse the relationship between a dependent variable and a set of explanatory variables, while applying different weights to observations. This is particularly useful when working with survey data, as some cases can be more representative than others.

In this study, WLS is used because the dataset includes a weight variable, which is applied in all models to obtain results that reflect the structure of the Irish labour market more accurately. Six weighted regression models are estimated: one with PC1_anxiety as the dependent variable

and five others with each original anxiety item separately. This approach makes it possible to identify which job-related and socio-demographic factors are more strongly associated with lower wellbeing among essential workers.

4.3.Results and analysis

Table 4. Weighted linear regression models (coefficients, p-values and R-squared)

Section	Variable	Model 1			Model 2			Model 3			Model 4			Model 5			Model 6		
		Coefficient	p-value	Other values	Coefficient	p-value	Other values	Coefficient	p-value	Other values	Coefficient	p-value	Other values	Coefficient	p-value	Other values	Coefficient	p-value	Other values
Control Variables	Q59_Gender[Female]	0.2314*	0.078		0.1850**	0.04		-0.0325	0.692		0.0879	0.368		0.138	0.121		0.1613*	0.079	
	Q4_AgeClassification[25-34]	-0.3570*	0.08		-0.1996	0.15		-0.1234	0.296		-0.158	0.308		-0.2317	0.104		-0.1805	0.211	
	Q4_AgeClassification[35-44]	-0.3591*	0.096		-0.0456	0.759		-0.0468	0.724		-0.3445**	0.044		-0.3256**	0.025		-0.1686	0.28	
	Q4_AgeClassification[45+]	-0.2117	0.261		-0.0614	0.63		0.0541	0.637		-0.1304	0.361		-0.2355*	0.061		-0.1742	0.19	
	Q62_Children[No]	-0.0344	0.801		0.0567	0.551		0.0028	0.973		-0.1335	0.193		-0.0734	0.403		0.056	0.567	
	Q67_Country[UK including NI]	-0.126	0.567		-0.0927	0.561		-0.2652**	0.034		0.1264	0.5		-0.0135	0.934		0.0087	0.962	
	Q67_Country[EU]	0.3498*	0.051		0.1484	0.273		-0.0346	0.752		0.4912***	0.001		0.2536**	0.032		0.043	0.73	
	Q67_Country[North America]	-0.407	0.293		-0.1808	0.547		-0.2151	0.541		-0.5115	0.191		-0.1768	0.73		0.1069	0.71	
	Q67_Country[Asia]	1.0808***	0		0.8438***	0		0.4767**	0.013		0.4873**	0.013		0.305	0.102		0.4998**	0.011	
	Q67_Country[Africa]	0.7359**	0.024		0.6733***	0.006		0.2677	0.264		0.1874	0.503		0.0905	0.726		0.5748**	0.015	
	Q67_Country[Other]	1.0204**	0.024		0.6985**	0.013		-0.0465	0.823		0.6662**	0.017		0.4513*	0.064		0.3414	0.25	
Independent Variables	Q18_Occupation[Professional occupations]	-0.6548**	0.01		-0.5393***	0.002		-0.2059	0.185		-0.1835	0.313		-0.2232	0.173		-0.3650**	0.046	
	Q18_Occupation[Associate professional occupations]	-0.3512	0.189		-0.2129	0.218		-0.1346	0.451		0.0186	0.927		-0.2803	0.119		-0.2791	0.13	
	Q18_Occupation[Administrative and secretarial occupations]	-0.5714*	0.061		-0.3728*	0.058		-0.0251	0.894		-0.3039	0.156		-0.3931**	0.049		-0.2982	0.177	
	Q18_Occupation[Skilled trades occupations]	-0.4470*	0.078		-0.3449**	0.036		-0.2029	0.155		-0.0863	0.649		-0.1489	0.355		-0.3156*	0.061	
	Q18_Occupation[Caring, leisure and other service occupations]	-0.1557	0.552		-0.2419	0.159		0.0096	0.95		-0.0786	0.687		0.0924	0.586		-0.1526	0.411	
	Q18_Occupation[Sales and customer service occupations]	0.1339	0.614		0.1942	0.273		0.1027	0.5		0.0069	0.972		-0.0947	0.58		0.0493	0.787	
