PharmacoEconomics (2023) 41:1117–1136
https://doi.org/10.1007/s40273-023-01283-6

ORIGINAL RESEARCH ARTICLE

Informal Caregiving Provision for Disabled or Elderly in the Families and Work Productivity: Evidence from 11 Waves of an Australian Population-Based Cohort

Syed Afroz Keramat[1] · Rubayyat Hashmi[2] · Bolaji Samson Aregbeshola[3] · Tracy Comans[1]

Accepted: 17 May 2023 / Published online: 20 June 2023

Abstract

Background Informal carers are family members, friends or neighbours who care for persons in need. In 2018, around one in ten Australians offered some informal care, most of which was unpaid. It is essential to comprehend how informal caregivers' productivity at work is affected by their caregiving responsibilities. We examine the association between informal caregiving and productivity loss in Australia.

Methods We utilised 11 waves of data drawn from the Household, Income and Labour Dynamics in Australia (HILDA) survey. Longitudinal random-effects logistic regression and random-effects Poisson regression techniques were used to assess the between-person differences in the association between informal caregiving and productivity loss (absenteeism, presenteeism and working hour tension).

Results The results suggest informal caregiving is associated with a higher rate of absenteeism, presenteeism and working hour tension. We reveal that absence/leave rates at work are greater for those with lighter, moderate and intensive care responsibilities than those without caregiving responsibilities, given other covariates reference categories remain constant. Our findings also indicate that workers with intensive, moderate, and light caregiving responsibilities have considerably higher rates of working hour tension than their peers without caregiving commitments if other covariate reference categories are held constant. The result further shows that, on average, an individual with lighter, moderate and intensive caregiving roles had incurred AUD 276.13, AUD 246.81, and AUD 1927.16, respectively, in absenteeism costs annually compared with their counterparts without caregiving duties.

Conclusion Our study reveals that working-age caregivers experience greater absenteeism, presenteeism and working hour tension. Adverse effects of informal caregiving are required to perform the cost effectiveness of an intervention given to caregivers to improve carer and patient health. Our findings will assist health technology assessment (HTA) practitioners in performing an economic evaluation of interventions given to caregivers by providing the indirect cost (productivity loss) of caregiving.

Abbreviations

HILDA	Household, Income and Labour Dynamics in Australia Survey
OECD	Organization for Economic Co-operation and Development
SF-36	36-Item Short-Form Health Survey

1 Introduction

Informal caregiving is mostly an unpaid job provided by family members and friends to the elderly and people with disability or long-term health conditions [1]. About 65% of informal caregivers across Organization for Economic Co-operation and Development (OECD) countries were women in 2019 [2]. In 2018, one in ten Australians provided informal care, representing 2.65 million people [3]. Informal caregiving has known adverse effects on the health of carers, leads to high rates of depression and anxiety, and causes emotional and physical strain as well as stress [4,

Extended author information available on the last page of the article

Key Points for Decision Makers

Informal caregiving involves millions of individuals who spend billions of hours caring for patients who would otherwise require care from the healthcare system. This resource should be seen as scarce and as valuable as any other health service within the health system. Therefore, it is important to consider the value of informal caring as part of the health technology assessment.

The provision of informal caregiving is adversely associated with the workplace productivity of caregivers in terms of increased absenteeism, a greater chance of presenteeism and higher working hour tension.

Policymakers should prioritise increasing access to publicly funded or subsidised formal care. If there were more formal care options available, informal caregivers might have less caregiving burden and be more productive at work.

5]. Policies to support informal caregivers in many OECD countries have included the provision of paid or unpaid care leave, cash benefits, cash-for-care allowances for recipients, periods of paid leave for informal carers and counselling/training services [2, 6]. Despite this, the work performance of informal caregivers continues to be negatively impacted as there is a competing demand between informal caregiving and paid work [7].

Unpaid carers contribute substantial value to the health system and society. Informal caregiving involves millions of individuals who spend billions of hours caring for patients who would otherwise require care from the healthcare system. This resource should be seen as scarce and as valuable as any other health service within the health system. Therefore, it is important to consider the value of informal caring as part of the health technology assessment. There are direct and indirect costs associated with the investment of time of the caregivers. There may be lost income because they are unable to work or unable to work as much as they performed before. There are indirect productivity losses to society. If a carer cannot come in to do their job in the workplace, society will miss out on the formal value of that carer's time. They may be otherwise volunteering in a capacity that would add value to society. Policymakers are often interested in knowing the value of the reduction in the burden on carers if there is a new treatment or a new health technology available that reduces the burden placed on informal carers. The goal of health technology assessment is to ensure the utilization of scarce and limited resources in the most efficient way. Therefore, it is important to take these values and burdens into consideration when health technology assessors consider the value of new medicines of new healthcare technology. Economic evaluations that disregard informal care would undervalue a health intervention that reduces the caregiving burden [8].

Informal caregiving for family members with long-term illnesses or disabilities burdens the caregiver [9]. Some empirical studies have examined the association between informal caregiving and productivity at work. However, results from these studies on the association between informal caregiving and productivity at work are mixed and inconclusive. For instance, a study by Bryan (2012), using matched employer–employee data, examined the association between employees' access to flexible working arrangements and the amount of informal care provision to sick or elderly friends and relatives. The authors found that about 13% more hours of informal care were associated with flexitime and the ability to reduce working hours [10]. Chen et al. (2017) utilized data from the 1991–2009 China Health and Nutrition Survey and examined the association between informal care and labour market outcomes among married women of working age. They found that the intensity of caregiving significantly reduced weekly hours of work among the study population [11]. Fakeye et al. (2022) estimated caregiving-related absenteeism and presenteeism among US adults. They found that formal caregiving reduced productivity at work by one-third, with productivity loss higher among older adult caregivers [12]. Johnson and Lo Sasso (2001) examined the association between labour supply, time help to parents and financial assistance to parents among US working-age individuals. They found that the provision of informal care to parents by women reduced work hours, while the provision of financial assistance increased the number of hours spent working [13].

Mazanec et al. (2011) examined the association between caregiving burden and productivity loss in the USA. They found that a greater number of caregiving hours was associated with greater work productivity loss, among others [4]. Using a prospective cohort study of working adults in France, Finland, and the UK, Mortensen et al. (2017) examined the effects of job strain and informal caregiving on long-term sickness absence with special attention to gender differences. They found that high job strain and informal caregiving were significantly associated with a higher risk of sickness absence among women [14]. Van Houtven et al. (2013) also examined the association between informal caregiving and work in the USA. The authors found that the provision of informal care by women who remain

working reduced work by 3–10 hours per week, while there was little effect of informal caregiving on working hours among men [15]. Wolf and Soldo (1994) estimated the effect of the provision of care to older parents on employment and hours of work among married women and found no evidence of the effect of the provision of care to older parents on employment and hours of work [16]. Yamada and Satoshi (2015) examined the association between informal care provision and labour market outcomes in Japan, and found that the provision of family care for parents adversely affected the probability of working hours worked and employment status, with the effect being greater among female caregivers compared with male caregivers [17]. A study in Australia by Gray and Hughes (2005) on the use of flexible working arrangements to provide adult care compared with the use by those caring for children found that one in seven working individuals with caregiving responsibilities desire but cannot utilise flexible working hours, shift work and work-from-home possibilities. However, this study did not examine the between-person differences in the association between informal caregiving and productivity burdens such as absenteeism, presenteeism and working hour tension [18].

In summary, while existing studies on the productivity burden of informal caregiving for disabled or elderly relatives have been conducted in other developed countries [4, 7, 10, 13–17, 19], no study has examined the between-person difference in the association between informal caregiving and productivity burden in Australia. Furthermore, results from previous studies cannot be generalised to the Australian population. We aim to fill this gap in the literature by examining the between-person differences in the association between informal caregiving and three measures of productivity following a retrospective, longitudinal research design.

2 Methods

2.1 Data Source

We used data from the Household, Income and Labour Dynamics in Australia (HILDA) survey for the empirical analyses. HILDA is a nationally representative longitudinal study that collects data annually from over 13,000 individuals from over 7000 households using a multi-stage sampling procedure since 2001. It is designed and managed by the Melbourne Institute of Applied Economic and Social Research with the financial support of the Australian Government Department of Social Services. The survey collects data from household members aged 15 years or above using a combination of self-completion questionnaires alongside in-person and telephone interviews conducted by professional interviewers. The survey collects detailed information on a wide range of topics, such as wealth, retirement, fertility, health, education and demographic characteristics. To perform the empirical analyses, we have selected the HILDA dataset since it contains information on informal caregiving, absenteeism, presenteeism, preferred hours to work and actual hours to work alongside socio-demographic and lifestyle characteristics at different periods. The details of the survey can be found elsewhere [20].

