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UNVEILING DEMOGRAPHIC DYNAMICS: A MULTINOMIAL LOGISTIC ANALYSIS OF EMPLOYMENT DISPARITIES AMONG MALAYSIA'S AGEING POPULATION

(*Meneliti Dinamik Demografi: Analisis Logistik Multinomial terhadap Ketidakseimbangan Pekerjaan dalam Kalangan Penduduk Warga Tua di Malaysia*)

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ABSTRACT

Anticipated to transition into an ageing society by 2030, Malaysia faces a pressing challenge related to workforce dynamics. Although demographic factors play a pivotal role in shaping the employment status of the elderly, existing analyses remain insufficient in providing comprehensive insights. To address this gap, this study employs a multinomial logistic regression model to examine disparities in the employment status of older individuals based on demographic factors. The study identifies five distinct categories of employment status among the elderly: employers, employees, self-employed individuals, unpaid family workers, and those not engaged in employment. Using microdata from the Labour Force Survey conducted by the Department of Statistics Malaysia between 2019 and 2021, the analysis focuses on a carefully selected sample of individuals age 60 and above: 46,315 people in 2019, 43,419 people in 2020, and 45,151 people in 2021. The demographic factors examined include strata, educational attainment, marital status, geographic zone, and ethnic group. This comprehensive approach seeks to highlight inequality gaps in elderly employment status across these demographic factors. The findings underscore the significance of the multinomial logistic regression model in understanding employment disparities among the elderly. Notably, lack of formal education, low education level, and marital status emerge as significant determinants. In essence, this study sheds light on the complexities of Malaysia's demographic landscape, offering valuable insights into the challenges faced by its ageing population and highlighting key factors shaping the employment trajectory of older adults.

Keywords: employment status of the elderly; multinomial logistic regression; demographic factors

ABSTRAK

Menjelang tahun 2030, Malaysia dijangka beralih menjadi sebuah negara tua, sekali gus berdepan dengan cabaran mendesak berkaitan perubahan corak tenaga buruh. Meskipun faktor demografi memainkan peranan penting dalam membentuk status pekerjaan dalam kalangan warga emas, analisis sedia ada masih belum mampu memberikan gambaran yang menyeluruh. Justeru, kajian ini bertujuan merapatkan jurang pengetahuan tersebut dengan menggunakan model regresi logistik multinomial, bagi menyingkap ketidaksamaan status pekerjaan warga emas berdasarkan faktor demografi. Kajian ini mengenal pasti lima kategori utama status pekerjaan warga emas, iaitu: majikan, pekerja, bekerja sendiri, pekerja keluarga tanpa gaji, dan tidak bekerja. Berdasarkan data mikro yang diperoleh daripada Kajian Tenaga Buruh yang dijalankan oleh Jabatan Perangkaan Malaysia bagi tempoh tahun 2019 hingga 2021, kajian ini memfokuskan kepada sampel individu berumur 60 tahun dan ke atas, melibatkan 46,315 orang pada tahun 2019, 43,419 orang pada tahun 2020, dan 45,151 orang pada tahun 2021. Faktor demografi yang dikaji meliputi strata tempat tinggal, tahap pendidikan, status perkahwinan, zon geografi, dan kumpulan etnik. Pendekatan menyeluruh ini bertujuan menjelaskan jurang ketidaksamaan dalam status pekerjaan warga emas berdasarkan faktor demografi terpilih. Dapatan kajian menegaskan kepentingan penggunaan model regresi logistik multinomial dalam

memahami ketidaksamaan pekerjaan warga emas. Secara khusus, faktor seperti ketiadaan pendidikan formal, tahap pendidikan rendah, dan status perkahwinan dikenal pasti sebagai penyumbang utama kepada perbezaan status pekerjaan. Secara keseluruhannya, kajian ini menyelami selok-belok landskap demografi Malaysia, seterusnya menawarkan pandangan yang bernilai terhadap cabaran yang dihadapi oleh populasi yang semakin menua serta menekankan faktor-faktor utama yang membentuk corak pekerjaan warga emas di negara ini.

Kata kunci: status tenaga kerja warga tua; regresi logistik multinomial; faktor-faktor demografi

1. Introduction

In a world marked by sweeping demographic transitions, the global populace is steadily embracing the inevitability of ageing (Tessier *et al*. 2022). This transformative phenomenon is largely driven by a sustained decline in fertility rates and improvements in elderly survival that contribute to increased life expectancy across numerous nations (Bloom & Luca 2016). According to the World Health Organization (2022), the population aged 60 and above is on track to surge from 900 million to a staggering 2 billion between 2015 and 2050. This seismic shift will constitute 22% of the total global population, a substantial leap from 12% in 2015. Notably, this trajectory toward an ageing population is unfolding at an unprecedented pace compared to historical trends. Malaysia is not immune to this global metamorphosis, experiencing an annual rise in the percentage of its population aged 60 and above. Projections indicate that by 2030, Malaysia will transition into an ageing nation, with individuals aged 60 and above surpassing 15% of the total population. The demographic projections, spanning from 2010 to 2040, underscore this inexorable ageing trend.

The United Nations defines a country as an ageing society when at least 7% of its population is 65 years or older. This percentage rises to 14% for an aged society and 20% for a super-aged society (United Nations 2019). According to these criteria, Malaysia is expected to become an ageing nation by 2030. Table 1 presents the observed demographic trends in Malaysia between 2020 and 2022. In 2020, the population aged 60 and above stood at 3.3 million, constituting 10.3% of the total population. This figure increased to 3.5 million (10.7%) in 2021 and 3.6 million (11.1%) in 2022. Similarly, the population aged 65 and above, recorded at 2.2 million (6.8%) in 2020, was anticipated to increase to 2.3 million (7.0%) in 2021 and 2.4 million (7.3%) in 2022. The consistent upward trajectory illustrated in this table reflects a persistent increase in Malaysia's elderly population (DOSM 2022). This detailed examination not only highlights the global shift towards an ageing population but also emphasizes Malaysia's commitment to this demographic transition. This is evident through national efforts such as the National Policy for Older Persons (2011) and the Action Plan for Older Persons, which are designed to promote active ageing, social inclusion, and economic engagement among the elderly. The meticulous documentation of these shifts serves as a vital tool for policymakers and stakeholders in navigating the challenges and opportunities presented by a progressively older population.

Table 1: Population aged 60 years and 65 years and over, Malaysia, 2020-2022

Age Group	2020	2021	2022
60+	3.3 million (10.3%)	3.5 million (10.7%)	3.6 million (11.1%)
65+	2.2 million (6.8%)	2.3 million (7.0%)	2.4 million (7.3%)

Source: Department of Statistics Malaysia (2022)

The data in Table 1 offers a clear depiction of Malaysia's demographic landscape among individuals aged 60 and above between 2020 and 2022. It highlights a steady increase in both absolute numbers and percentage representation of this age group, signalling a demographic shift that warrants careful examination. A particularly notable finding is the consistent upward trend in the proportion of elderly individuals, which has implications for workforce participation. However, this trend should not be misinterpreted as a direct rise in participation rates, which are more strongly influenced by factors such as policy changes, retirement regulations, and overall labour market conditions. One of the primary forces driving this demographic expansion is the global ageing phenomenon, a megatrend reshaping social and economic structures worldwide. Its implications extend well beyond Malaysia's borders, underscoring the need for a nuanced understanding of its impact on workforce dynamics. The rising number of older workers can be attributed to multiple factors, including improvements in health and longevity, a cultural shift towards later retirement, better access to pension and superannuation schemes, and heightened job insecurity, as noted by Farr-Wharton *et al*. (2023).

The decision is closely linked to financial considerations. Individuals in a strong financial position may choose to retire at any age or stage, while those facing financial constraints may find such a decision less feasible. The economic dimension becomes particularly significant for women, especially those who are separated or divorced, where financial independence is paramount. Moreover, with the growing trend of individuals having children later in life, many may remain financially responsible for their dependents even upon reaching the conventional retirement age of 65, thereby introducing unique financial pressures (Murthy *et al*. 2019). In addition to financial factors, health plays a pivotal role in influencing retirement decisions. Those experiencing health problems may opt to retire earlier, particularly if they have adequate family support. The natural decline of bodily functions with age often gives rise to health issues, making health a central concern for elderly individuals in both their personal lives and professional pursuits.

Hence, this study investigates the correlation between elderly employment status and a range of demographic characteristics using a multinomial logistic regression (MLR) model. This method is well-suited to analysing outcomes with multiple nominal categories and to modelling the probability of each category as a function of demographic predictors. The choice of this model is particularly pertinent when the dependent variable follows a multinomial distribution and the independent variables include a mix of categorical and continuous variables, aligning with the methodological insights of Arı (2016). This ensures a rigorous and meaningful analysis of the complex relationship between employment status and demographic factors among the elderly.