	Q18_Occupation[Process, plant and machine operatives]	-0.4602**	0.044		-0.1688	0.275		-0.2079	0.114		-0.2848	0.106		-0.2856*	0.063		-0.2192	0.18	
	Q18_Occupation[Managers, directors and senior officials]	-0.7667**	0.02		-0.3217	0.175		-0.3841**	0.032		-0.2657	0.255		-0.6873***	0		-0.1478	0.534	
	Q16_Sector[Energy & Construction]	0.3773	0.307		0.254	0.332		-0.1668	0.485		0.105	0.705		0.4079*	0.053		0.3158	0.274	
	Q16_Sector[Wholesale & retail]	0.2239	0.505		0.1451	0.557		-0.1182	0.604		-0.1691	0.506		0.3966**	0.034		0.3652	0.175	
	Q16_Sector[Transport & hospitality]	0.5029	0.126		0.1902	0.42		0.1159	0.6		-0.0082	0.974		0.5949***	0.001		0.3309	0.211	
	Q16_Sector[ICT, professional, scientific, technical, admin & support, arts and other services]	0.2523	0.468		0.2954	0.24		-0.165	0.472		-0.2647	0.308		0.3627*	0.067		0.3526	0.208	
	Q16_Sector[Financial services & real estate]	0.4011	0.357		0.014	0.964		0.3535	0.246		-0.1846	0.578		0.4109	0.121		0.4211	0.217	
	Q16_Sector[Public administration & defence]	0.1675	0.707		-0.1508	0.634		-0.0376	0.903		-0.0882	0.786		0.5080*	0.095		0.3107	0.374	
	Q16_Sector[Education]	0.7762	0.148		0.5105	0.154		0.1995	0.54		-0.1198	0.73		0.6478*	0.059		0.6630*	0.077	
	Q16_Sector[Human Health]	0.1738	0.622		0.1313	0.612		-0.1123	0.632		-0.082	0.75		0.3665*	0.066		0.2327	0.403	
	Q16_Sector[Manufacturing]	0.4144	0.21		0.3261	0.186		-0.0222	0.922		-0.1475	0.56		0.3381*	0.071		0.5864**	0.032	
	Q31_RightToDisconnect	0.0356	0.545		0.0395	0.327		0.0181	0.596		-0.021	0.643		-0.0169	0.674		0.0444	0.284	
	Q33_HighSpeeds	0.0099	0.876		-0.0027	0.949		-0.0519	0.162		0.032	0.474		0.0376	0.329		-0.0062	0.885	
	Q33_TightDeadlines	-0.0927	0.12		-0.0782**	0.046		-0.0194	0.562		-0.0720*	0.087		-0.0536	0.142		-0.0052	0.894	
	Q33_Stressful	-0.053	0.443		-0.0161	0.726		-0.035	0.424		0.0631	0.219		-0.0494	0.284		-0.0211	0.666	
	Q33_WorryAfterWork	-0.2709***	0		-0.1804***	0		-0.1593***	0		-0.1214**	0.024		-0.0678	0.17		-0.1196**	0.016	
	Q33_Replaceable	-0.2153***	0		-0.0937***	0.004		-0.0722***	0.01		-0.0980***	0.007		-0.1202***	0		-0.1292***	0	
	Q33_DifficultToUnwind	-0.1094*	0.067		-0.0357	0.387		-0.0589	0.116		-0.071	0.118		-0.0531	0.205		-0.0831*	0.051	
	Q33_InterfereWithLife	-0.0642	0.326		-0.0195	0.65		0.0022	0.956		-0.0203	0.683		-0.0906**	0.039		0.0126	0.774	
	Q37_TradeUnion	0.0058	0.962		0.0786	0.357		-0.065	0.406		0.0152	0.869		-0.064	0.437		0.0875	0.327	
	Q41_Respects	0.0133	0.896		0.0465	0.482		0.0151	0.809		0.0635	0.394		-0.073	0.304		0.0448	0.529	
	Q41_Praise	-0.0131	0.847		0.0061	0.897		-0.0365	0.4		0.0056	0.922		-0.0321	0.513		0.0156	0.753	
	Q41_Helpful	0.0769	0.335		0.0255	0.633		0.0627	0.242		-0.0095	0.877		0.0647	0.244		0.0268	0.637	
	Q41_Encourages	0.0737	0.351		-0.0436	0.395		0.0682	0.185		0.0054	0.931		0.0827	0.139		0.0616	0.257	
	Q42_Trust	0.1355**	0.04		0.0714*	0.078		0.0221	0.562		0.0731	0.148		0.0936**	0.026		0.0497	0.291	
	Q66_Education	-0.0239	0.766		-0.0003	0.996		-0.0382	0.435		-0.0621	0.283		0.0056	0.912		0.0122	0.831	
	Q30_LongHours48H	-0.0621	0.753		0.0177	0.897		-0.0368	0.758		0.0587	0.669		-0.042	0.728		-0.1375	0.316	
	N			784			801			800			795			799			801
	R-squared			0.2623			0.2012			0.1735			0.1208			0.2128			0.1822
	Adjusted R-squared			0.2184			0.1547			0.1253			0.0692			0.1668			0.1346