2.2 Analytic Sample and Missing Data

This study analysed data from 11 waves (waves 11–21) of the HILDA survey, spanning the period from 2011 to 2021. The analysis is restricted to individuals currently in paid employment for the regression analyses of presenteeism and working hour tension. However, we considered both employed and unemployed respondents for the regression analysis of absenteeism. Our sample is confined to respondents having complete data on the main variable of interest (informal caregiving) and outcome variables (absenteeism, presenteeism and working hour tension). The final analytic sample comprises 97,521 yearly observations (18,612 unique participants) for absenteeism, and 96,818 yearly observations (18,139 unique participants) for presenteeism and working hour tension. Figure 1 depicts the flow of participants into the analytic sample.

2.3 Measures

2.3.1 Outcome Variables

We measure productivity through absenteeism (count variable), presenteeism (binary variable) and working hour tension (count variable). The outcome variable, absenteeism, is a self-reported measure of the number of leave taken in the previous 12 months. Total leave of a respondent was ascertained through asking four questions: how many days of paid annual leave, sick leave, unpaid leave and other leave (maternity, paternity, bereavement, etc.) have you taken in last 12 months. To determine absenteeism, we additionally counted the number of days a responder was unemployed over the previous fiscal year. We summed four forms of leave and days unemployed to compute a respondent's overall absenteeism in the previous 12 months.

Another outcome, presenteeism, was derived from the short form (SF-36) Health Survey, administered yearly in the HILDA survey as part of the self-completion questionnaire (SCQ). More specifically, individuals are asked whether, as a result of any emotional problems, they have

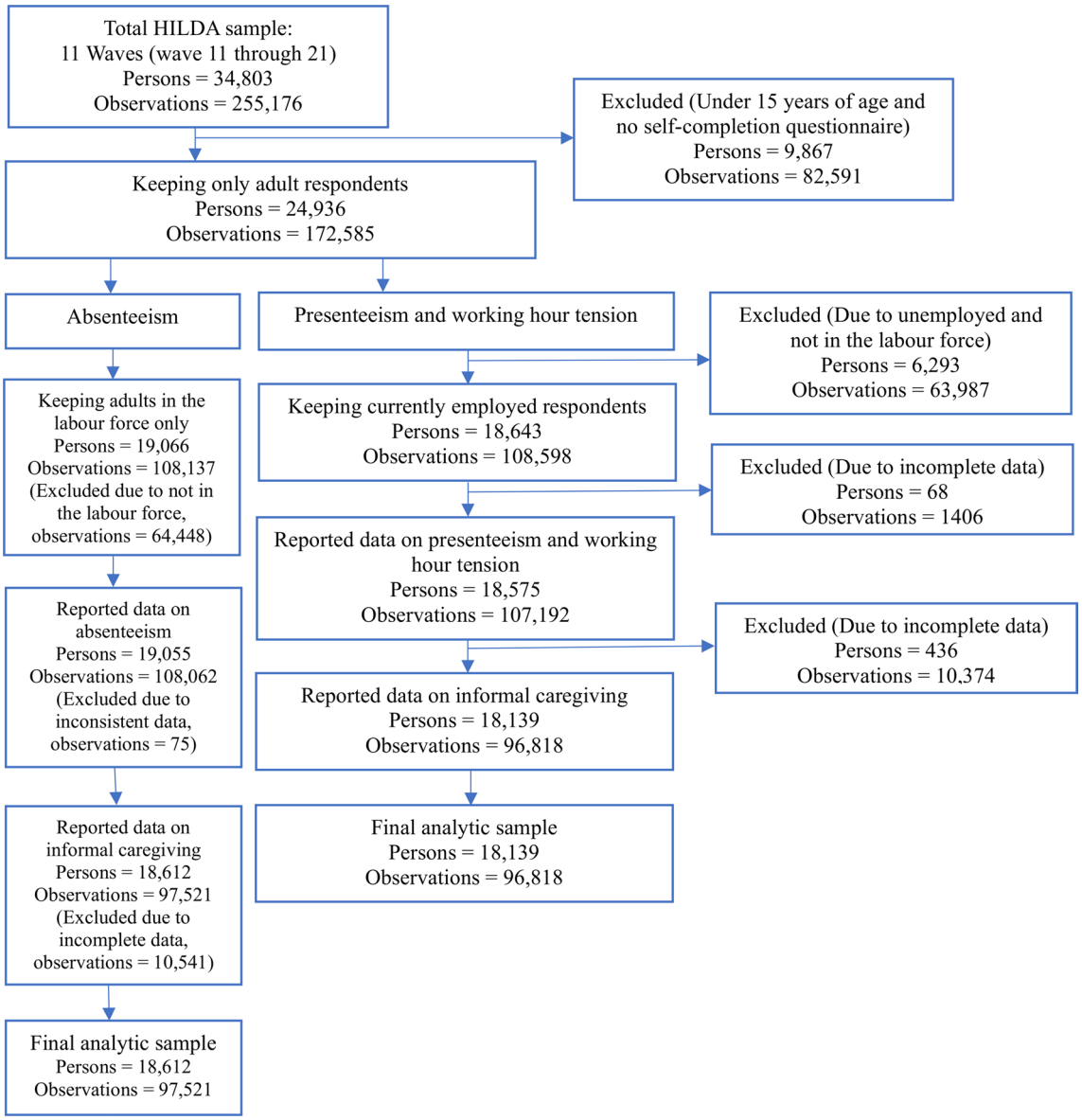

Fig. 1 Participants flow into the analytic sample and missing data

experienced any of the following in the past four weeks: 'cutting down the amount of time you spent on work or other activities', 'accomplished less than you would like' and 'did not do work or other activities as carefully as usual'. Participants were also asked whether they have experienced any of the following three events in the past four weeks due to any physical problems: 'cut down the amount of time spent on work or other activities', 'accomplished less than would like' and 'were limited in the kind of work'. The responses were recorded in binary form: yes or no. Using these six questions, we construct a binary indicator taking the value of 1 if a respondent answered 'Yes' to any of the questions in that year and 0 otherwise.

Working hour tension is a count variable derived from two variables following previous research [21]. The authors derived working hour tension by subtracting hours per week usually worked in all jobs from hours preferred to work per week. If the weekly worked hours are higher or equal to the preferred working hour, then the derived variable 'working hour tension' takes the value zero. Working hour tension will be non-negative integers if a respondent's preferred hours to work is greater than weekly worked hours.

2.3.2 Exposure Variable

Informal caregiving is the act of providing assistance to family members, friends or neighbours who are in need. The HILDA survey identifies informal carers by asking respondents if they provide ongoing care or assistance to a family member with a long-term health condition, a disability or who is old. The self-administered follow-up questionnaire asks about respondents' time commitment in a typical week to caregiving. These questions are used to identify informal carers and quantify their caregiving commitments (in hours per week). We classified informal caregiving responsibilities as non-caregiver, lighter caregiving (< 5 hours/week), moderate caregiving (5–19 hours/week) and intensive caregiving (20 or more hours/week) following a prior study [22].

2.3.3 Control Variables

We included potential confounders that are important correlates of workplace productivity based on previous research. The socio-demographic covariates included in the study are age, gender, relationship status, education, annual household disposable income, Indigenous status and region of residence. We have included childcare use as an exposure variable in the regression analyses. Childcare use is constructed from three variables (childcare used for any not yet at school child, childcare used for any school-age child during term and childcare used by any school-age child during school holidays). The responses to these questions were recorded in binary form (not used and used). If a respondent answered 'used' to any of the three questions, we considered them to have utilised childcare. The current study included two key measures of health-related characteristics (weight and disability status) and three health-related behavioural characteristics (smoking, alcohol consumption and physical activity). Moreover, the authors also considered a wide range of job-related characteristics (farm size, employment contract, occupation, supervisory responsibilities, union membership, paid holiday leave, sick leave and overall job satisfaction) as the potential confounders. We provide a detailed description of the control variables in Table 5 (Appendix).

2.4 Estimation Strategy

2.4.1 Conceptual Framework

We begin our conceptual framework by noting that workers who provide informal care owing to the presence of a disabled family member must decide whether to go to work or stay at home. This decision may also be influenced by a variety of other factors. For example, workers might become unwell and opt not to report to work. This process will be determined by the health and health-related behaviour of the individual. In addition, workplace policies (e.g. if the employee is eligible for sick leave or sick pay, employment contract, etc.) and work culture (kind of vocation, whether the employee has a supervisory relationship, farm size, etc.) will also influence this choice. Hence, the decision to report to work or not depends on the costs and benefits of the alternatives available to the workers.