2. Literature Review

2.1. *Exploring the key factors that drive older adults to remain in the workforce*

a) Health and Well-Being

The employment landscape for the elderly, often referred to as seniors or older workers, is shaped by individual circumstances and broader societal dynamics. Health is a critical factor influencing the work status of seniors, as demonstrated by Mor-Barak *et al*. (1995) and Franssen *et al*. (2020), among others. There is a significant link between older people's well-being and their capacity to continue working, as health issues can hinder their ability to perform specific jobs or work long hours. The study by Jeon and Kim (2012) provides an insightful analysis of this relationship, examining health, sleep patterns, and depression among older individuals. They analysed data from the 2008 Korean National Survey on Older Adults,

which included 5,204 employed and 9,942 unemployed seniors out of 15,146 participants. The findings revealed notable differences in depression, sleep quality, and overall health based on employment status, with deep sleep, perceived health, and disease-related daily challenges being significant contributors to depression among employed seniors, accounting for 29% of cases. In contrast, these factors, along with sleep duration, contributed to 32% of depression cases among unemployed seniors, indicating a stronger impact of these factors in jobless seniors. Nam *et al*. (2017) further explored the relationship between employment and depression in individuals over 65, utilizing data from the 2014 National Elderly Survey. Their study, which included 10,451 seniors, found that unemployment or precarious employment significantly increased the risk of depression, with those affected being 1.68 times more likely to experience depression compared to their employed counterparts.

b) Economic dan Financial Security

In regions experiencing an increase in average life expectancy and a significant proportion of senior citizens living in poverty, the employment activities of the elderly become increasingly important for maintaining economic stability and reducing medical costs associated with depression. Therefore, boosting the employment rate among older individuals is crucial not just from a financial perspective, but also for the overall social and medical well-being of the ageing population. Alongside the economic factors driving employment among the elderly (Li & Mutchler 2020; Thongsrikate *et al*. 2021), the financial security of older adults is a critical consideration when assessing job opportunities. Beyond the necessity of financial survival, some individuals continue working longer to meet ongoing financial obligations. Conversely, those who have diligently saved for retirement may opt to exit the workforce earlier than originally planned. In a comprehensive study by Son and Park (2011), the employment characteristics of individuals over 65 were examined, focusing on two distinct groups: one with a history of work changes and another with job stability over the past decade.

The study's findings, offering nuanced insights, resonate deeply with the complexities of elderly employment. It was initially observed that those with low socioeconomic status and education levels, particularly householders and elderly couples, were more likely to continue working. These older workers often took on roles as self-employed entrepreneurs, employers, or performed unpaid labour within industries such as mining, forestry, farming, and fishing. A common feature among them was a history of frequent job changes over the preceding decade, illustrating a dynamic employment trajectory. Further exploration of economic characteristics revealed that working-age adults often rely on private income transfers, highlighting a dimension of financial dependence. The study also noted significant differences in work status, business type, and occupational category between older individuals who sustained employment and those who experienced multiple job transitions.

c) Policy Development

A comprehensive study by Hong (2005) examined the intricate link between senior poverty and economic positioning in Korea, offering vital insights into older adults' previous job market experiences. Traditional explanations for elderly poverty have often relied on proxy factors such as age, marital status, and gender, leaving a significant gap in understanding the impact of past employment experiences on retirees' financial well-being. Hong's findings underscore the importance of employment type and previous job roles as crucial indicators of financial status in later life. The study demonstrated how a person's employment history significantly shapes their financial trajectory over time, emphasizing the enduring effect of job type on financial security. Furthermore, the motivation and interests of older workers play a significant role in their decision to continue working post-retirement. Many seniors opt to keep working for the

intrinsic satisfaction and valued social connections their job provides, underlining the importance of personal fulfilment and motivation in extending their careers.

Rau and Adams (2005) examined the reasons motivating older individuals to seek employment during their later years, identifying key factors such as self-assessment, motivations, social support, and work-related reasons. Additionally, demographic characteristics including age, income, gender, and marital status significantly influence their decision-making, encompassing elements such as job-seeking self-efficacy and retirement attitudes. Despite sharing some characteristics with younger job seekers (Kanfer *et al*. 2001), older workers have distinct motivations, including a negative view of retirement. Given the diversity within the older job-seeking population, it is critical for organizations to recognize and understand the unique drivers of this demographic. Addressing these varied motivations is essential for effectively engaging older adults in the workforce, catering to their diverse needs and aspirations.

Building on these insights, Posthuma and Campion (2023) highlighted that the ongoing involvement of older employees in the workforce is shaped not only by financial needs but also by psychological factors such as the search for purpose, identity, and social interaction. Their study reinforces the importance of tailoring workplace policies to address the diverse motivations and abilities of older workers, particularly in societies with ageing populations. Consequently, both organizations and policymakers need to acknowledge and address these multidimensional factors to successfully engage and support the ageing workforce.

2.2. *Exploring the delayed retirement trend in Malaysia*

Currently, Malaysia's demographic landscape is shifting significantly, as evidenced by the rapidly increasing elderly population (Ismail *et al*. 2021). This demographic transformation presents both challenges and opportunities in the labour market, particularly in relation to potential employment gaps among the elderly. In this context, MLR is a highly effective analytical tool (Szczepaniak-Kozak *et al*. 2020). Its ability to handle diverse job situations enables it to unpack the complexities that influence the work engagement patterns of older adults. This review synthesizes existing research on the subject, highlighting key findings and identifying important gaps that warrant further investigation. Understanding the drivers of this trend is crucial for addressing its broad implications for the labour market, social policy, and individual well-being. Accordingly, this review examines the existing literature, focusing on three primary influences: economic necessity, health status, and changing societal norms.

Jamaluddin *et al*. (2023) found the inadequacies of current pension systems, which has left a considerable number of the elderly financially insecure and heavily reliant on continued employment (Sulaiman & Masud 2012). Ramely *et al*. (2018) further emphasize that this need is exacerbated by rising living costs and uncertainties in the job market. Additionally, the obligation to support younger generations amidst changing family dynamics often leads older adults to extend their working lives, as observed by Yin-Fah *et al*. (2010). In contrast to prior assumptions, a better health has also emerged as a factor contributing to delayed retirement.

Research by Kimm *et al*. (2023) and Minhat and Suwanmanee (2023) revealed a positive correlation between good health and extended work engagement among the older population in Malaysia. This trend is attributed to enhanced healthcare access and increased life expectancy, allowing individuals to remain productive for longer periods. However, it's crucial to recognize the challenges posed by chronic health conditions, which may force employees to leave the workforce due to physical constraints. Additionally, Minhat *et al*. (2024) demonstrated the significant impact of health status on intentions to re-engage in employment after initial

retirement, underscoring the need for comprehensive healthcare support for an ageing population.

Moreover, traditional views on retirement and ageing in Malaysia are evolving. Mokal *et al*. (2023) observed a shift towards more positive perceptions of ageing, with younger generations increasingly valuing the ongoing contributions of the elderly. Changes in family dynamics and rising educational levels are also reshaping retirement decisions (Ganguly & Prakash 2023). For many, the choice to continue working is driven not only by financial needs but also by the desire to maintain a certain lifestyle, engage socially, and achieve personal satisfaction (Lim *et al*. 2023).

2.3. *Navigating the diverse employment landscape for older workers in Malaysia*

In Malaysia, a complex interplay of demographic factors significantly influences older workers' participation in the workforce. A study by Gragnano *et al*. (2020) found that continued employment positively affects the well-being of older individuals. This review aims to explore how employment status, urban-rural dynamics, education, geographical location, marital status, and ethnicity affect labour market participation.

Employment status plays a key role, with Kikkawa and Gaspar (2023) noting an increase in labour force participation among older Malaysians, reflecting broader demographic shifts and economic needs. Employment prior to retirement heavily influences retirement decisions, with workers in the informal sector often extending their working years due to economic reasons (Minhat & Suwanmanee 2023). Given Malaysia's trajectory towards becoming an ageing nation by 2030, the government's prioritization of older adults' labour market participation is crucial for promoting productive ageing (Ramely *et al*. 2016).