Table 4 shows the results of the six weighted linear regression models done in this study. The first model uses **PC1_anxiety** as the dependent variable, while the other five models take each of the original **Q35 anxiety items** separately as the dependent variables: anxiety about losing their job, anxiety about not being able to use their skills, anxiety about a pay reduction, anxiety about a reduction in working hours, and anxiety about difficulty securing new employment. This modelling strategy makes it possible to go beyond a single global indicator of anxiety and to study if the explanatory variables are associated in a similar way with the broader anxiety component and with its more specific dimensions.

From a general perspective, the models show moderate explanatory capacity. The strongest model is the one using **PC1_anxiety**, with an R-squared of 0.2623 and an adjusted R-squared of 0.2184. This means that the set of explanatory variables accounts for around one quarter of the variation of the combination of the five anxiety variables, which is a meaningful result for survey-based social data. The remaining five models are weaker, but still informative. Their R-

squared values go from 0.1208 in the pay reduction model to 0.2128 in the hours reduction model. This pattern suggests that the outcome based on PCA is more stable and easier to explain than some of the individual **Q35 items** on their own.

Model 1 gives the clearest overall picture of wellbeing within essential workers. As higher values of **PC1_anxiety** mean more anxiety and therefore lower wellbeing, positive coefficients should be interpreted as being associated with worse wellbeing, while negative coefficients indicate lower anxiety, meaning relatively better wellbeing. From the control variables, gender stands out, as the coefficient for **women** is positive and marginally significant, suggesting that women report higher anxiety than men once the rest of the variables are considered. Some categories of **age** also show negative and significant coefficients, particularly the older groups, which means there's lower anxiety in these groups compared to the reference category, which in this case is ages from 15-24. **Country of origin** is another important control variable, as the coefficients for respondents from Asia and Africa are positive and statiscally significant, indicating higher levels of anxiety compared with the category of reference, which in this case is Ireland. These results propose that the background characteristics do matter, but they don't appear to be the main source of variation in wellbeing.

The strongest findings in Model 1 come from the independent variables. **Stressful work** is positive and significant, which suggest that more stressful work is associated with greater anxiety and therefore lower wellbeing. This is one of the clearest pieces of evidence in the whole study, as it directly supports **H1**, which proposes the idea that heavier job demands have a negative impact on essential workers' wellbeing. At the same time, **feeling replaceable** is negative and highly significant, which means that workers that feel less replaceable usually report lower anxiety and therefore better wellbeing. **Difficult to unwind** shows a similar pattern, as it's also negative and highly significant, which leads to the conclusion that one of the most important drivers of wellbeing is the degree to which work pressure persists in a psychological way after the working day ends. Finally, **trust in management** is positive and significant, which shows that the organizational climate also plays a part in wellbeing. To conclude, Model 1 gives the strongest support to the argument that job demands and insecurity are strongly associated with lower wellbeing. This is aligned with **H1**, as mentioned before, and also supports the broader expectation in H6 that greater work effort and job strain are negatively related to mental wellbeing.

Model 2 uses anxiety about losing one's job as the dependent variable. Even though its explanatory value is weaker than the one for Model 1, it still shows a consistent and theoretically meaningful pattern. In this model, like in Model 1, **women** is significant, suggesting that women have greater anxiety about job loss than men. Categories of **country of origin** are still important, especially Asia and Africa, which once again show positive and significant coefficients. Regarding the occupational variables, professional occupations show a clearly negative coefficient, indicating lower anxiety about job loss compared to the reference category (elementary occupations). Administrative occupations and skilled trades occupations also show negative associations. This confirms that labour-market position keeps shaping insecurity, even when it comes to essential workers.