In making a work participation choice, we assume workers build expectations about their on-the-job productivity and their firm's productivity loss. Workers might stay at home if they expect reduced workplace productivity owing to informal caregiving duties. On the other hand, if the worker's absence causes considerable productivity losses for the firm and the worker's employment is at risk, they are more likely to report to work despite informal caregiving commitments. Of course, the worker might fail to recognise the expectations, in which case neither absenteeism, presenteeism nor work hour tension would emerge.

In model estimation using our conceptual framework, three essential observations should be emphasised. First, the productivity loss associated with informal caregiving is contingent on several factors, not all of which may be observable in our data. Consequently, estimation error may be present in the analysis. Second, absenteeism, presenteeism and work hour tension may be conceptually related, but we cannot estimate them simultaneously. This is because we do not observe every incidence of informal caregiving scenarios with a matching work attendance decision. Lastly, it is unclear whether absenteeism, presenteeism and work hour tension are inherently negative outcomes from the standpoint of either the employer or the employee. Continuing to work when excessively burdened with informal caregiving obligations, for instance, may not result in a loss of productivity provided the work environment is accommodating enough to meet the worker's circumstances. Similarly, the firm's productivity loss might well be minimised if employees with caregiving responsibilities choose to stay at home rather than report to work.

2.4.2 Model Estimation: Absenteeism and Working Hour Tension

According to this study, absenteeism (A_{it}) is measured by the number of absent days in the last 12 month period, which is a count variable. Similarly, person i experience working hour tension (number of hours like to work – number of hours

actually worked) at time t is denoted as W_{it}, which is also count variable that. As a result, we estimate random-effects Poisson regression models of the following form [23]:

$$\Pr\left(A_{it} = a_{it}|x_{it}\right) = \frac{e^{-\lambda_{it}}\lambda_{it}{}^{a_{it}}}{a_{it}!} \tag{1}$$

and

$$\Pr\left(W_{it} = w_{it}|x_{it}\right) = \frac{e^{-\lambda_{it}}\lambda_{it}{}^{w_{it}}}{w_{it}!} \tag{2}$$

Where, $\lambda_{it} = exp^{x_{it}\beta}$; x_{it} is a vector of control and exposure variables (informal caregiving IC_{it}, childcare-related characteristics C_{it}, health-related characteristics and behaviour H_{it}, job characteristics JC_{it} and demographic X_{it}).

Thus, the random-effects Poisson model is specified in our study in the following form:

$$\log\left(\lambda_{it}\right) = \gamma_0 + \gamma_1 IC_{it} + \gamma_2 C_{it} + \gamma_3 H_{it} + \gamma_4 JC_{it} + \gamma_5 X_{it} + \overline{X}_i\eta + \alpha_i + \varepsilon_{ij} \tag{3}$$

The primary parameter of interest to be estimated is γ_1 indicating the impact of informal caregiving on productivity loss.

2.4.3 Model Estimation: Presenteeism

Since our measure of presenteeism is a binary indicator variable, we use a random-effects logistic model to examine the link between productivity loss and informal care. Consequently, we postulate that the following logistic functional forms may be employed to characterise presenteeism associated productivity losses resulting from informal caregiving in the family:

$$P_{it}^{*} = \Lambda(IC_{it}, C_{it}, H_{it}, JC_{it}, X_{it}, \alpha_i, \varepsilon_{it}) \tag{4}$$

Where P_{it}^{*} is the person i's continuous latent response, reflecting the propensity to experience presenteeism at time t. The independent variable IC_{it} is an ordinal indicator on the level of informal caregiving, C_{it} indicates childcare use, H_{it} is a vector of health-related characteristics and behaviour, JC_{it} is a vector of job characteristics, X_{it} is a vector of demographic controls, α_i is unobserved time-invariant heterogeneity and ε_{it} is the error term. The subscript it refers to person i and time t respectively.

Since P_{it}^{*} is unobserved, the following is the observed response:

$$P_{it} = \begin{cases} 1, if\ P_{it}^{*} > 0 \\ 0, otherwise \end{cases} \tag{5}$$

The random-effects logistic model (see Wooldridge, J.M., 2010 for details) for individuals experiencing presenteeism is as follows [24]:

$$log\left(\frac{\Pr\left(P_{it}=1\right)}{1-\Pr\left(P_{it}=1\right)}\right) = \beta_1 IC_{it} + \beta_2 H_{it} + \beta_3 JC_{it} + \beta_4 X_{it} + \alpha_i \tag{6}$$

With $\alpha_{i\sim}N(0, \sigma_{\alpha}^{2})$; $\beta_i[i = 1 \ldots 4]$ is a vector of parameters to be estimated.

As with our analysis of absenteeism, presenteeism and work hour tension, the main parameter of interest β_1 will capture the impact of productivity loss due to informal caregiving variable IC_{it}. We expect higher odds of productivity loss for a higher level of informal caregiving.

3 Results

3.1 Descriptive Analyses

Table 1 presents the socio-demographic, health and employment characteristics of the analytic sample at baseline, the final wave and the pooled in all waves. The majority of the sample were middle-aged adults (45.82%), partnered (63.89%), non-Indigenous (97.85%) and lived in major cities (69.89%). Table 2 also shows that 23.87% were obese, 17.41% had a disability, 16.41% currently smoked, 86.38% consumed alcohol and 64.87% did not engage in the recommended amount of physical exercise. A larger proportion of individuals worked in a small firm (42.69%), had a permanent employment contract (67.85%), were professionals (26.01%), had no supervisory duties (56.14%), were not union members (77.61%), had paid holiday leave (73.58%) and had paid sick leave (73.89%). The average level of job satisfaction among workers is 7.73, with a standard deviation of 1.56 (pooled data).

Table 3 displays the distribution of the outcome variables (absenteeism, presenteeism and working hour tension) and main variable of interest (informal caregiving) at the baseline (2011), final (2021) and pooled across all waves. The mean level of absenteeism is 39.31 days with a substantial standard deviation of 73.53 days. Among the study participants, nearly one-third reported presenteeism (31.73%). The mean working hour tension

Table 1 Distribution of the analytic sample (socio-demographic, health and job-related characteristics): baseline, final and pooled across all waves

Variables	Baseline wave (2011)		Final wave (2021)		Pooled data (2011–2021)	
	n	%	*n*	%	*n*	%
Socio-demographic characteristics						
Age						
15–24 years (youth)	1610	18.63	1295	14.30	16,247	16.78
25–39 years (young adult)	2634	30.48	3250	35.88	32,273	33.33
40–64 years (middle-aged adult)	4120	47.67	4062	44.84	44,364	45.82
≥ 65 years (elderly)	279	3.23	451	4.98	3934	4.06
Gender						
Male	4457	51.57	4395	48.52	48,465	50.06
Female	4186	48.43	4663	51.48	48,353	49.94
Relationship status						
Partnered	5431	62.84	5881	64.93	61,765	63.79
Unpartnered	3212	37.16	3177	35.07	35,053	36.21
Highest education level completed						
Year 12 and below	3235	37.43	2644	29.19	31,489	32.52
Professional qualifications	2818	32.60	3043	33.59	32,730	33.81
University qualifications	2590	29.97	3371	37.22	32,599	33.67
Household yearly disposable income						
Quintile 1 (poorest)	1730	20.02	1812	20.00	19,364	20.00
Quintile 2 (poorer)	1728	19.99	1813	20.02	19,365	20.00
Quintile 3 (middle)	1728	19.99	1810	19.98	19,362	20.00
Quintile 4 (richer)	1729	20.00	1813	20.02	19,364	20.00
Quintile 5 (richest)	1728	19.99	1810	19.98	19,363	20.00
Indigenous status						
Not of Indigenous origin	8506	98.41	8834	97.53	94,740	97.85
Indigenous origin	137	1.59	224	2.47	2078	2.15
Region of residence						
Major city	6074	70.28	6227	68.75	67,662	69.89
Regional city and remote area	2569	29.72	2831	31.25	29,156	30.11
Childcare-related characteristics						
Use of childcare						
No	7786	90.08	7959	87.87	86,132	88.96
Yes	857	9.92	1099	12.13	10,686	11.04
Health-related characteristics						
BMI						
Underweight	192	2.22	142	1.57	1,854	1.91
Healthy weight	3552	41.10	3270	36.10	38,102	39.35
Overweight	3008	34.80	3145	34.72	33,748	34.86
Obesity	1891	21.88	2501	27.61	23,114	23.87
Disability						
No	7203	83.34	7308	80.68	79,960	82.59
Yes	1440	16.66	1750	19.32	16,858	17.41
Health-related behaviours						
Smoking status						
Non-smoker	6992	80.90	7795	86.06	80,929	83.59
Current smoker	1651	19.10	1263	13.94	15,889	16.41
Alcohol consumption						
Non-drinker	1075	12.44	1290	14.24	13,183	13.62
Current drinker	7568	87.56	7768	85.76	83,635	86.38
Physical activity						