Urban-rural dynamics reveal significant differences in retirement confidence and labour force engagement among older workers, influenced by their geographical setting. Urban dwellers face distinct challenges compared to their rural counterparts (Shanmugam 2019; Liu *et al*. 2021), with educational status also playing a critical role. Higher education correlates with increased employment participation later in life (Murthy *et al*. 2019), emphasizing the importance of skill acquisition for older workers. Masud and Haron (2008) noted that education enhances employability and income, with Azizan *et al*. (2021) highlighted the challenges older workers face due to the varied educational backgrounds acquired in their youth. Furthermore, disparities between rural and urban areas significantly impact employment, with rural Malaysians tending to retire due to limited opportunities, while those in urban areas often delay retirement because of higher living costs (Abas @ Hamdan *et al*. 2018). Östh *et al*. (2014) emphasized the need for individualized solutions to address these regional differences, underscoring the multifaceted nature of ageing and employment in Malaysia.

Although prior studies have examined the influence of individual demographic factors—such as marital status (Sharma & Kaur 2019; Mussida & Patimo 2021; McDonald 2020) and ethnicity (Gordon 2020; Selden & Berdahl 2020) - on labour force participation, these factors are often analysed in isolation. However, gaps remain in understanding how intersecting demographic elements such as ethnicity, education level, marital status, and living conditions collectively affect the employment outcomes of older adults. Current research rarely captures the complexity of these combined effects, particularly in the Malaysian context. Addressing this gap is crucial for formulating more informed and inclusive employment policies, especially as Malaysia transitions into an ageing society. This study responds to this need by employing multinomial logistic regression to simultaneously analyse multiple

demographic predictors, thereby offering a more comprehensive picture of the factors shaping elderly employment.

2.4. *Exploring employment disparities among Malaysia's older workers using multinomial logistic regression*

As Malaysia approaches the status of an ageing society by 2030, it becomes crucial to thoroughly investigate employment trends among older adults. Focusing on the workforce involvement of this demographic is vital for fostering productive ageing and addressing both regional and demographic inequalities (Zainuddin *et al*. 2020; Jaffer *et al*. 2023). Advanced statistical techniques, such as MLR, are instrumental in examining the intricate employment situations encountered by Malaysia's senior population. MLR models the relationship between various employment categories and independent demographic variables—such as education, health, marital status, ethnicity, geographic location, and urban-rural differences—offering detailed insights into labour market engagement. These analyses aid in formulating specific retirement policies and interventions, while identifying obstacles such as age discrimination and workforce biases that affect older employees (Ganguly & Prakash 2023; Khairi *et al*. 2021). Despite MLR's effectiveness, a gap remains in research regarding its application to Malaysia's changing labour market, particularly in the context of new trends such as the gig economy and digitalisation. Although current studies emphasize gender disparities among older Malaysian workers, few employ MLR to explore the intersection of demographic factors with emerging employment types. Understanding how older individuals adapt to digital changes and participate in non-traditional work settings is essential for developing inclusive labour policies, especially for vulnerable groups such as persons with disabilities. In light of the gaps, this study adopts a cross-sectional approach to assess employment statuses at a specific time, providing a snapshot of the dynamic employment landscape among Malaysia's elderly. By applying MLR in this context, the study aims to generate comprehensive insights that not only address existing research limitations but also guide policies designed to support an ageing workforce in a rapidly evolving job market.

3. Method

In this study, we explored the employment dynamics of the elderly by thoroughly examining their demographic characteristics through the lens of a MLR model. The analysis was based on microdata from the Labour Force Survey in Malaysia for the years 2019, 2020, and 2021—a comprehensive dataset meticulously maintained by the Department of Statistics, Malaysia (DOSM). Although this research relies on cross-sectional data, future studies employing panel data could track employment trends over time and evaluate the long-term effects of demographic factors on employment status.

A two-stage stratified sampling design was employed to ensure coverage of all states in Malaysia, including all administrative districts within each state, as well as urban and rural areas. Household samples within each area were then selected using a systematic random sampling method. This approach was implemented in a structured and scientific manner to yield an unbiased sample that accurately represents the national household population. The survey questionnaire was administered to a substantial number of participants, involving 46,315 elderly individuals in 2019, 43,419 in 2020, and 45,151 in 2021. To investigate the complex interplay of variables, employment status (Y), was defined as the dependent variable, categorized into five distinct groups: (1) employer, (2) employee, (3) self-employed, (4) unpaid

family worker, and (5) not working. The "not working" group served as the reference category in the model.

It is important to note that during the COVID-19 pandemic years (2020–2021), the Department of Statistics Malaysia adapted its survey methodology to comply with movement restrictions by shifting from traditional face-to-face interviews to telephone and online surveys. While DOSM applied weighting adjustments and quality control procedures to preserve the reliability and representativeness of the Labour Force Survey, pandemic-related disruptions may have influenced response behaviour and employment patterns. Accordingly, findings from these years should be interpreted within the pandemic context, and generalisation to non-pandemic conditions should be made with caution.

Employing the maximum likelihood estimator, we computed the odds ratios of the model variables, encapsulating the nuanced relationships within our research framework. The model's robustness and validity were assessed through a likelihood ratio test, ensuring the reliability of our analytical approach. The data were analysed using the R software package, facilitated a comprehensive examination of the employment status of the elderly and its connection with their demographic characteristics. Identifying the factors affecting the employment status of the elderly requires careful consideration of demographic variables such as gender, strata, educational status, geographical zone, marital status, and ethnic group. Table 2 outlines the independent variables utilized in this study and their corresponding levels. However, our preliminary investigation revealed that gender, despite its perceived significance, does not emerge as a substantial determinant of labour force participation among the elderly. As a result, we directed our focus towards exploring alternative demographic factors that may exert a more substantial influence on the labour force participation in later life.

With regard to ethnicity, we employed the commonly used classification of Bumiputera and Non-Bumiputera. While this approach ensures statistical stability in the multinomial logistic regression model—particularly since some minority groups (e.g., Indians and East Malaysian Bumiputera) are comparatively small in number—it inevitably oversimplifies Malaysia's ethnic diversity. Distinct socioeconomic patterns across Malays, Chinese, Indians, and East Malaysian Bumiputera have been documented in prior research, and we acknowledge that our aggregated classification does not capture these nuances. This limitation is explicitly noted in our discussion, and we highlight the importance of future studies incorporating more detailed ethnic categories when subgroup sample sizes allow.

Table 2: The levels of independent variables used in the study

Independent Variables	Levels of Independent Variables	
Strata (X_1)	1.	Urban
	2.	Rural
Educational status (X_2)	1.	No formal education
	2.	Primary
	3.	Secondary
	4.	Tertiary
Geographical zone (X_3)	1.	North
	2.	South
	3.	East
	4.	West
	5.	Borneo
Marital status (X_4)	1.	Married
	2.	Not married
Ethnic group (X_5)	1.	Bumiputera
	2.	Non Bumiputera

Table 3 displays the demographic characteristics of elderly participants surveyed in 2019, 2020, and 2021. This includes variables such as employment status, used as the dependent variable, and strata, educational status, geographical zone, marital status, and ethnic group as independent variables. The table also presents the corresponding numbers and percentages of participants. Employment status was categorized include employer, employee, self-employed, unpaid family worker, and not working. The 'not working' category was the most predominant, rising from 77.31% in 2019 to 81.59% in 2021, followed by the 'self-employed' category, which declined from 13.54% in 2019 to 9.50% in 2021. This trend suggests a gradual withdrawal of older adults from active employment, reflecting both demographic pressures and changing economic conditions over the three-year period.

Table 3: The levels of dependent and independent variables used in the study

Demographic information	2019		2020		2021	
	N	%	*N*	%	*N*	%
Employment Status (*Y*)						
Employer	808	1.74	502	1.16	564	1.25
Employee	2,574	5.56	5,832	13.43	3,024	6.70
Self-employed	6,271	13.54	3,544	8.16	4,289	9.50
Unpaid family worker	857	1.85	699	1.61	437	0.97
Not working	35,805	77.31	32,842	75.64	36,837	81.59
Strata (X_1)						
Urban	29,976	64.72	28,321	65.23	29,324	64.95
Rural	16,339	35.28	15,098	34.77	15,827	35.05
Educational status (X_2)						
No formal education	9,190	19.84	7,987	18.40	8,359	18.51
Primary	20,517	44.30	17,944	41.33	16,777	37.16
Secondary	13,574	29.31	14,241	32.80	16,115	35.69
Tertiary	3,034	6.55	3,247	7.48	3,900	8.64
Geographical zone (X_3)						
North	13,360	28.85	12,290	29.76	13,174	29.18
South	9,385	20.26	9,022	20.78	9,188	20.35
East	9,013	19.46	7,272	16.75	8,830	19.56
West	4,494	9.70	4,525	10.42	4,443	9.84
Borneo	10,063	21.73	9,680	22.29	9,516	21.08
Marital status (X_4)						
Married	30,572	66.01	29,231	67.32	30,030	66.51
Not married	15,743	33.99	14,188	32.68	15,121	33.49
Ethnic group (X_5)						
Bumiputera	28,643	61.84	27,961	64.40	27,557	61.03
Non bumiputera	17,672	38.16	15,458	35.60	17594	38.97

The first independent variable, 'strata', was categorized into urban and rural areas. Across all three years, participation from urban areas consistently exceeded that from rural areas. In 2019, urban participation was 64.72%, which slightly rose to 65.23% in 2020, before failing marginally to 64.95% in 2021. Conversely, the proportion of rural participants, initially 35.28% in 2019, decline slightly to 35.05% in 2021. This indicates a stable dominance of urban representation throughout the survey period, reflecting Malaysia's ongoing trend toward urbanisation.