However, the most relevant part of Model 2 is, like in Model 1, the set of explanatory variables related to respondents' job. **Tight deadlines** is negative and significant, proposing that lower deadline pressure is related to less fear of losing one's job. **feeling replaceable** is, like before, strongly negative and significant, while **trust in management** is positive and slightly significant. This means that perceived replaceability and work-related strain are still central to understanding anxiety about job loss. This pattern reinforces the argument that subjective insecurity and demanding work conditions go together, which therefore provides additional support for **H1** and for the job-demand component of **H3**. At the same time, the role of trust gives partial support to **H2**, which states that perceived organizational support is positively associated with mental wellbeing. However, the evidence isn't strong enough to suggest a fully consistent protective effect across all support variables.

Model 3 explains anxiety about not being able to use one's skills and is quite weaker, but still informative. Here, the most notable control effects come from country of origin, especially the **UK (including Northern Ireland)**, Asia, and **Africa**. There's also a significant negative coefficient for the category of managers, directors and senior officials, which implies lower anxiety about skill use in respondents in higher occupational positions. In contrast with the first two models, however, less of the variables related to job demand remain significant. The strongest and most consistent coefficient across the models is found for **feeling replaceable**, which remains negative and significant. This suggests that workers that feel more secure and less easily replaceable also feel less anxious about their future ability to use their skills. Because of all this, the results for this model still fit the general insecurity argument about workers with more insecurity at work and feel less protected reporting lower wellbeing, even though the

overall pattern shown in this model is more limited than in Models 1 and 2. **H1** still receives some support, but weaker than in the main model.

Model 4 is the weakest model in the study, with reduction in pay as the dependent variable. Its R-squared is only 0.1208 and the adjusted R-squared decreases to 0.0692, meaning it's the specification that explains the least variation. Still, some findings remain meaningful, like **country-of-origin** categories, especially EU, Asia and Africa, which indicates that anxiety about a possible pay reduction is higher in some countries than others. Regarding the explanatory variables, **worrying after work** stands out as the most significant predictor, as it has a negative coefficient that implies that workers who worry less after work tend to report less anxiety about a reduction in pay. This reinforces the idea that one of the main reasons for poorer wellbeing is that work stress continues even after finishing work. However, apart from this variable, this model provides less evidence for the hypotheses.

Model 5 explains anxiety about a possible reduction in working hours and shows a clearer and stronger pattern. It's the second-best fitting model after Model 1, as it has an R-squared of 0.2128. Several **age** categories show negative coefficients, especially the 35-44 group, indicating lower anxiety compared to the youngest category. Regarding occupational variables, administrative and secretarial occupations are associated with lower anxiety, while some sector categories become important, particularly Wholesale &retail and Transport & hospitality, both showing positive and significant coefficients. This suggests that anxiety about working hours is strongly shaped by the **sector** respondents belonged to. Regarding explanatory variables, **feeling replaceable** again stands out as negative and highly significant. Additionally, **interference with life** is negative and significant, which is especially relevant as it means that workers who report less work-life interference also report less anxiety about reductions in working hours. This aspect leads to the conclusion that this model gives some of the clearest support in the whole analysis to the idea that work-family conflict is associated with lower wellbeing. In this sense, **H4** can be considered partially supported, as it states that more work-family conflict and more care responsibilities are negatively related to mental wellbeing in essential workers.

Model 6 focuses on anxiety about securing new employment and shows a moderate explanatory power, with an R-squared of 0.1822, which, again, points to insecurity and labour-market vulnerability leading to more anxiety and lower wellbeing. **Women** report higher anxiety, while **professional occupations** show lower anxiety than the reference category, which are

elementary occupations. Several sector categories, particularly Education and Manufacturing, are positively associated with anxiety about securing new employment. Country is still important, especially Africa and Asia, which show positive and significant coefficients. Essentially, this means that concern about future employability is socially uneven, even within essential workers. Among the explanatory variables, **worrying after work** and **feeling replaceable** are again highly significant, while **difficult to unwind** is weakly significant, which is repeated and consistent across the full set of models and indicates that workers who feel mentally unable to disconnect from work and who feel more easily replaceable also tend to be more anxious about their future employment prospects. This is one of the strongest conclusions of the analysis. By contrast, trade union presence isn't significant in this model, or any other, which is important as **H5** proposed that union presence or worker representation at the workplace would be positively associated with mental wellbeing. This means that **H5** must be considered as unsupported.