Table 1 (continued)

Variables	Baseline wave (2011)		Final wave (2021)		Pooled data (2011–2021)	
	n	%	*n*	%	*n*	%
Less than the recommended level	5611	64.92	5794	63.97	62,809	64.87
Recommended level	3032	35.08	3264	36.03	34,009	35.13
Job-related characteristics						
Firm size						
Small (1–19 employees)	3743	43.31	3739	41.28	41,332	42.69
Medium (20–99 employees)	2395	27.71	2526	27.89	26,485	27.36
Large (≥ 100 employees)	2505	28.98	2793	30.83	29,001	29.95
Employment contract						
Permanent	5871	67.93	6449	71.20	65,692	67.85
Fixed term	786	9.09	742	8.19	9149	9.45
Casual	1986	22.98	1867	20.61	21,977	22.70
Occupation						
Professional	2154	24.92	2524	27.86	25,179	26.01
Manager	1123	12.99	1291	14.25	13,357	13.80
Technician and trade workers	1135	13.13	1056	11.66	11,992	12.39
Community and personal service workers	899	10.40	1082	11.95	11,488	11.87
Clerical and administrative workers	1331	15.40	1174	12.96	13,252	13.69
Sales workers	789	9.13	727	8.03	8166	8.43
Machinery operators and drivers	481	5.57	547	6.04	5491	5.67
Labourers	731	8.46	657	7.25	7893	8.15
Supervisory responsibilities						
Yes	3915	45.30	3734	41.22	42,461	43.86
No	4728	54.70	5324	58.78	54,357	56.14
Union membership						
Yes	2101	24.31	1924	21.24	21,679	22.39
No	6542	75.69	7134	78.76	75,139	77.61
Paid holiday leave						
Yes	6337	73.32	6897	76.14	71,234	73.58
No	2306	26.68	2161	23.86	25,584	26.42
Paid sick leave						
Yes	6350	73.47	6927	76.47	71,541	73.89
No	2293	26.53	2131	23.53	25,277	26.11
Overall job satisfaction, mean (SD)	8643	7.66 (1.66)	9058	7.91 (1.44)	96,818	7.73 (1.56)

Notes: 1. In the pooled analyses, $n_{\text{individuals}} = 18{,}139$, and $n_{\text{observations}} = 96{,}818$. 2. We equivalised annual household income using the OECD-modified equivalence scale and then categorised into quintiles. 3. Values are rounded off to two decimal places

is 1.78 with a standard deviation of 5.15 h. Table 2 also indicates that 4.35%, 3.10% and 0.66% of participants provided lighter, moderate and intensive informal caregiving, respectively (pooled data).

Figure 2 displays the mean absence/leave days at work by the informal caregiving responsibilities of the study sample. We found that the average number of absence days is highest among those with intensive caregiving obligations in all years. For example, average absence/leave days of the respondents with intensive caregiving duties is 54.54 days, followed by moderate (41.27 days) and no caregiving responsibilities (40.33 days) in 2021.

Figure 3 shows a breakdown of the presenteeism rate among the study population according to their level of informal caregiving responsibilities. The graph indicates that participants with no caregiving role had the lowest rate

Table 2 Distribution of the outcome and main variables of interest: baseline, final and pooled across all waves

Variables	Baseline wave (2011)		Final wave (2021)		Pooled data (2011–2021)	
	n	%	*n*	%	*N*	%
Outcome variables						
Presenteeism						
No	6122	70.83	5716	63.10	66,099	68.27
Yes	2521	29.17	3342	36.90	30,719	31.73
Days absent in the past 12 months (mean [SD])	6718	36.59 (68.19), (min = 0, max = 365)	9354	40.33 (77.28), (min = 0, max = 365)	97,521	39.31 (73.53), (min = 0, max = 365)
Working hour tension (mean [SD])	8643	1.81 (5.26), (min = 0, max = 66)	9058	1.47 (4.80), (min = 0, max = 55)	96,818	1.78 (5.15), (min = 0, max = 86)
Main variable of interest						
Informal caregiving						
Non-caregiver	7942	91.89	8290	91.52	88,971	91.90
Lighter caregiving (< 5 h/week)	373	4.32	434	4.79	4209	4.35
Moderate caregiving (5–19 h/week)	277	3.20	275	3.04	3001	3.10
Intensive caregiving (≥ 20 h/week)	51	0.59	59	0.65	637	0.66

Notes: 1. In the pooled analyses, $n_{\text{individuals}}$ = 18,139, and $n_{\text{observations}}$ = 96,818 except absenteeism. 2. Values are rounded off to two decimal places. 3. *SD* Standard Deviation

of presenteeism in all years. The rate of presenteeism in the most recent year (2021) was highest among the respondents who provide intensive care (64.41%), followed by those with a moderate (46.55%), a lighter (46.54%) and a non-caregiving role (35.87%).

Figure 4 outlines the mean working hour tension by the study sample's informal caregiving responsibilities. As expected, workers with intensive caregiving responsibilities had the highest working hour tension rate in most studied years. In 2021, we found that mean working hour tension is highest among person who had moderate caregiving duties (2.53 h), followed by intensive (1.92 h) and lighter caregiving duties (1.46 h).

3.2 Regression Modelling

Table 3 presents the adjusted regression analyses, which were based on 97,521 (model 1) and 96,818 (models 2 and 3) person–year observations. After adjusting for sociodemographic, health and job-related covariates, we found that the rates of absence/leave at work are 1.03, 1.02 and 1.19 times higher in case of lighter [IRR (95% CI): 1.03 (1.02, 1.03)], moderate [IRR (95% CI): 1.02 (1.02, 1.03)] and intensive caregiving duties [IRR (95% CI): 1.19 (1.18, 1.21)], respectively, compared with no caregiving duties. The regression results also indicated the predicted change in the odds of presenteeism associated with different levels of informal caregiving (model 2). The results indicate that all things being equal, the odds of reporting presenteeism are higher amongst workers with intensive caregiving responsibilities [OR (95% CI): 1.78 (1.41, 2.25)], followed by lighter [OR (95% CI): 1.24 (1.13, 1.37)] and moderate [OR (95% CI): 1.23 (1.10, 1.38)] caregiving responsibilities compared with non-caregiving counterparts (model 2). Our results also show that the rates of having working hour tension are significantly greater in workers with intensive caregiving responsibilities [IRR (95% CI): 1.19 (1.11, 1.27)], followed by moderate [IRR (95% CI): 1.15 (1.11, 1.19)] and lighter [IRR (95% CI): 1.08 (1.04, 1.12)] caregiving responsibilities than their peers without caregiving responsibilities given other covariates reference categories are held constant (model 3).

3.3 Informal Caregiving—Attributable Costs of Absenteeism

Table 4 presents the costs of lost productivity in terms of absenteeism due to informal caregiving. The result shows that, on average, an individual with lighter, moderate and intensive caregiving role had incurred AUD 276.13, AUD

Table 3 Results from the longitudinal random-effects Poisson regression (models 1 and 3) and random-effects logistic regression models (model 2)

Variables	Model 1: Absenteeism Adjusted IRR (95% CI)	Model 2: Presenteeism aOR (95% CI)	Model 3: Working hour tension Adjusted IRR (95% CI)
Informal caregiving			
Non-caregiver (ref)			
Lighter caregiving (< 5 h/week)	1.03***	1.24***	1.08***
	[1.02–1.03]	[1.13–1.37]	[1.04–1.12]
Moderate caregiving (5–19 h/week)	1.02***	1.23***	1.15***
	[1.02–1.03]	[1.10–1.38]	[1.11–1.19]
Intensive caregiving (≥ 20 h/week)	1.19***	1.78***	1.19***
	[1.18–1.21]	[1.41–2.25]	[1.11–1.27]
Childcare use			
No (ref)			
Yes	1.02***	1.07*	1.04**
	[1.02–1.02]	[1.01–1.15]	[1.01–1.06]
Socio-demographic characteristics			
Age			
15–24 years (youth) (ref)			
25–39 years (young adult)	0.92***	1.10*	0.81***
	[0.91–0.92]	[1.02–1.19]	[0.79–0.83]
40–64 years (middle-aged adult)	0.87***	0.97	0.78***
	[0.86–0.87]	[0.89–1.05]	[0.75–0.81]
≥ 65 years (elderly)	0.96***	1.58***	0.65***
	[0.94–0.97]	[1.38–1.81]	[0.60–0.70]
Gender			
Male (ref)			
Female	1.05**	1.75***	1.00
	[1.01–1.09]	[1.63–1.87]	[0.93–1.08]
Relationship status			
Partnered (ref)			
Unpartnered	1.04***	1.36***	1.18***
	[1.04–1.05]	[1.28–1.44]	[1.15–1.20]
Highest education level completed			
Year 12 and below (ref)			
Professional qualification	0.80***	1.11**	1.04*
	[0.79–0.81]	[1.03–1.19]	[1.01–1.07]
University qualification	0.86***	1.15**	1.19***
	[0.85–0.87]	[1.06–1.24]	[1.15–1.24]
Indigenous status			
Not of Indigenous origin (ref)			
Indigenous origin	1.89***	1.33**	1.44**
	[1.71–2.09]	[1.09–1.61]	[1.16–1.78]
Region of residence			
Major city (ref)			
Regional city and remote area	1.05***	0.98	0.99
	[1.04–1.06]	[0.92–1.04]	[0.96–1.02]
Household yearly disposable income			
Quintile 1 (poorest)	1.75***	1.00	1.54***
	[1.74–1.76]	[0.93–1.07]	[1.50–1.59]
Quintile 2 (poorer)	1.18***	0.92*	1.34***
	[1.17–1.18]	[0.86–0.98]	[1.30–1.38]