Educational status, the second variable, was categorized into four group: no formal education, primary, secondary, and tertiary. The majority of participants had at least a primary education. In 2019, 44.30% had primary education, decreasing to 41.33% in 2020 and 37.16% in 2021. Participants with secondary education increased from 29.31% in 2019 to 35.69% in 2021, while those with tertiary education rose from 6.55% in 2019 to 8.64% in 2021. This

indicates a gradual shift toward higher educational attainment among the elderly population, reflecting improvements in Malaysia's long-term access to education and its potential influence on later-life employment opportunities.

The third variable, geographical zone, comprises North, South, East, West, and Borneo. The North and Borneo recorded the highest participants, while the West had the lowest. For instance, participants from the North slightly increased from 28.85% in 2019 to 29.18% in 2021. This suggests that regional representation was uneven across zones, with persistent concentration in the North and Borneo, reflecting demographic distribution patterns that may shape employment opportunities for the elderly.

Marital status, the fourth variable, distinguishes between married and not married. The majority were married, with 66.01% in 2019, increasing to 67.32% in 2020 before slightly declining to 66.51% in 2021. The percentage of unmarried participants decreased from 33.99% in 2019 to 33.49% in 2021. This indicates that marriage remained the dominant status among the elderly throughout the period, suggesting the continued relevance of spousal and family support in shaping later-life employment decisions.

The final variable, ethnic group, divides participants into Bumiputera and non-Bumiputera. Bumiputera participants constituted the majority, decreasing slightly from 61.84% in 2019 to 61.03% in 2021. Conversely, non-Bumiputera participants increased from 38.16% in 2019 to 38.97% in 2021. This reflects a modest demographic shift, with Bumiputera remaining the dominant group while the relative share of non-Bumiputera participants gradually expanded, potentially influencing patterns of labour force participation and inequality.

3.1. *Multinomial logistic regression*

This research employs multinomial logistic regression, a common method for examining categorical outcome variables, to investigate how demographic factors influence employment status among older adults. MLR is a statistical model designed to handle multi-class problems with more than two possible outcomes, extending the concept of binary logistic regression. This model allows the prediction of probabilities across various outcomes of a dependent variable that is categorically distributed. It utilizes a set of independent variables, which can be continuous, binary, or categorical, to estimate the probabilities of each outcome. The dependent variable is nominal, indicating the presence of more than two categories. In this study, interpretation was based on odds ratios (exponentiated coefficients), which illustrate how changes in the independent variables affect the likelihood of being in a given employment category relative to the reference group. While marginal effects could provide a more intuitive interpretation of probability changes, these were not computed due to methodological constraints and are highlighted as an avenue for future research.

In summary, MLR is a valuable tool for analysing and predicting outcomes in multi-class problems with multiple categories (Prasad & Vaidya 2016). It models nominal outcome variables, where the log odds of different outcomes are expressed as a linear combination of predictor variables (Prasad & Vaidya 2016). An important assumption of regression models, including MLR, is the absence of problematic multicollinearity among independent variables. In this study, the predictors are categorical and represent distinct demographic dimensions—making the likelihood of multicollinearity minimal. Nevertheless, we acknowledge this as a limitation and recommend that future studies formally test this assumption using diagnostic measures such as variance inflation factors (VIF).

In the context of this study, MLR was employed to identify demographic characteristics influencing elderly employment status. Specifically, the analysis aimed to assess the impact of changes in independent variables on the probabilities of each employment outcome. For this

scenario, where employment status (Y) consists of five categories, i.e. (1) employer, (2) employee, (3) self-employed, (4) unpaid family worker, and (5) not working), can be expressed as follows:

$$\ln\left(\frac{P(Y=1)}{P(Y=5)}\right) = \beta_{01} + \beta_{11}X_1 + \beta_{21}X_2 + \beta_{31}X_3 + \beta_{41}X_4 + \beta_{51}X_5 \quad (1)$$

$$\ln\left(\frac{P(Y=2)}{P(Y=5)}\right) = \beta_{02} + \beta_{12}X_1 + \beta_{22}X_2 + \beta_{32}X_3 + \beta_{42}X_4 + \beta_{52}X_5 \quad (2)$$

$$\ln\left(\frac{P(Y=3)}{P(Y=5)}\right) = \beta_{03} + \beta_{13}X_1 + \beta_{23}X_2 + \beta_{33}X_3 + \beta_{43}X_4 + \beta_{53}X_5 \quad (3)$$

$$\ln\left(\frac{P(Y=4)}{P(Y=5)}\right) = \beta_{04} + \beta_{14}X_1 + \beta_{24}X_2 + \beta_{34}X_3 + \beta_{44}X_4 + \beta_{54}X_5 \quad (4)$$

where:

- Y is the categorical dependent variable (employment status) with five categories.
- β_{01}, β_{02}, β_{03} and β_{04} are the intercepts for the independent categories 1 to 4.
- β_{11}, β_{12}, β_{13} and β_{14} are the coefficients for the predictor variable X_1 (Strata).
- β_{21}, β_{22}, β_{23} and β_{24} are the coefficients for the predictor variable X_2 (Educational status).
- β_{31}, β_{32}, β_{33} and β_{34} are the coefficients for the predictor variable X_3 (Geographical Zone).
- β_{41}, β_{42}, β_{43} and β_{44} are the coefficients for the predictor variable X_4 (Marital status).
- β_{51}, β_{52}, β_{53} and β_{54} are the coefficients for the predictor variable X_5 (Ethnic group).

'Not working' was specified as the reference category, and the odds ratios (exponentiated coefficients) provide insights into how each independent variable influences the likelihood of being in the other employment categories relative to 'not working'. For categorical predictors with multiple categories, such as educational status and geographical zone, dummy coding was applied, with tertiary education and the Western zone designated as the reference groups.

Once the model was specified, the likelihood function was introduced to estimate the model parameters. In multinomial logistic regression, the likelihood function represents the probability of observing the specified outcomes (dependent variable categories) given the model and its parameters. The primary objective is to maximize the likelihood function in order to obtain accurate parameter estimates for the model.

Let's define the likelihood function for a MLR with five categories (1-employer, 2-employee, 3-self-employed, 4-unpaid family worker, and 5-not working) in Eq. (5).

$$L(\beta) = \prod_{i=1}^{N} P(Y_i = y_i) \quad (5)$$

where:

- N is the number of observations.
- y_i is the observed category for observation i.
- $P(Y_i = y_i)$ is the predicted probability of observing category y_i based on the model

The log-likelihood function, often used for computational convenience, is given by Eq. (6).

$$ln\ L(\beta) = \sum_{i=1}^{N} P(Y_i = y_i) \quad (6)$$

Maximizing the log-likelihood involves finding the values of the model parameters (β) that maximize the probability of observing the actual outcomes. The results of MLR analysis typically include estimates of the model parameters (β) along with their standard errors. In addition, the likelihood ratio test can be employed to evaluate the overall significance of the model.

For the interpretation, β_{ij}, represents the log-odds change of being in category j (1-employer, 2-employee, 3-self-employed, or 4-unpaid family worker) relative to 'not working' (category 5) for a one-unit increase in Strata (X_1). The same interpretation applies to β_{2j} for Educational Status (X_2), β_{3j} for Geographical Zone (X_2), β_{4j} or Marital Status (X_4) and β_{5j} for Ethnic Group (X_5). In multinomial logistic regression, the common practice of reporting odds ratios rather than parameter coefficients is motivated by the goal of providing a more straightforward interpretation and communication of results, especially when dealing with categorical dependent variables. Odds ratios offer a clearer understanding of how changes in independent variable influences the odds of being in specific employment category. This is particularly important for categorical outcomes, as it makes results more accessible to a wider audience. Reporting odds ratios also enables direct comparison of the impact of different independent variables across various employment categories. In summary, focusing on odds ratios in MLR facilitates more intuitive interpretation of the influence of demographic factors on employment outcomes, thereby contributing to better-informed decision-making and more effective communication of research findings.