Looking across all six models, several conclusions can be drawn. First, the most consistent explanatory variables are those related to insecurity and psychological strain, as feeling replaceable and worrying after work are both significant in all or almost all models. This suggests that wellbeing among essential workers is shaped less by one isolated working condition and more by a general experience of insecurity and emotional pressure, which offers great support for **H1** and partial but meaningful support for **H3**. The results indicate that high job demands, especially those that invade workers' emotional lives, are negatively associated with wellbeing.

Second, the evidence for organizational support is more selective. Some variables related to organizational support, especially trust, are significant in some models, which provides partial support for **H2**. However, trade union presence isn't significant in any of the six models, so **H5** isn't supported.

Third, the results about socio-demographic variables are mixed. Gender appears repeatedly, always pointing to women reporting slightly higher anxiety, which gives partial support to **H6a**, which proposed women would have lower wellbeing. However, **having children** isn't significant in the main models, so **H6b** isn't supported, as it stated essential workers with children would also have lower wellbeing. This suggests that work-family conflict seems to matter more through interference with life than through having children or not.

Overall, the six weighted linear regression models point to a clear message. The factors most strongly linked to worse wellbeing among essential workers aren't just **age**, **gender**, or other personal background characteristics, but mainly **stressful work**, **insecurity**, and **not being able to switch off mentally after work.**

5. Discussion

The results of this study reinforce the idea that essential workers' wellbeing during the COVID-19 pandemic was shaped by work-related strain, perceived insecurity, and the extent to which work pressure continued beyond working hours. This is consistent with the literature review and especially with the Job Demands-Resources framework, which states that high job demands tend to affect wellbeing negatively when they require continued physical and psychological effort. As explained in the theoretical framework, stressful work, emotional pressure and work-family conflict were expected to reduce wellbeing, while supportive resources were expected to mitigate some of these effects.

In this context, the hypothesis that higher work-related strain, particularly stressful work and difficulty unwinding after work, is negatively associated with mental wellbeing among essential workers is supported by the results, as variables like stressful work, difficulty unwinding, worrying after work and feeling replaceable repeatedly show as significant across the models, especially in the main model using the PCA combination of the anxiety variables. This is consistent with the Job Demands-Resources model, which predicts that sustained physical and psychological effort leads to health impairment and lower wellbeing (Bakker & Demerouti, 2017), It also fits evidence showing that frontline workers in high-exposure environments had higher levels of anxiety and depression during the pandemic (Pappa et at., 2020; Vindegaard & Benros, 2020), and that the inability to mentally detach from work is an important mechanism linking poor working conditions with lower wellbeing (Geary & Belizón, 2022). The consistency of these variables across several outcomes suggests that wellbeing wasn't only affected by one specific pressure, but by a broader experience of insecurity and emotional exhaustion.

The hypothesis that higher work effort, measured with longer working hours and greater work intensity, is negatively associated with mental wellbeing in essential workers receives partial support, as the results suggest that work effort matters, but not all indicators of effort are equally relevant. Long working hours is not one of the strongest predictors, while other dimensions of strain, like tight deadlines, stressful work and difficulty disconnecting, are more consistently associated with anxiety. This is consistent with the distinction between extensive and intensive effort described in the literature (Green, 2001) and with evidence from ireland showing that work intensity was more strongly related to worse mental health indicators than hours alone (Geary & Belizón, 2022). The fact that working hours did not emerge as a strong predictor may be because many essential workers already had relatively fixed schedules due to the nature of

their roles. which would limit the variation in this variable and reduce its explanatory power What seems to matter most is not how long workers worked, but rather working under pressure and carrying that pressure into their personal life.

By contrast, support for the hypothesis that higher perceived organizational support is positively associated with mental wellbeing among essential workers is weaker and more selective. There is some evidence for perceived organizational support, especially through trust in management, which is significant in some of the models. This fits the expectation from the JD-R model that job resources can buffer the negative effects of demands (Bakker & Demerouti, 2017) and evidence that workers who feel supported by their organization report less stress (Xiao et al., 2020). However, the effect isn't consistent across all variables related to support, so the findings don't fully validate the expectation that organizational support would act as a broad mitigator. One possible explanation is that during the pandemic, the gap between formal support measures and workers' real daily experiences was too large for organizational support to have a consistently measurable protective effect. In other words, organizational support may not always translate into real protection when working conditions are extremely demanding, or support may simply not have been enough to cancel out the strong negative effect of stressful working conditions.