Table 3 (continued)

Variables	Model 1: Absenteeism Adjusted IRR (95% CI)	Model 2: Presenteeism aOR (95% CI)	Model 3: Working hour tension Adjusted IRR (95% CI)
Quintile 3 (middle)	1.04***	0.90**	1.11***
	[1.03–1.04]	[0.85–0.97]	[1.08–1.14]
Quintile 4 (richer)	1.00	0.94	1.10***
	[0.99–1.00]	[0.88–1.00]	[1.08–1.13]
Quintile 5 (richest) (ref)			
Health-related characteristics			
BMI			
Underweight	1.05***	1.08	0.93**
	[1.04–1.06]	[0.93–1.26]	[0.89–0.97]
Healthy weight (ref)			
Overweight	0.98***	1.07*	1.02*
	[0.97–0.98]	[1.01–1.13]	[1.00–1.04]
Obesity	1.05***	1.43***	1.08***
	[1.05–1.06]	[1.34–1.53]	[1.05–1.11]
Disability			
No (ref)			
Yes	1.10***	3.34***	1.09***
	[1.09–1.10]	[3.16–3.52]	[1.07–1.11]
Health-related behaviours			
Smoking status			
Non-smoker (ref)			
Current smoker	0.97***	1.37***	1.05***
	[0.96–0.97]	[1.29–1.47]	[1.03–1.08]
Alcohol consumption			
Non-drinker (ref)			
Current drinker	0.81***	0.88***	1.12***
	[0.81–0.82]	[0.83–0.95]	[1.10–1.15]
Physical activity			
Less than the recommended level (ref)			
Recommended level	0.95***	0.70***	1.03***
	[0.95–0.95]	[0.67–0.73]	[1.02–1.05]
Job-related characteristics			
Firm size			
Small (1–19 employees) (ref)			
Medium (20–99 employees)	1.07***	0.92**	0.82***
	[1.06–1.07]	[0.87–0.97]	[0.81–0.84]
Large (≥ 100 employees)	1.03***	0.89***	0.78***
	[1.03–1.04]	[0.84–0.95]	[0.76–0.79]
Employment contract			
Permanent (ref)			
Fixed term	1.01**	0.94	0.95***
	[1.00–1.01]	[0.88–1.01]	[0.93–0.97]
Casual	1.11***	1.08	1.38***
	[1.11–1.12]	[0.98–1.19]	[1.34–1.42]
Occupation			
Professional (ref)			
Manager	0.91***	0.95	0.80***
	[0.90–0.91]	[0.87–1.02]	[0.77–0.83]
Technician and trade workers	0.91***	0.90*	1.04*

Table 3 (continued)

Variables	Model 1: Absenteeism Adjusted IRR (95% CI)	Model 2: Presenteeism aOR (95% CI)	Model 3: Working hour tension Adjusted IRR (95% CI)
	[0.90–0.92]	[0.82–0.99]	[1.01–1.08]
Community and personal service workers	0.84***	0.91*	1.29***
	[0.84–0.85]	[0.83–1.00]	[1.25–1.34]
Clerical and administrative workers	0.94***	0.86***	0.99
	[0.94–0.95]	[0.79–0.94]	[0.95–1.02]
Sales workers	0.81***	0.89*	1.14***
	[0.80–0.81]	[0.81–0.98]	[1.10–1.17]
Machinery operators and drivers	0.93***	0.87*	1.06**
	[0.92–0.94]	[0.77–0.98]	[1.01–1.10]
Labourers	0.87***	0.86**	1.19***
	[0.87–0.88]	[0.77–0.95]	[1.15–1.23]
Supervisory responsibilities			
Yes (ref)			
No	1.07***	1.04	1.33***
	[1.07–1.07]	[0.99–1.09]	[1.31–1.35]
Paid holiday leave			
Yes (ref)			
No	0.93***	1.14	1.33***
	[0.92–0.95]	[0.93–1.40]	[1.25–1.41]
Paid sick leave			
Yes (ref)			
No	0.96***	0.91	1.27***
	[0.94–0.97]	[0.74–1.12]	[1.19–1.34]
Union membership			
Yes (ref)			
No	0.94***	0.99	1.09***
	[0.94–0.94]	[0.94–1.05]	[1.07–1.12]
Overall job satisfaction	1.00***	0.82***	0.90***
	[1.00–1.00]	[0.81–0.83]	[0.89–0.90]
Observations	$n_{individuals}$ = 18,612; $n_{observations}$ = 97,521	$n_{individuals}$ = 18,139; $n_{observations}$ = 96,818	$n_{individuals}$ = 18,139; $n_{observations}$ = 96,818

Notes: 1. 95% confidence intervals are reported in parentheses. 2. * Indicate significance at the 5% level, ** indicate significance at the 1% level, *** indicate significance at the 0.1% level. 3. Abbreviation: aOR, adjusted odds ratio; IRR, incidence rate ratio; Ref, reference category. 4. Values are rounded off to two decimal places

246.81 and AUD 1927.16, respectively, in absenteeism costs annually compared with their counterparts without caregiving duties (Appendix Tables 6 and 7 contains further details).

4 Discussion

4.1 Key Findings

Informal care is crucial to the well-being of the elderly and individuals with long-term health conditions or disabilities. The services provided by informal caregivers are vital to society. However, the intensity of caregiving may negatively impact the workplace productivity of caregivers. The primary goal of this study is to investigate the indirect costs of informal caregiving in terms of absenteeism, presenteeism and working hour tension. We utilised data from 11 successive waves of the HILDA survey conducted between 2011 and 2021. Longitudinal random-effects logistic regression and negative binomial regression models were employed to assess the influence of informal caregiving on workplace productivity among working-age Australians. We observed that being an informal carer significantly reduced productivity at