The odds ratio formula in a MLR model quantifies the change in the odds of being in one category relative to a reference category for a one-unit change in a predictor variable. In the context of the model described, where employment status (Y) has five categories, the odds ratio (OR) for a predictor variable X_j associated with a one-unit change is defined as follows in Eq. (7).

$$OR_{X_j} = e^{\beta_{1j}} \quad (7)$$

where:

- OR_{X_j} is the odds ratio for the predictor variable X_j.
- β_{1j} is the coefficient of the predictor variable X_j in the model.

Here, j represents one of the categories (1=employer, 2=employee, 3=self-employed, or 4=unpaid family worker) compared to the reference category (5 - not working). The odds ratio indicates how a one-unit change in X_j affects the odds of being in category j relative to the odds of being in the reference category. For example, consider the following equation.

$$OR_{X_1} = e^{\beta_{11}}$$

- If $OR_{X_1} > 1$, an increase in X_1 raises the odds of being an employer (category 1) relative to the odds of not working (category 5).
- If $OR_{X_1} < 1$, an increase in X_1 lowers the odds of being an employer relative to not working.
- If $OR_{X_1} = 1$, a one-unit change in X_1 does not alter the odds of being an employer compared to not working.

In summary, odds ratios offer a quantified measure of the likelihood of different employment statuses among the elderly relative to the reference category. An odds ratio less than 1 indicates a lower likelihood of belonging to a given employment category compared to the reference group, whereas values greater than 1 suggest a higher likelihood. Expressing these results in percentage terms provides a more intuitive understanding of the comparative probabilities across groups.

Odds ratios are widely used in both the social sciences and epidemiological research because they provide valuable insights into relative likelihoods across categories (Cohen 2000; Szumilas 2010). Their strength lies in quantifying the odds of one group relative to another rather than offering direct probability estimates, making them particularly suitable for modelling categorical outcomes such as multinomial work status classifications (Biswas *et al*. 2019). However, their interpretive clarity is context dependent. When outcomes are rare, odds ratios approximate relative risks closely (Cummings 2009; Grimes & Schulz 2008), but with common outcomes, they can substantially exaggerate effect sizes (Sainani 2011). Furthermore, odds ratios are conditional on the model and dataset used, meaning they should not be directly compared across studies or across models with differing explanatory variables (Norton & Dowd 2018; Uanhoro *et al*. 2021). Given these considerations, we use odds ratios in this study as a meaningful and established method to describe associations between demographic characteristics and elderly employment. At the same time, we acknowledge that complementary measures—such as marginal effects or risk ratios—could provide additional interpretive clarity by translating these associations into more intuitive probability-based outcomes (Karlson & Jann 2023).

4. Findings

In this study, the *not working* category was designated as the reference level for the dependent variable. For the independent variables, the following categories were set as baseline: rural (residence), tertiary (education), west (region), not married (marital status), and non-Bumiputera (ethnicity). The results were interpreted relative to these baseline categories.

Distinct β coefficients were obtained for each employment category in the MLR model, resulting in varying odds ratios for each predictor. This indicates that the influence of independent variable differs across employment categories. Specifically, β_1 captures the log-odds change of being an employer (category 1) relative to *not working* (category 5), β_2 represents the log-odds change of being an employee (category 2) relative to *not working*, and so forth. Thus, slope estimates (βs) vary across employment status categories.

Significant predictors were interpreted based on their impact on the odds ratios, which quantify how much more or less likely individuals were to belong to a particular employment category compared to the *not working* group. Table 4 presents the Likelihood Ratio Tests (LRT) for the final model, highlighting the contribution of each predictor. The chi-square statistic was computed as the difference in -2 log-likelihood values between the full model and a reduced model (excluding one effect at a time). A significant p-value (< 0.05) indicates that the excluded effect contributes meaningfully to the model.

As shown in Table 4, all predictors made significant contributions to the model across all three years (2019, 2020, and 2021), with the exception of the South region in 2021, which yielded a non-significant p-value ($p = 0.535$). This suggests that, in 2021, the South region did not significantly influence employment outcomes among the elderly. Overall, the results support retaining all predictors in the final MLR model. Detailed coefficient estimates, odds ratios, and significance levels for each predictor are reported in Tables 5 through 7.

Table 4: Likelihood ratio test for model

Year	Effect	Model Fitting Criteria	Likelihood Ratio Tests		
		-2 Log Likelihood of Reduced Model	Chi-Square	*df*	*p*-value
2019	Intercept	3257.994	.000	0	.
	Urban	4559.638	1301.643	4	.000
	No formal education	3592.149	334.155	4	.000
	Primary	3604.368	346.373	4	.000
	Secondary	3408.911	150.916	4	.000
	Married	4126.391	868.396	4	.000
	North	3345.435	87.441	4	.000
	South	3332.212	74.218	4	.000
	East	3431.780	173.786	4	.000
	Borneo	3589.642	331.648	4	.000
	Bumiputera	3666.284	408.290	4	.000
2020	Intercept	3289.402	.000	0	.
	Urban	4180.050	890.648	4	.000
	No formal education	3848.589	559.188	4	.000
	Primary	3985.289	695.887	4	.000
	Secondary	3464.915	175.514	4	.000
	Married	3873.374	589.973	4	.000
	North	3387.545	98.143	4	.000
	South	3308.287	18.885	4	.001
	East	3382.625	93.223	4	.000
	Borneo	3695.097	405.695	4	.000
	Bumiputera	3669.268	379.866	4	.000
2021	Intercept	2582.965	.000	0	.
	Urban	3533.885	950.920	4	.000
	No formal education	3272.952	689.987	4	.000
	Primary	3452.883	869.918	4	.000
	Secondary	2979.950	396.985	4	.000
	Married	3344.502	761.537	4	.000
	North	2654.667	71.702	4	.000
	South	2586.101	3.136	4	.535
	East	2665.166	82.201	4	.000
	Borneo	2839.223	256.258	4	.000
	Bumiputera	2945.145	362.180	4	.000

Based on the 2019 data presented in Table 5, the Strata variable (urban vs. rural) significantly influenced elderly employment outcomes, particularly for the categories of self-employed and unpaid family work. With rural areas sets as the reference category, elderly individuals residing in urban areas were 68% less likely to be self-employed (odds ratio = 0.32, 95% CI: 0.25–0.39) and 72% less likely to work as unpaid family workers (odds ratio = 0.28, 95% CI: 0.08–4.01). These findings highlight a greater prevalence of informal employment among the rural elderly population, suggesting that rural environments may provide stronger reliance on household-based or subsistence forms of work.

Educational status also exerted a substantial impact across employment categories. Compared to those with tertiary education, elderly individuals with primary and secondary education were less likely to be employers (odds ratios = 0.39 and 0.79, respectively) but significantly more likely to be self-employed (odds ratios = 3.16 and 2.54, respectively) and unpaid family workers (odds ratios = 4.82 and 3.34, respectively). This pattern underscores the role of education in shaping access to formal and stable employment opportunities. Lower education levels appear to push elderly individuals toward informal work arrangements, whereas tertiary education is more strongly associated with participation in formal employment or opting out of the labour force altogether.

Table 5: Coefficient, odds ratio estimates and *p*-values of the MLR model in 2019