The hypothesis that higher work-family conflict and more care responsibilities are negatively associated with mental wellbeing in essential workers is partially supported, since the clearest evidence is found in the model that explains anxiety about reduced working hours, where the variable capturing interference with life appears as statistically significant. This is consistent with literature showing that work-family tensions intensified during the pandemic, especially for workers in frontline occupations (Collins et al., 2021; Alon et al., 2020). However, the variable measuring if respondents had children isn't significant, so the evidence supports work-life conflict more than family status itself. A likely explanation is that work-family conflict was experienced broadly across essential workers regardless of parental status, since pandemic-related restrictions and pressures affected personal life in general, not only through childcare demands.

The hypothesis that the presence of trade unions or worker representation at the workplace is positively associated with mental wellbeing within essential workers is not supported, as trade union presence doesn't appear as significant in any of the six models. This is a notable finding given that the literature suggests unions can improve safety conditions and provide greater

protection in the workplace (Bryson et al., 2019; Eurofound, 2021). One possible explanation is that the binary nature of the union presence variable does not capture the actual quality or effectiveness of representation during the pandemic. A union may formally exist in a workplace without actively negotiating COVID-19 safety measures or mental health support, meaning that the variable measures institutional presence rather than the practical impact that would translate into better wellbeing outcomes.

Finally, the socio-demographic hypotheses show mixed results. The hypothesis that female essential workers report lower mental wellbeing than male essential workers receives partial support, since women tend to report higher anxiety in several models. This is in line with previous research on gendered inequalities in paid and unpaid work during the pandemic (Burström & Tao, 2020; Collins et al., 2021). However, the hypothesis that essential workers with children have lower mental wellbeing is not supported, as having children isn't significant. This may be because the effect of parenthood on wellbeing depends heavily on the availability of informal support networks, the age of the children and the specific household arrangements, factors that vary considerably and which the survey variables available could not capture with enough precision. Overall, the discussion suggests that lower wellbeing among essential workers is better explained by work strain and insecurity than by personal background alone.

6. Recommendations

The empirical results of this study show that wellbeing among essential workers during the COVID-19 pandemic was shaped mainly by work-related strain. perceived insecurity and the inability to mentally disconnect from work, rather than by socio-demographic background alone. These findings have direct implications for how public institutions and organizations should act, both to address the consequences of the pandemic and to be better prepared for similar situations in the future. This section translates the main conclusions into practical recommendations, divided into recommendations for public policies and recommendations for organizations.

Recommendations for public policies

The first recommendation is to strengthen employment security and reduce precariousness. The most consistent finding across all six models is that feeling replaceable is strongly associated with higher anxiety and lower wellbeing. This suggests that policies aimed at reducing job insecurity, like limiting the abuse of temporary contracts, guaranteeing access to sick pay and protecting essential workers against arbitrary dismissal, could have a direct positive effect on wellbeing.

A second recommendation is to promote the right to disconnect. Since difficulty unwinding and worrying after work emerged as some of the strongest predictors of low wellbeing, public regulation should reinforce workers' right to disconnect from work outside of working hours. Ireland already introduced a Code of Practice on the Right to Disconnect in 2021, and the results of this study support extending and enforcing this kind of regulation, especially for essential workers who could not rely on remote work to manage their time.

Third, public policies should recognise and fairly reward essential work. During the pandemic, essential workers were publicly praised but often kept low wages and insecure conditions. To correct this imbalance between effort and reward, policies should improve the pay, recognition and career prospects of essential occupations, particularly in sectors like health and social care, retail and transport, which the analysis identified as especially exposed to anxiety about working hours and employment.

A fourth recommendation is to target support to the most affected groups. The models show that women and workers from certain regions, particularly Asia and Africa, reported higher anxiety even after controlling for job conditions. This points to the need for inclusive public

policies that consider gender inequalities in paid and unpaid work and the specific vulnerabilities of migrant essential workers, for example through accessible information, language support and equal access to protection measures.

Finally, governments should strengthen mental health systems and crisis preparedness. The psychological effects of the pandemic did not disappear once the most critical phase had passed, so public institutions should invest in accessible mental health services and design preparedness plans that explicitly protect the wellbeing of essential workers in future health emergencies.