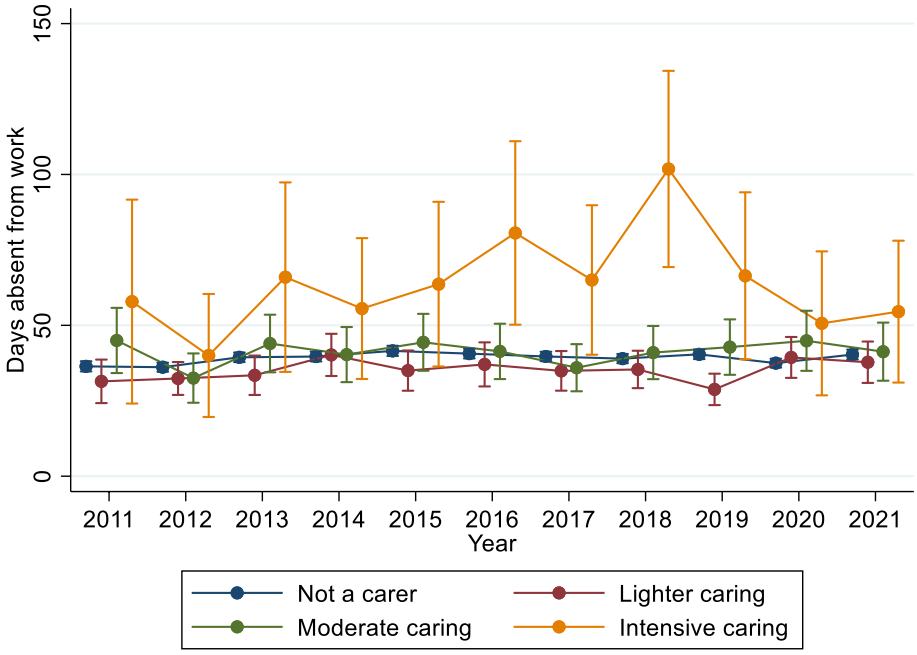

Fig. 2 Mean absence/leave days over the informal caregiving role

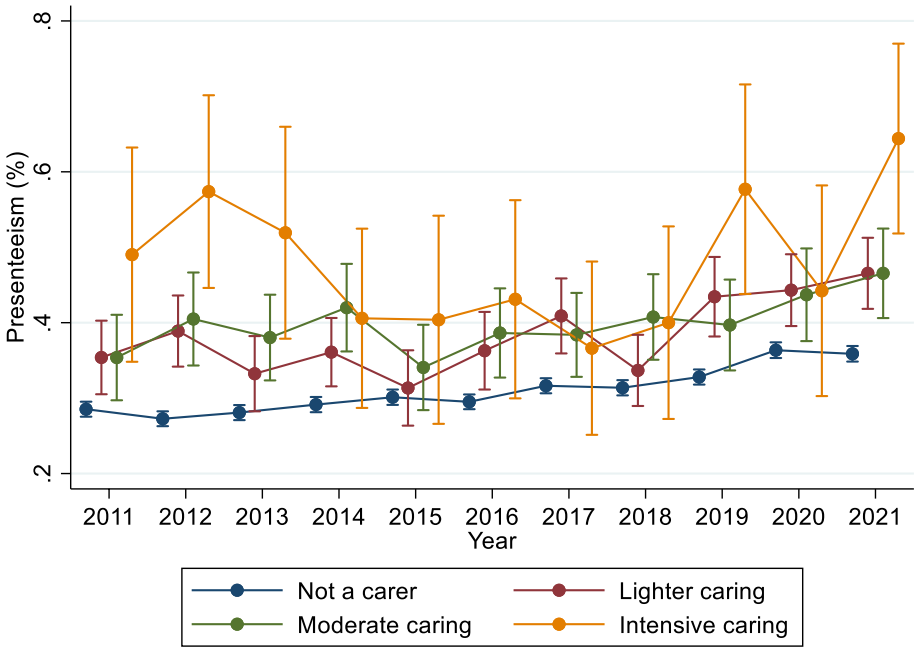

Fig. 3 Rate of presenteeism over the informal caregiving role

work. More specifically, intensive caregiving is linked to a higher number of days missed from work. We also found that all types of informal caregiving responsibilities are associated with an increased likelihood of presenteeism at work. Further, our findings demonstrated that moderate informal caregiving involvement could increase working hour tension.

Prior research on the burden of informal caregiving has concentrated mostly on the relationship between caregiving and labour force participation. Relatively little is known regarding the extent to which workplace productivity of the caregivers' changed by their caregiving responsibility. This research contributes to the current body of knowledge by pointing out the indirect costs incurred by employees who have informal caregiving duties. This study considered three measures of productivity (absenteeism, presenteeism and working hour tension) while examining the impact of informal caregiving burden on the workplace productivity of caregivers. The present study is one of the few that employed

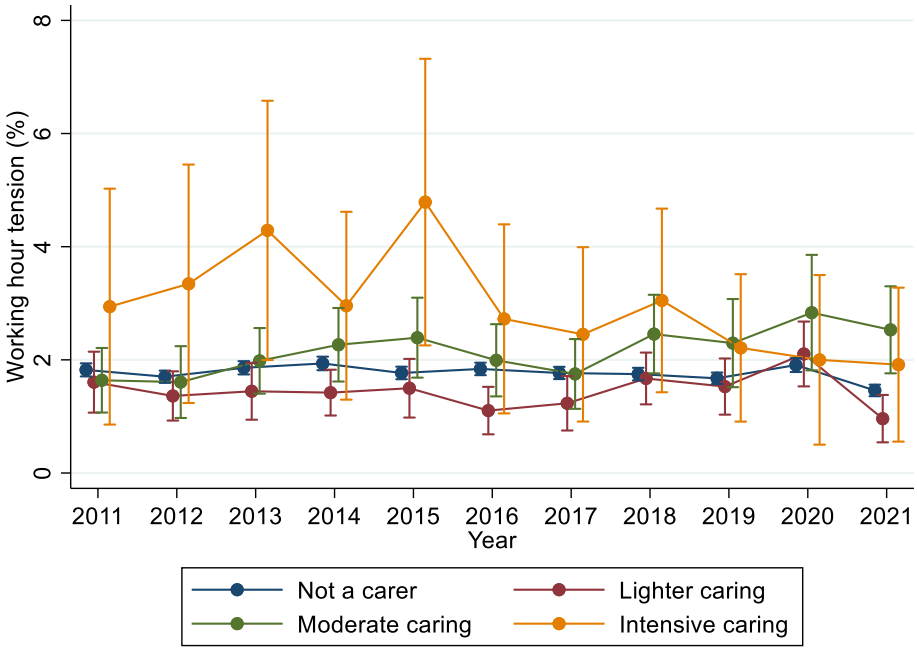

Fig. 4 Mean working hour tension over the informal caregiving role

Table 4 Costs of absenteeism attributed to informal caregiving according to gender

Types of productivity costs	Unit wages estimated from HILDA sample			Unit wages according to ABS		
	Male	Female	Overall	Male	Female	Overall
Costs of absenteeism by informal caregiving						
Mean comparison, unadjusted						
Lighter caregiving	N/A	N/A	N/A	N/A	N/A	N/A
Moderate caregiving	499.55	361.73	431.31	644.08	455.33	547.70
Intensive caregiving	6418.01	4647.39	5541.36	8274.91	5849.91	7036.64
Random effects, adjusted						
Lighter caregiving	6.88	4.98	5.94	8.88	6.27	7.55
Moderate caregiving	6.16	4.46	5.32	7.94	5.62	6.76
Intensive caregiving	44.52	32.24	38.44	57.40	40.58	48.81
Zero random effects, adjusted						
Lighter caregiving	319.82	231.58	276.13	412.35	291.51	350.64
Moderate caregiving	285.86	206.99	246.81	368.56	260.56	313.41
Intensive caregiving	2232.04	1616.26	1927.16	2877.82	2034.46	2447.18

Source: Authors' own calculations.

Notes: 1. Values for each cell were obtained by multiplying respective daily wages and salary with additional absent days. Please refer to Appendix Table 6 and 7 for gross wages and salary, and additional absent days, respectively. 2. Abbreviation: N/A, not applicable; ABS, Australian Bureau of Statistics. 3. Mean absent days (unadjusted) for lighter caring is lower than non-caregiving responsibility; therefore, the cost of absenteeism for lighter caregiving is N/A. 4. All values are reported in Australian dollars and were rounded into two decimal points.

longitudinal data to investigate how informal caregiving affects the job productivity of caregivers. Using simple cross-sectional data while exploring the relationships between informal caregiving and lost productivity may provide a biased estimate due to omitted variable bias. Using longitudinal data, this study could keep track of the same people over time and see how their productivity changed as their caregiving responsibilities changed. This makes the present study unique among previous research on the topic.

We found evidence that employees providing informal care were more likely to be absent from work, which matches the results of two recent longitudinal studies in European countries [14, 19]. Men and women are equally likely to be absent from work due to caregiving responsibilities in the Netherlands [19]. However, informal caregiving increases sickness absence exclusively among women in France, Finland, and the UK [14]. A significant finding of the current study is informal caregiving is linked to a higher rate of presenteeism. This confirms the results of a previous study showing that informal caregiving is linked to reduced productivity while at work [4]. A recent study in the USA also found that nearly one in four employed caregivers has reduced productivity while at work [12].

Another key finding of our study is that informal caregivers experience greater working hour tension (desired working hours are greater than the actual working hours) than their counterparts, which is in line with several previous studies. A recent longitudinal study in the Netherlands confirmed that taking up informal caregiving responsibilities reduce women's working hours [19]. The provision of informal caregiving had a negative impact on the number of hours worked in Japan [17] and a Chinese study discovered that intensive caregiving considerably reduces weekly working hour [11]. Further, several US studies concluded that females with informal caregiving provision worked fewer hours than their counterparts [13, 15]. However, a study conducted in the USA indicated that caregiving for an older parent does not prevent married women from participating in paid employment or reducing the number of hours worked [16].

Previous research has uncovered the mechanisms by which informal caregiving impacts the workplace productivity of caregivers. For example, an Australian study revealed that one in seven working individuals with caregiving responsibilities desire but cannot utilise flexible working hour, shift work and work-from-home possibilities [18]. Due to the 24 hour day, informal caregiving responsibilities may discourage individuals from entering the workforce. Moreover, the increased absenteeism rates among informal caregivers may be attributable to their added stress and workload [19]. Informal care provision leads to negative health outcomes arising from physical and mental strain [6]. Studies in the Netherlands, Germany, European countries, and the UK have shown that informal care provision has negative effects on the physical and mental health of informal caregivers over the long term, especially for high-intensity caregivers [6, 25–28], and this could have a negative effect on productivity at work (presenteeism). The emotional strain of caregiving makes it difficult for carers to effectively carry out their job responsibilities while at work. Therefore, caregivers may cut back their working hours or be absent due to unpredictable caregiving responsibilities [29].