Status of work	Variable	β	*p*-value	Odds Ratio	95% Confidence Interval for Odds Ratio	
					Lower bound	Upper bound
Employer	Urban	-0.16	0.08	0.85	0.65	1.62
	No formal education	-2.12	0.0	0.12	0.01	0.45
	Primary	-0.95	0.00	0.39	0.01	0.47
	Secondary	-0.23	0.03	0.79	0.55	1.56
	Married	0.75	0.00	2.11	0.39	0.57
	North	-0.27	0.00	0.77	0.02	1.65
	South	-0.09	0.45	0.91	0.87	1.42
	East	0.54	0.00	1.72	0.45	1.74
	Borneo	-0.23	0.08	0.79	0.65	1.08
	Bumiputera	-0.98	0.00	0.38	0.26	3.52
Employee	Urban	0.05	0.40	1.05	0.89	1.10
	No formal education	-1.21	0.00	0.30	0.47	3.72
	Primary	-0.23	0.00	0.79	0.04	1.42
	Secondary	0.13	0.09	1.14	0.74	1.00
	Married	0.38	0.00	1.46	0.61	.74
	North	-0.09	0.21	0.92	0.90	1.28
	South	0.10	0.16	1.11	0.79	1.25
	East	-0.06	0.47	0.94	0.90	1.29
	Borneo	-0.06	0.42	0.94	0.69	0.97
	Bumiputera	-0.70	0.00	0.51	0.67	2.00
Self employed	Urban	-1.13	0.00	0.32	0.25	0.39
	No formal education	0.45	0.00	1.57	0.50	1.73
	Primary	1.15	0.00	3.16	0.25	5.36
	Secondary	0.93	0.00	2.54	0.32	.446
	Married	0.66	0.00	1.93	0.48	2.55
	North	0.52	0.00	1.68	0.51	3.68
	South	0.51	0.00	1.67	0.52	370
	East	0.87	0.00	2.38	0.39	4.52
	Borneo	1.05	0.00	2.85	0.30	5.40
	Bumiputera	-0.11	0.00	0.90	0.82	2.94
Unpaid family worker	Urban	-1.26	0.00	0.28	0.08	4.01
	No formal education	1.64	0.00	5.17	0.11	6.35
	Primary	1.57	0.00	4.82	0.13	6.41
	Secondary	1.21	0.00	3.34	0.19	5.62
	Married	2.01	0.00	7.44	0.10	8.17
	North	1.25	0.00	3.51	0.17	4.52
	South	1.28	0.00	3.58	0.16	4.48
	East	1.57	0.00	4.80	0.14	5.44
	Borneo	1.79	0.00	6.02	0.06	7.19
	Bumiputera	-0.88	0.00	0.42	0.33	1.87

Marital status also exhibited a strong association with employment status. Married elderly individuals were more likely to participate in all employment categories compared to their unmarried counterparts, with odds ratios of 2.11 for employers, 1.46 for employees, 1.93 for self-employed, and a striking 7.44 for unpaid family workers. These results imply that marriage may provide both economic and social incentives for elderly individuals to remain engaged in the labour force, particularly in informal or family-based work arrangements.

Regional disparities were likewise evident. Relative to the Western region, elderly individuals in the North, South, East, and Borneo regions had significantly higher odds of being self-employed (odds ratios = 1.68, 1.67, 2.38, and 2.85, respectively) and unpaid family workers (odds ratio = 3.51, 3.58, 4.80, and 6.02, respectively). This pattern reinforces the notion that informal work is more prevalent in non-western regions, possibly reflecting regional variations in economic structure, access to formal sector jobs, and reliance on household or agricultural labour.

Finally, ethnicity emerged as a significant determinant of employment outcomes. Compared to non-Bumiputera, Bumiputera elderly individuals demonstrated consistently lower odds of employment across all categories: 0.38 for employers, 0.51 for employees, 0.90 for self-employed, and 0.42 for unpaid family workers. These disparities may signal broader socio-economic differences in labour force participation between ethnic groups, potentially linked to differences in occupational opportunities, economic resources, or social networks.

The results align with established theories in labour economics and sociology. The higher incidence of informal work among the rural elderly corresponds with Dual Labour Market Theory, which distinguishes between formal urban labour markets and informal rural employment (Piore 1979). Similarly, Human Capital Theory explains the strong link between educational level and employment type, suggesting that lower education is associated with greater participation in informal work (Becker 1964). The positive association between marital status and employment can be interpreted by Social Support Theory, which underscores the role of spousal support in extending labour force participation (Thoits 1995). Regional differences highlight spatial inequalities in economic opportunities (Harvey 1973), while ethnic variations in employment outcomes reflect processes of social stratification and labour market segmentation processes (Blau & Duncan 1967). Together, these theoretical perspectives provide a robust framework for understanding the demographic determinants of elderly employment in Malaysia.

According to the 2020 data presented in Table 6, the Strata variable (urban vs. rural) exerted a significant impact across all employment categories—employer, employee, self-employed, and unpaid family worker. Compared to their rural counterparts, elderly individuals residing in urban areas, those in rural areas were less likely to participate in the workforce, as reflected by the lower odds of being employed in urban areas: 0.72 for employers, 0.45 for employees, 0.50 for self-employed, and 0.29 for unpaid family workers. These findings underscore the greater prevalence of informal employment among the rural elderly population. The educational status variable also demonstrated a substantial influence across employment types. Compared to elderly individuals with tertiary education, those with no formal education or only primary education were significantly less likely to be employers (odds ratios = 0.01 and 0.01, respectively) or employees (0.37 and 0.82, respectively). However, they were more likely to be self-employed (odds ratios = 1.70 and 3.05) and unpaid family workers (odds ratios = 2.50 and 2.56). This indicates that lower levels of educational status are strongly associated with informal labour participation, while higher education correlates with formal employment or detachment from the labour force. A similar trend was observed among those with secondary education: although the odds of being self-employed (2.85) and unpaid family workers (1.84) remained relatively high, their likelihood of being employers or employees were still lower compared to individuals with tertiary education.

Table 6: Coefficients, odds ratio estimates and *p*-values of the MLR model in 2020

Status of work	Variable	β	*p*-value	Odds Ratio	95% Confidence Interval for Odds Ratio	
					Lower bound	Upper bound
Employer	Urban	-0.33	0.02	0.72	0.06	1.81
	No formal education	-4.87	0.00	0.01	0.00	1.04
	Primary	-4.73	0.00	0.01	0.00	1.02
	Secondary	-0.75	0.00	0.47	0.07	2.57
	Married	0.56	0.00	1.75	0.44	2.74
	North	-0.11	0.43	0.89	0.84	1.48
	South	0.22	0.13	1.25	0.60	1.26
	East	0.21	0.21	1.23	0.58	1.32
	Borneo	0.54	0.00	1.72	0.43	2.78
	Bumiputera	-1.57	0.00	0.21	0.10	5.93
Employee	Urban	-0.80	0.00	0.45	0.07	2.36
	No formal education	-1.00	0.00	0.37	0.36	3.11
	Primary	-0.20	0.00	0.82	0.09	1.36
	Secondary	0.08	0.16	1.08	0.83	1.03
	Married	0.49	0.00	1.63	0.57	2.65
	North	-0.15	0.00	0.86	0.04	1.29
	South	0.08	0.16	1.08	0.82	1.03
	East	0.24	0.00	1.27	0.70	1.87
	Borneo	0.30	0.00	1.35	0.66	1.82
	Bumiputera	-0.25	0.00	0.78	0.20	1.37
Self employed	Urban	-0.69	0.00	0.50	0.03	2.15
	No formal education	0.53	0.00	1.70	0.46	2.74
	Primary	1.12	0.00	3.05	0.26	4.40
	Secondary	1.05	0.00	2.85	0.28	3.43
	Married	0.56	0.00	1.75	0.52	2.62
	North	0.72	0.00	2.05	0.40	3.58
	South	0.25	0.16	1.28	0.64	1.95
	East	0.66	0.00	1.94	0.42	2.62
	Borneo	1.40	0.00	4.07	0.20	5.29
	Bumiputera	0.12	0.00	1.13	0.81	1.96
Unpaid family worker	Urban	-1.24	0.00	0.29	0.87	4.12
	No formal education	0.91	0.00	2.50	0.24	2.65
	Primary	0.94	0.00	2.56	0.24	3.62
	Secondary	0.61	0.01	1.84	0.33	2.87
	Married	1.75	0.00	5.77	0.13	6.22
	Bumiputera	-0.83	0.00	0.44	0.02	2.74
	North	0.89	0.00	2.38	0.25	3.69
	South	0.81	0.00	2.23	0.26	3.76
	East	1.26	0.00	3.53	0.16	4.47
	Borneo	2.05	0.00	7.79	0.07	8.21
	Bumiputera	-0.83	0.00	0.44	0.02	2.74

Marital status was also a significant determinant of work status among the elderly. Compared to those who were not married, married elderly individuals had increased odds of being employed across all categories—1.75 for employers, 1.63 for employees, 1.75 for the

self-employed, and a notably high 5.77 for unpaid family workers. This suggests that marital support may be linked to greater economic participation in later life. The regional (zone) variable also had a meaningful impact on work status. Compared to the Western region of Malaysia, elderly individuals in the North, East, and Borneo had higher odds of being self-employed (2.05, 1.94, and 4.07, respectively) and unpaid family workers (2.38, 3.53, and 7.79, respectively). Although the odds of being an employee were slightly lower in the North (0.86), they were higher in the East (1.27) and Borneo (1.35), indicating regional disparities in employment patterns among the elderly. Moreover, the odds of being an employer were also higher in Borneo (1.72), reflecting a regional concentration in small business ownership or self-employment initiatives among the elderly in this area.