Recommendations for organizations

At the organizational level, the first recommendation is to reduce job strain and intensity. As stressful work and tight deadlines are negatively associated with wellbeing, organizations should review workloads, ensure adequate staffing and set realistic deadlines, especially during periods of higher demand. Reducing demands is one of the most direct ways to protect employees' mental health.

Second, organizations should encourage psychological detachment from work. Given that the inability to switch off after work was one of the clearest drivers of low wellbeing, organizations should actively discourage after-hours contact, respect rest periods and avoid creating an "always available" culture. Practical measures like limiting out-of-hours communication and clearly separating shifts can help workers recover between working days.

A third recommendation is to build genuine organizational support and trust. Trust in management appeared as a relevant factor in several models. However, the effect of support was not consistent, suggesting that symbolic gestures are not enough. Organizations should translate support into concrete actions, like transparent communication, fair treatment, supportive supervision and visible concern for safety, so that employees feel genuinely valued.

Fourth, organizations should reduce the sense of replaceability and insecurity. Since feeling replaceable was the most consistent predictor of anxiety. organizations should pay attention to how they communicate about job stability. Offering clarity about contracts, involving workers in decisions and recognising their contribution can reduce subjective insecurity, which the results show is closely linked to wellbeing.

A fifth recommendation is to provide mental health resources and flexibility. Organizations should offer accessible psychological support, like employee assistance programmes or

counselling, and introduce flexibility to help workers manage care responsibilities. As interference with life was significant in explaining anxiety about working hours, measures that ease work-family conflict could be particularly beneficial, especially for women, who tend to carry a larger share of unpaid care work.

Lastly, organizations should make worker representation more effective. Although union presence was not significant in any model, this does not mean that representation is irrelevant. It rather suggests that the mere existence of a union is not enough, and that organizations and worker bodies should focus on the quality and effectiveness of representation, ensuring that workers' voice translates into real improvements in working conditions.

Taken together, these recommendations highlight that protecting essential workers' wellbeing requires action at both the institutional and the organizational level.

Public policies can set the framework by reducing precariousness, protecting rest time and rewarding essential work fairly, while organizations can act more directly on the daily working conditions that the analysis identified as most harmful. Combining both levels would help ensure that essential workers, who were so important during the COVID-19 pandemic, are better protected in the future.

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8. Anexos

8.1.ANEXO 1: Declaración de Uso de Herramientas de Inteligencia Artificial Generativa en Trabajos Fin de Grado

ADVERTENCIA: Desde la Universidad consideramos que ChatGPT u otras herramientas similares son herramientas muy útiles en la vida académica, aunque su uso queda siempre bajo la responsabilidad del alumno, puesto que las respuestas que proporciona pueden no ser veraces. En este sentido, NO está permitido su uso en la elaboración del Trabajo fin de Grado para generar código porque estas herramientas no son fiables en esa tarea. Aunque el código funcione, no hay garantías de que metodológicamente sea correcto, y es altamente probable que no lo sea.

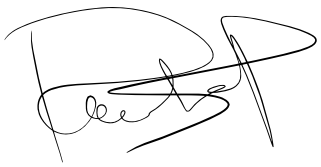
Por la presente, yo, Paola Petidier Sánchez, estudiante de Business Analytics de la Universidad Pontificia Comillas al presentar mi Trabajo Fin de Grado titulado " FACTORS ASSOCIATED WITH ESSENTIAL WORKERS' WELLBEING DURING THE COVID-19 PANDEMIC", declaro que he utilizado la herramienta de Inteligencia Artificial Generativa ChatGPT u otras similares de IAG de código sólo en el contexto de las actividades descritas a continuación:

1. **Referencias:** Usado conjuntamente con otras herramientas, como Science, para identificar referencias preliminares que luego he contrastado y validado.
2. **Corrector de estilo literario y de lenguaje:** Para mejorar la calidad lingüística y estilística del texto.
3. **Generador previo de diagramas de flujo y contenido:** Para esbozar diagramas iniciales.
4. **Sintetizador y divulgador de libros complicados:** Para resumir y comprender literatura compleja.
5. **Traductor:** Para traducir textos de un lenguaje a otro.

Afirmo que toda la información y contenido presentados en este trabajo son producto de mi investigación y esfuerzo individual, excepto donde se ha indicado lo contrario y se han dado los créditos correspondientes (he incluido las referencias adecuadas en el TFG y he explicitado para que se ha usado ChatGPT u otras herramientas similares). Soy consciente de las implicaciones académicas y éticas de presentar un trabajo no original y acepto las consecuencias de cualquier violación a esta declaración.