4.2 Implications for Policy and Practice

The substantial indirect costs of informal caregiving cannot be overlooked. The present study's findings have implications for formulating public policies regarding informal caregiving. Due to an ageing population, working-age individuals in developed countries, particularly women, face the challenge of balancing caregiving with paid work. Since the working-age population offers a large portion of informal care, it is crucial to understand how it influences workplace productivity to create regulations that assist caregivers. Substitution between formal and informal care may be an effective strategy for enhancing workplace productivity. The results suggest that policymakers should prioritise increasing access to publicly funded or subsidised formal care. This suggestion is in line with Australia's recent reforms that include the introduction of a National Disability Insurance Scheme [30] and Nursing Home Care Reforms [31] aiming to extend formal care. If more formal care options were available, informal caregivers might have less caregiving burden and be more productive at work. Time spent providing care is associated with the quality of life of both the caregiver and the person being cared for. It has been demonstrated that an improvement in the care recipient's quality of life reduces the time spent providing care and improves the caregivers' quality of life [32]. Evidence also suggests that public long-term care insurance programme helps to lessen the burden on primary caregivers [17]. In addition, this study emphasises the necessity for care-friendly workplace regulations that will protect caregivers from productivity loss and allow them to continue working healthily. There is evidence that flexible time and reduced working hour opportunity result in more hours of informal caregiving [10].

4.3 Role in Health Technology Assessment (HTA)

Economic evaluation is the comparative analysis of alternative courses of action in terms of costs and effectiveness. Our results provide evidence that informal caregiving is associated with productivity loss. Insight into the costs of informal caregiving is helpful for efficient resource allocation. Economic evaluations of interventions to improve the outcomes of children, the disabled or the elderly should include the cost of caregiving when measuring the cost effectiveness of an intervention from the societal perspective. These costs include productivity loss (not able to work, reduced work hours, less ability to take higher income jobs), as well as travel and support costs. Our findings will serve as an input

for future economic evaluations regarding productivity loss associated with informal caregiving. Alongside the development of techniques to integrate informal care into economic evaluation, policymakers are beginning to recognise the significance and necessity of incorporating informal care into policy decisions [33]. Several earlier studies evaluated interventions that jointly or primarily targeted carers [34–37]. For example, a study conducted in Australia demonstrates the costs and benefits of implementing an evidence-based reablement program that aims to enhance the function and capability of dementia patients [34]. According to the findings of the study, dementia patients and their carers endure the costs, while the Australian health and social care system benefits the most from the implementation of the programme. Their findings suggest that decision-makers in Australia should offer financial incentives to assist dementia patients and their carers to engage in reablement programs in Australia [34].

4.4 Limitations and Avenues for Further Research

This study has two major limitations that need to be acknowledged. First, this study's unbalanced longitudinal research design prevents drawing any conclusions about the causal effects of informal caregiving on workplace productivity. Second, the study's findings could be susceptible to bias due to the use of self-reported data on time spent for informal caregiving. There is evidence that if participants felt social pressure, they would overstate their readiness to work extra hours [29]. Apart from these, there are limitations with how each of the key dependent variables are measured. For example, we measured presenteeism through the SF-36 questionnaire which is not exclusively designed to assess presenteeism. Widely utilised instruments, such as the Work Productivity and Activity Impairment Questionnaire (WPAI), the Health and Work Performance Questionnaire (HPQ) and the Work Limitations Questionnaire (WLQ), may be able to analyse absenteeism and presenteeism behaviour of respondents more accurately. Given these caveats, the authors call for a well-designed cohort study to determine the causal effect of informal caregiving on workplace productivity. Besides, future studies may point out the increasing rate of switching to part-time employment from full time, and job losses due to informal caregiving.

5 Conclusion

Informal caregiving is demanding and challenging. The demand for informal care is anticipated to increase worldwide due to the ageing population. Therefore, knowing the impact of informal caregiving on workplace productivity is essential. This study provides new evidence on the relationship between informal caregiving and workplace productivity, focusing particularly on absenteeism, presenteeism and working hour tension. We found that the provision of informal caregiving is adversely associated with the workplace productivity of caregivers in terms of increased absenteeism, a greater chance of presenteeism and higher working hour tension. The negative effect of informal caregiving on health, and adverse labour market outcomes continues to be a major concern in most developed countries as they rely on informal care to reduce the burden on the health system. Our findings provide evidence to inform the design and effective implementation of policies that improve the productivity of informal caregivers at work. Policymakers may respond to the excessive demand for informal care by increasing the availability of paid care. However, the impact of informal caregiving on workplace productivity must be well understood before implementing the policy.

Appendix

See Tables 5, 6 and 7.

Table 5 Description of the control variables

Variables	Measure
Socio-demographic characteristics	
Age, years	0 = 15–24 (youth) 1 = 25–39 (young adult) 2 = 40–64 (middle-aged adult) 3 = ≥ 65 (elderly)
Gender	0 = Male 1 = Female
Relationship status	0 = Partnered (married in a registered marriage, and never married but living with someone in a relationship) 1 = Unpartnered (never married and not living with someone in a relationship, separated but not divorced, divorced and widowed)
Highest education level completed	0 = Year 12 and below (year 12, and year 11 and below) 1 = Professional qualification (advance diploma or diploma, and certificate III or IV) 2 = University qualification (postgraduate—masters or doctorate, graduate diploma or certificate, bachelor or honours)
Household yearly disposable income	0 = Quintile 1 (poorest) 1 = Quintile 2 (poorer) 2 = Quintile 3 (middle) 3 = Quintile 4 (richer) 4 = Quintile 5 (richest)
Indigenous status	0 = Not of Indigenous origin 1 = Indigenous origin (Aboriginal, Torres Strait Islander, and both Aboriginal and Torres Strait Islander)
Region of residence	0 = Major city 1 = Regional or remote area (inner regional, outer regional, remote and very remote Australia)
Childcare-related characteristics	
Use of childcare	0 = No 1 = Yes
Health-related characteristics	
Weight category	0 = Underweight (BMI < 18.50) 1 = Healthy weight (BMI 18.50–24.99) 2 = Overweight or pre-obese (BMI 25.00–29.99) 3 = Obese (BMI ≥ 30)
Long-term health condition or disability	0 = No 1 = Yes
Health-related behaviours	
Smoking status	0 = Non-smoker (never smoked, and former smoker) 1 = Current smoker (smoke daily, smoke at least weekly and smoke less often than weekly)
Alcohol consumption	0 = Non-drinker (never drunk and ex-drinker) 1 = Current drinker (only rarely, 1–2 days, 2–3 days, 3–4 days, 5–6 days per week and every day)
Physical activity	0 = Less than the recommended level (not at all, less than once, 1–2 and 3 times a week) 1 = Recommended level (> 3 times a week and every day)
Job-related characteristics	
Firm size	0 = Small (1–19 employees) 1 = Medium (20–99 employees) 2 = Large (≥ 100 employees)
Employment contract	0 = Permanent 1 = Fixed term 2 = Casual
Occupation	0 = Professional 1 = Manager 2 = Technician and trade workers 3 = Community and personal service workers 4 = Clerical and administrative workers 5 = Sales workers 6 = Machinery operators and drivers 7 = Labourers

Table 5 (continued)

Variables	Measure
Supervisory responsibilities	0 = Yes 1 = No
Union membership	0 = Yes 1 = No
Paid holiday leave	0 = Yes 1 = No
Paid sick leave	0 = Yes 1 = No
Overall job satisfaction	0–10 scale (higher score indicates more job satisfaction)

Table 6 Weekly and daily gross wages and salary according to gender in Australia

Gross wages and salary by gender	Sources	
	HILDA sample	ABS statistics
Overall		
Weekly	A$ 1085.644	A$ 1378.60
Daily	A$ 217.13	A$ 275.72
Hourly	A$ 31.02	A$ 39.39
Male		
Weekly	A$ 1257.393	A$ 1621.20
Daily	A$ 251.48	A$ 324.24
Hourly	A$ 35.93	A$ 46.32
Female		
Weekly	A$ 910.506	A$ 1146.10
Daily	A$ 182.101	A$ 229.22
Hourly	A$ 26.01	A$ 32.75