Finally, the ethnic group variable showed significant influence for most employment categories. Compared to non-Bumiputera individuals, Bumiputera elderly had lower odds of being employers (0.21), employees (0.78), and unpaid family workers (0.44) which may reflect ethnic disparities in access to employment opportunities or socio-economic conditions. In contrast, the odds of Bumiputera individuals being self-employed were slightly higher (1.13). Although this difference was statistically significant, it suggests only a modest variation in self-employment likelihood between the two ethnic groups. Overall, the findings from 2020 reinforce the patterns observed in 2019, highlighting the consistent influence of demographic, geographic, and socio-economic factors on elderly employment status in Malaysia.

The 2020 data on the employment status of the elderly in Malaysia correspond closely with several well-established theoretical models. The increased participation in informal jobs among the rural elderly aligns with Dual Labor Market Theory, which posits the existence of distinct formal and informal labour markets, often differentiated along urban-rural lines (Doeringer & Piore 1971). Educational disparities are consistent with Human Capital Theory, which emphasises the importance of skills and qualifications in securing formal employment opportunities (Becker 1964). The association between marital status and employment supports Social Support and Role Theories, both of which highlight the economic and psychosocial benefits of spousal support in sustaining labour force participation (Thoits 1995). Regional variations in employment reflect Spatial Inequality Theory, demonstrating how uneven distribution of economic infrastructure and industrial development shapes employment opportunities across different zones of Malaysia (Harvey 1973). Finally, ethnic disparities in employment correspond with Social Stratification and Labour Market Segmentation, which account for persistent socio-economic inequalities that constrain labour force participation among certain groups (Blau & Duncan 1967). Taken together, theoretical perspectives provide a comprehensive foundation for interpreting the demographic, geographic, and socio-economic factors influencing elderly employment in Malaysia.

According to the 2021 data presented in Table 7, the strata variable (urban vs. rural) continued to be a significant determinant of employment status among the elderly, particularly in the employer, self-employed, and unpaid family worker categories. Compared to their urban counterparts, elderly individuals in rural areas were 4% less likely to be employers (odds ratio = 0.96), 67% less likely to be self-employed (0.33), and 72% less likely to work as unpaid family workers (0.28), reinforcing earlier trends that highlighted the predominance of informal employment in rural settings.

Table 7: Coefficients, Odds Ratio Estimates and *p*-values of the MLR model in 2021

Status of work	Variable	β	*p*-value	Odds Ratio	95% Confidence Interval for Odds Ratio	
					Lower bound	Upper bound
Employer	Urban	-0.04	0.00	0.96	0.79	1.36
	No formal education	-4.08	0.00	0.02	0.01	0.04
	Primary	-4.58	0.00	0.01	0.00	0.02
	Secondary	-0.75	0.00	0.47	0.06	2.54
	Married	0.95	0.00	2.59	0.29	3.50
	North	0.15	0.27	1.16	0.66	1.12
	South	-0.04	0.77	0.96	0.78	1.50
	East	-0.14	0.45	0.87	0.80	1.63
	Borneo	0.74	0.00	2.11	0.36	3.62
	Bumiputera	-1.50	0.00	0.23	0.01	5.27
Employee	Urban	-0.06	0.24	0.95	0.90	1.16
	No formal education	-1.40	0.00	0.25	0.14	4.87
	Primary	-0.43	0.00	0.65	0.34	1.70
	Secondary	0.14	0.02	1.15	0.76	1.98
	Married	0.50	0.00	1.65	0.55	0.66
	North	-0.07	0.32	0.93	0.90	1.22
	South	-0.05	0.46	0.95	0.91	1.20
	East	0.25	0.00	1.28	0.67	2.90
	Borneo	0.49	0.00	1.62	0.53	2.70
	Bumiputera	-0.47	0.00	0.63	0.47	1.73
Self employed	Urban	-1.12	0.00	0.33	0.03	3.30
	No formal education	1.08	0.00	2.94	0.26	3.44
	Primary	1.60	0.00	4.76	0.16	5.27
	Secondary	1.69	0.00	5.43	0.14	6.23
	Married	0.76	0.00	32.14	29.43	35.50
	North	0.66	0.00	1.93	0.43	2.61
	South	-0.06	0.12	0.94	0.88	1.27
	East	0.71	0.75	2.04	0.41	4.58
	Borneo	1.05	0.00	3.85	0.29	4.41
	Bumiputera	0.05	0.00	1.05	0.87	2.03
Unpaid family worker	Urban	-1.26	0.00	0.28	0.06	4.40
	No formal education	3.07	0.00	21.48	19.01	22.18
	Primary	2.70	0.00	14.95	0.01	15.27
	Secondary	2.61	0.00	13.55	0.01	14.29
	Married	2.47	0.00	11.78	0.05	12.12
	North	0.34	0.21	1.40	0.42	2.20
	South	-0.47	0.12	0.63	0.87	2.90
	East	-0.09	0.75	0.91	0.61	1.95
	Borneo	1.48	0.00	4.37	0.13	5.38
	Bumiputera	-0.56	0.00	0.57	0.38	2.21

The educational status variable also exhibited consistent and significant effects across all employment categories. Elderly individuals with no formal education had substantially lower odds of being employers (0.02) and employees (0.25) compared to those with tertiary education, while their odds of being self-employed (2.94) and unpaid family workers (21.48) were markedly higher. A similar pattern was observed among those with primary education, where the odds of being employers (0.01) and employees (0.65) were reduced, but the odds of being self-employed (4.76) and unpaid family workers (14.9) were considerably higher.

Elderly individuals with secondary education also displayed distinctive patterns. They had lower odds of being employers (0.47), but higher odds of being employees (1.15), self-employed (5.43), and unpaid family workers (13.55). These results reinforce the broader trend that lower educational level is strongly associated with increased participation in informal work sectors, whereas tertiary education is more closely linked to formal employment or non-participation in the labour force.

The marital status variable similarly demonstrated a significant influence across all employment categories. Compared to those who were not married, married elderly individuals were considerably more likely to be employed: 2.59 times more likely to be employers, 1.65 times more likely to be employees, 32.14 times more likely to be self-employed (though this exceptionally large estimate may warrant closer examination), and 11.78 times more likely to be unpaid family workers. These findings suggest that marital status may help to sustain economic participation among the elderly, potentially through social support mechanisms or shared household responsibilities.

Regarding the zone variable, significant regional differences were evident. In the North, elderly individuals were 1.93 times more likely to be self-employed than those in the West. In the East, a significant increase was observed only in the employee category (odds ratio = 1.28), while the South showed no significant effects across any employment category. In Borneo, however, elderly individuals were significantly more likely to be in all work categories compared to the West: 2.11 times more likely to be employers, 1.62 times more likely to be employees, 3.85 times more likely to be self-employed, and 4.37 times more likely to be unpaid family workers.

The ethnic group variable had a significant influence across most employment categories. Compared to non-Bumiputera, Bumiputera elderly individuals had lower odds of being employers (0.23), employees (0.63), and unpaid family workers (0.57). Interestingly, their odds of being self-employed were slightly higher (1.05), although the effect size was small. Overall, these results suggest persistent ethnic disparities in access to or participation in various types of employment among the elderly in Malaysia. The 2021 findings are consistent with earlier years, reinforcing the influence of education, region (zone), marital status, and ethnicity in shaping elderly labour force dynamics.

The 2021 data support established theoretical perspectives on the socio-demographic determinants of employment among the elderly in Malaysia. The continued prevalence of informal employment in rural regions corresponds with Dual Labor Market Theory, which emphasizes the structural division between formal urban and informal rural labour markets (Doeringer & Piore 1971). Educational disparities align with Human Capital Theory, highlighting how limited educational status constrains access to formal employment opportunities (Becker 1964). The positive effect of marital status on employment is consistent with Social Support and Role Theories, which stress the importance of spousal and social networks in sustaining economic activity among older individuals (Thoits 1995). Regional employment variations reflect Spatial Inequality Theory, demonstrating how geographic economic disparities shape patterns of labour participation (Harvey 1973). Finally, ethnic disparities resonate with Social Stratification and Labour Market Segmentation frameworks, which explain the persistent socio-economic inequalities in employment access and participation (Blau & Duncan 1967). Collectively, these theoretical perspectives provide a comprehensive foundation for understanding the complex demographic, educational, and socio-economic factors influencing elderly labour force participation in Malaysia.