Fecha: 16/06/2026

Firma:



8.2.ANEXO 2: Código de Python

```
import pandas as pd

import numpy as np

import statsmodels.api as sm

# 1. FILE PATHS

input_file = r"/Users/pao/Documents/tfg analytics/bases datos
finales/base_valores_20abril_con_PC1.xlsx"

output_file = r"/Users/pao/Documents/tfg analytics/bases datos
finales/resultados_6_modelos_WLS.xlsx"

# 2. LOAD DATA

df = pd.read_excel(input_file)

df.columns = df.columns.str.strip()

# 3. DEFINE TARGET VARIABLES

target_vars = [
    "PC1_anxiety",
    "Q35_LosingJob",
    "Q35_DifficultToUseSkills",
    "Q35_ReducePay",
    "Q35_Hours",
    "Q35_SecuringNewEmployment"
]

# 4. VARIABLES TO ALWAYS IGNORE

ignore_vars = ["Q44_WorkFromHome", "Weight", "Respondent_Serial"]

weight_var = "Weight"


# 5. CHECK THAT REQUIRED COLUMNS EXIST

missing_targets = [v for v in target_vars if v not in df.columns]

if missing_targets:
    raise ValueError(f"Faltan estas variables objetivo en la base: {missing_targets}")

if weight_var not in df.columns:
    raise ValueError("No existe la columna 'Weight' en la base de datos.")

# 6. FUNCTION TO RUN ONE WLS MODEL
```

```
def run_wls_model(data, y_var, target_vars, ignore_vars, weight_var):
    excluded = set(target_vars + ignore_vars)
    predictors = [col for col in data.columns if col not in excluded]
    cols_needed = [y_var] + predictors + [weight_var]
    temp = data[cols_needed].dropna().copy()
    # Y
    y = temp[y_var]
    # X
    X = temp[predictors]
    X = sm.add_constant(X)
    # Weights
    w = temp[weight_var]
    # Modelo WLS
    model = sm.WLS(y, X, weights=w)
    results = model.fit(cov_type="HC3")
    # Coefficients
    coef_table = pd.DataFrame({
        "Variable": results.params.index,
        "Coefficient": results.params.values,
        "Std_Error": results.bse.values,
        "t_value": results.tvalues.values,
        "p_value": results.pvalues.values,
        "CI_low": results.conf_int()[0].values,
        "CI_high": results.conf_int()[1].values
    })
    # Model Statistics
    fit_stats = pd.DataFrame([{
        "Dependent_variable": y_var,
        "N": int(results.nobs),
        "R_squared": results.rsquared,
        "Adj_R_squared": results.rsquared_adj
    }])
```

```
    return results, coef_table, fit_stats, predictors
# 7. RUN THE 6 MODELS
all_fit_stats = []
all_coef_tables = []
all_predictor_lists = []
for y_var in target_vars:
    results, coef_table, fit_stats, predictors = run_wls_model(
        df, y_var, target_vars, ignore_vars, weight_var
    )
    coef_table.insert(0, "Dependent_variable", y_var)
    all_coef_tables.append(coef_table)
    all_fit_stats.append(fit_stats)
    predictor_list_df = pd.DataFrame({
        "Dependent_variable": [y_var] * len(predictors),
        "Predictor_used": predictors
    })
    all_predictor_lists.append(predictor_list_df)
    print("\n" + "=" * 80)
    print(f"MODEL WITH DEPENDENT VARIABLE: {y_var}")
    print("=" * 80)
    print(results.summary())
# 8. COMBINE OUTPUTS
fit_stats_df = pd.concat(all_fit_stats, ignore_index=True)
coef_results_df = pd.concat(all_coef_tables, ignore_index=True)
predictors_df = pd.concat(all_predictor_lists, ignore_index=True)
# 9. SAVE TO EXCEL
with pd.ExcelWriter(output_file, engine="openpyxl") as writer:
    fit_stats_df.to_excel(writer, sheet_name="Model_fit", index=False)
    coef_results_df.to_excel(writer, sheet_name="Coefficients_all_models", index=False)
    predictors_df.to_excel(writer, sheet_name="Predictors_used", index=False)
print("\nArchivo guardado en:")
print(output_file)
```