The results of the MLR analysis indicate that older adults with less educational status are considerably more likely to participate in informal forms of work, such as self-employment and

unpaid family labour. This finding is consistent with the study by Rahayuwati *et al*. (2024), which demonstrated that older adults with lower educational attainment are more likely to engage in informal employment. Marital status also emerged as a significant determinant, with married individuals demonstrating a higher likelihood of labour force participation. This supports prior studies which suggest that spousal support can encourage sustained economic activity in later life (Rau & Adams 2005). Meanwhile, the observation that Bumiputera older workers are less likely to be engaged as formal employers or employees is consistent with the findings of Cuberes *et al*. (2023), who reported that significant ethnic disparities persist in labour force participation and employment status across different ethnic groups. A plausible explanation for this inconsistency is the economic disruption associated with the COVID-19 pandemic, which may have disproportionately affected certain groups. The result of geographic stratification was also consistent with the report from Schmillen *et al*. (2020), which highlighted that older individuals living in rural areas are more likely to engage in self-employment and informal economic activities, whereas those living in urban areas tend to participate more in wage employment within the formal sector due to better access to structured labour markets.

5. Implication and Significance

The primary objective of this study was to employ MLR to examine the relationship between the employment status of the elderly and their demographic characteristics. To date, relatively few studies have statistically established these association, particularly in the Malaysian context. Hence, this analysis contributes a distinctive dimension to the existing literature, given the psychological, sociological, and societal significance of elderly labour market participation.

In this study, we conducted a comprehensive overview of the demographic characteristics of elderly respondents surveyed in 2019, 2020, and 2021. The descriptive analysis covered variables such as strata, educational status, geographical zone, marital status, and ethnic group, with corresponding participant numbers and percentages. Several notable patterns emerged: consistently higher participation in urban compared to rural areas, fluctuations across educational levels, distinct variations in participation across geographical zones, and changes in marital and ethnic compositions over the three years.

The MLR analysis further evaluated the effect of these demographic variables on employment status categories. Significant predictors included strata, educational status, marital status, geographical zone, and ethnic, though their influence varied across occupational categories (employer, employee, self-employed, and unpaid family worker, with 'not working' as the reference). The statistically significant odds ratios demonstrated that the impact of these variables was not uniform but instead differentiated, highlighting how demographic and socio-economic characteristics shaped the likelihood of elderly individuals engaging in different types of work.

The in-depth analysis from 2019 and 2020 underscores the influence of strata, educational status, marital status, geographical zone, and ethnic group on specific occupational categories. Rural areas consistently demonstrated lower odds of employment across various categories, while educational status particularly tertiary education, emerged as a key determinant with differentiated effects across occupational groups. In 2021 and beyond, the study extended its focus to specific categories, further emphasizing how these variables shape occupational outcomes. Strata remained consistently significant factor, particularly in relation to the employer, self-employed, and unpaid family worker categories. Similarly, educational status, marital status, geographical zone, and ethnic group exerted substantial effects across occupational groups, offering critical insights into the complex dynamics of elderly labour force participation.

Building on the empirical results of this study, several key demographic factors should guide policymakers in promoting elderly employment in Malaysia. First, low educational level was strongly associated with informal work, underscoring the need to expand lifelong learning and skills development programmes tailored to older adults, particularly those with limited or no formal education. Second, regional disparities, especially in rural and non-Western areas, call for customised strategies such as community-based job initiatives and rural economic development programmes to expand access to formal employment. Third, the positive relationship between marital status and employment suggests that family support can encourage workforce participation; thus, family-oriented policies and community employment schemes, including flexible work arrangements, may further sustain active ageing. Fourth, the persistent employment gap among Bumiputera seniors highlights the importance of inclusive labour market policies, such as targeted hiring incentives or support mechanisms for Bumiputera-owned businesses. Finally, the high prevalence of self-employment and unpaid family work among older adults points to the necessity of strengthening social protection systems, including improved access to retirement savings schemes and healthcare coverage, for those engaged in informal work. Collectively, these recommendations emphasise the urgency of developing comprehensive, demographically sensitive policies to promote productive ageing and equitable labour force participation among Malaysia's elderly population.

Although the study was unable to compute marginal effects due to data and methodological constraints, the odds ratios nonetheless provide substantive insights into the practical significance of demographic predictors. For example, the substantially higher odds of self-employment and unpaid family work among those with lower educational attainment underscore the barriers less-educated elderly face in accessing formal jobs. Similarly, the consistently lower odds of employment in rural areas point to spatial inequalities in labour opportunities, while the markedly elevated odds for married individuals highlight the role of household support in sustaining labour participation. The ethnic disparities observed, with Bumiputera elderly less likely to be formal employers or employees, further reveal enduring inequalities in access to formal labour markets. These interpretations complement the statistical results by clarifying how odds ratios translate into meaningful, real-world implications for elderly employment, thereby addressing the substantive importance of the findings even in the absence of marginal effect estimates.

Nevertheless, certain limitations must be acknowledged. Odds ratios, while widely applied and useful for modelling categorical outcomes, are inherently conditional on model specification and can exaggerate effect sizes when outcomes are common (Cummings 2009; Grimes & Schulz 2008; Sainani 2011). This restricts their direct comparability across studies or alternative model settings (Norton & Dowd 2018; Uanhoro *et al*. 2021). Furthermore, the absence of marginal effects in this study reduces the ability to express results in terms of direct probability changes, which may be more intuitive for policy audiences (Karlson & Jann 2023).

In addition, the classification of ethnicity into Bumiputera and Non-Bumiputera represents another limitation. While this grouping ensures statistical stability in the MLR - given the comparatively smaller number of respondents in some minority groups such as Indians and East Malaysian Bumiputera - it inevitably oversimplifies Malaysia's diverse ethnic landscape. Previous studies have shown that Malays, Chinese, Indians, and East Malaysian Bumiputera each display distinct socioeconomic behaviours and employment patterns. Future research should therefore aim to incorporate more detailed ethnic breakdowns, where subgroup sizes permit, to provide richer insights into the nuanced intersections of ethnicity and elderly labour force participation.

Additionally, while the independent variables employed in this study (educational status, marital status, ethnic group, geographical zone, and strata) are categorical and conceptually distinct, we recognise that multicollinearity diagnostics were not formally conducted. Although the likelihood of problematic multicollinearity is considered minimal, future studies could incorporate diagnostic measures such as variance inflation factors (VIF) to further confirm the independence of predictors, especially if more continuous or overlapping variables are included.

Finally, as this study is based on cross-sectional data, the findings represent a snapshot of elderly employment patterns at specific points in time. Future research would benefit from the use of panel (longitudinal) data, which would enable the tracking of employment trajectories across years, capture dynamic changes in labour force participation, and evaluate the long-term effects of demographic and socioeconomic factors on elderly employment outcomes.

Taken together, these limitations suggest promising avenues for further research, including the integration of marginal effects, risk ratios, longitudinal data, and more nuanced demographic classifications, to offer a more comprehensive picture of elderly labour force participation.

6. Conclusion

Because of Malaysia's rapidly ageing population, it has become increasingly important to develop a comprehensive understanding of the employment landscape of older individuals. The dynamics are shaped by a complex interplay of health, education, socio-economic status, and shifting societal norms, all of which manifest in diverse patterns of part-time and full-time labour. For policymakers and stakeholders to design strategies that effectively support and empower older workers, it is crucial to recognise and analyse these intersecting factors. This study has undertaken in-depth investigation into the multitude of variables influencing elderly employment. Key trends include the postponement of retirement—driven by economic necessity, improved health, and changing social perceptions—and the persistence of informal work in rural areas. Nevertheless, considerable gaps remain in understanding the differentiated impacts across demographic groups, the functioning of labour dynamics, and the adequacy of social safety nets. In this regard, MLR proves to be an indispensable tool, enabling the disaggregation of these dynamics and offering a sophisticated understanding of how demographic factors such as strata, educational attainment, geographical location, marital status, and ethnicity intersect to shape elderly participation in the labour market.

Our analysis of data from 2019 to 2021 revealed significant associations across these variables. Urban areas consistently displayed higher elderly participation, while educational attainment strongly influenced the type of employment, with tertiary education linked to formal work and lower educational levels associated with informal sectors. Regional disparities persisted, with the North, East, and Borneo showing stronger engagement in informal labour. Marital status enhanced labour force participation, while ethnic differences reflected persistent socio-economic inequalities. These findings underscore the complexity of elderly labour market participation and highlight the necessity for demographically sensitive and multidimensional policy approaches.

In conclusion, this study represents a pioneering effort to apply MLR to the analysis of elderly employment in Malaysia, contributing both methodologically and substantively to the literature. By revealing statistically significant relationships between employment status and demographic characteristics, it adds a distinctive perspective to an underexplored area of research. Future studies could strengthen the analysis by integrating additional variables, exploring ordered categorical structures with ordered logit models, and examining the influence

of government policy measures on elderly labour force participation. Addressing these dimensions will advance understanding of the intricate interplay between demographic factors and the ageing workforce, supporting the design of informed, inclusive, and effective labour policies.

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