Notes: 1. Authors have calculated weekly gross wages and salary using the HILDA sample. For comparison purpose, the authors have accessed Australian Bureau Statistics (ABS) data on gross wages and salary from the following web link: https://www.abs.gov.au/statistics/labour/earnings-and-working-conditions/average-weekly-earnings-australia/nov-2022 Daily gross wages and salary were calculated by dividing weekly gross wages and salary by 5. Hourly gross wages and salary were calculated by dividing weekly gross wages and salary by 35 (assuming full time job). 2. Abbreviation: A$ = Australian Dollar

Table 7 Additional absent days and working hour tension of an informal caregiver compared to a non-caregiver by three measures

Productivity measures	Informal caregiving		
	Lighter caregiving (days)	Moderate caregiving (days)	Intensive caregiving (days)
Additional absent days by three measures			
Mean comparison, unadjusted	−3.87	1.99	25.52
Random effects, adjusted	0.03	0.03	0.18
Assuming zero random effects, adjusted	1.27	1.14	8.88

Source: Authors' own calculations

Acknowledgements The authors are grateful to the Melbourne Institute of Applied Economic and Social Research for providing HILDA data access for conducting the study. This paper uses unit record data from the HILDA Survey guided by the Australian Government's DSS. The findings and views reported in this paper are those of the authors and should not be attributed to the Australian Government, DSS or any contractors or partners of DSS. https://doi.org/10.26193/OFRKRH, ADA Dataverse, V2.

Declarations

Funding Open Access funding enabled and organized by CAUL and its Member Institutions.

Conflict of interest The authors have no conflicts of interest to declare.

Ethics approval This study used secondary data from de-identified existing unit records from the HILDA Survey, so ethical approval was not required. However, the authors completed and signed the Confidentiality Deed Poll and sent it to NCLD (ncldresearch@dss.gov.au) and ADA (ada@anu.edu.au) before receiving approval for their data application. The datasets analysed and/or generated during the current study are subject to the signed confidentiality deed.

Availability of data and materials The data were obtained from the Melbourne Institute of Applied Economic and Social Research (https://melbourneinstitute.unimelb.edu.au/). Though the information is not openly available, appropriately qualified researchers can access the data after following their protocols and meeting their requirements. Their contact address is Melbourne Institute of Applied Economic and Social Research, the University of Melbourne, VIC 3010, Australia.

Consent to participate Not Applicable.

Consent for publication Not Applicable.

Code availability All STATA codes (do files) for this study are available by request from the authors.

Authors' contributions Conceptualization: SAK, RH, TC. Formal analysis: SAK, RH. Methodology: SAK, RH. Writing—original draft: SAK, RH, BSA. Writing—review and editing: SAK, RH, BSA, TC.

References

1. Ciccarelli N, Van Soest A. Informal caregiving, employment status and work hours of the 50+ population in Europe. Economist. 2018;166:363–96.
2. OECD. Informal carers. 2021.
3. OECD, Australian Institute of Health and Welfare. Informal carers [Internet]. 2021. https://www.aihw.gov.au/reports/australias-welfare/informal-carers. Accessed 5 Aug 2022.
4. Mazanec SR, Daly BJ, Douglas SL, Lipson AR. Work productivity and health of informal caregivers of persons with advanced cancer. Res Nurs Health. 2011;34:483–95.
5. Mikkola TM, Mänty M, Kautiainen H, von Bonsdorff MB, Haanpää M, Koponen H, et al. Work incapacity among family caregivers: a record linkage study. J Epidemiol Commun Health. 2022;76:580–5.
6. Stöckel J, Bom J. Revisiting longer-term health effects of informal caregiving: evidence from the UK. J Econ Ageing. 2022;21: 100343.
7. Martsolf GR, Kandrack R, Rodakowski J, Friedman EM, Beach S, Folb B, et al. Work performance among informal caregivers: a review of the literature. J Aging Health. 2020;32:1017–28.
8. Goodrich K, Kaambwa B, Al-Janabi H. The inclusion of informal care in applied economic evaluation: a review. Value Health. 2012;15:975–81.
9. Wittenberg E, Prosser LA. Disutility of illness for caregivers and families: a systematic review of the literature. Pharmacoeconomics. 2013;31:489–500.
10. Bryan ML. Access to flexible working and informal care. Scott J Polit Econ. 2012;59:361–89.
11. Chen L, Zhao N, Fan H, Coyte PC. Informal care and labor market outcomes. Res Aging. 2017;39:345–71.
12. Keita Fakeye MB, Samuel LJ, Drabo EF, Bandeen-Roche K, Wolff JL. Caregiving-related work productivity loss among employed family and other unpaid caregivers of older adults. Value Health. 2022.
13. Johnson RW, Lo Sasso AT. Balancing retirement security with the needs of frail parents. N Am Actuar J. 2001;5:104–8.
14. Mortensen J, Dich N, Lange T, Alexanderson K, Goldberg M, Head J, et al. Job strain and informal caregiving as predictors of long-term sickness absence: a longitudinal multi-cohort study. Scand J Work Environ Health. 2017;43:5–14.
15. Van Houtven CH, Coe NB, Skira MM. The effect of informal care on work and wages. J Health Econ. 2013;32:240–52.
16. Wolf DA, Soldo BJ. Married women's allocation of time to employment and care of elderly parents. J Hum Resour. 1994;29:1259.
17. Yamada H, Shimizutani S. Labor market outcomes of informal care provision in Japan. J Econ Ageing. 2015;6:79–88.
18. Gray M, Hughes J. Caring for children and adults: differential access to familyfriendly work arrangements. Fam Matters. 2005;70:18–25.
19. Josten EJC, Verbakel E, de Boer AH. A longitudinal study on the consequences of the take-up of informal care on work hours, labour market exit and workplace absenteeism due to illness. Ageing Soc. 2022;173:1–24.
20. Watson N. Finding your way around the HILDA survey data. Aust Econ Rev. 2021;54:554–64.
21. Kler P, Potia AH, Shankar S. Underemployment in Australia: a panel investigation. Appl Econ Lett. 2018;25:24–8.
22. Bittman M, Hill T, Thomson C. The impact of caring on informal carers' employment, income and earnings: a longitudinal approach. Aust J Soc Issues. 2007;42:255–72.
23. Colin Cameron A, Trivedi PK. Count panel data: Oxford, Handbook of panel data econometrics. 233–256. New York: Oxford University Press; 2015.
24. Wooldridge JM. Econometric analysis of cross section and panel data. Cambridge: MIT Press; 2010.
25. Bom J, Stöckel J. Is the grass greener on the other side? The health impact of providing informal care in the UK and the Netherlands. Soc Sci Med. 2021;269: 113562.
26. de Zwart PL, Bakx P, van Doorslaer EKA. Will you still need me, will you still feed me when I'm 64? The health impact of caregiving to one's spouse. Health Econ. 2017;26:127–38.
27. Schmitz H, Westphal M. Short- and medium-term effects of informal care provision on female caregivers' health. J Health Econ. 2015;42:174–85.
28. Schmitz H, Westphal M. Informal care and long-term labor market outcomes. J Health Econ. 2017;56:1–18.
29. Leigh A. Informal care and labor market participation. Labour Econ. 2010;17:140–9.
30. Productivity Commission. Caring for older Australians: overview. Report no. 53, final inquiry report, Canberra; 2011.
31. Productivity Commission. Disability care and support. Report no. 54, Canberra; 2011.
32. Dixon S, Walker M, Salek S. Incorporating carer effects into economic evaluation. Pharmacoeconomics. 2006;24:43–53.

33. Brouwer WB, Koopmanschap MA. On the economic foundations of CEA. Ladies and gentlemen, take your positions! J Health Econ. 2000;19:439–59.
34. Rahja M, Nguyen K, Laver K, Clemson L, Crotty M, Comans T. Implementing an evidence-based dementia care program in the Australian health context: a cost–benefit analysis. Health Soc Care Commun. 2020;28:2013–24.
35. Patel A, Knapp M, Evans A, Perez I, Kalra L. Training care givers of stroke patients: economic evaluation. BMJ. 2004;328:1102.
36. Wilson E, Thalanany M, Shepstone L, Charlesworth G, Poland F, Harvey I, et al. Befriending carers of people with dementia: a cost utility analysis. Int J Geriatr Psychiatry. 2009;24:610–23.
37. Browne G, Roberts J, Watt S, Gafni A, et al. Community rehabilitation: strategies, outcomes, expenditures. Can J Rehabil. 1994;8:9–22.

Authors and Affiliations

Syed Afroz Keramat[1] · Rubayyat Hashmi[2] · Bolaji Samson Aregbeshola[3] · Tracy Comans[1]

✉ Syed Afroz Keramat
s.keramat@uq.edu.au

Rubayyat Hashmi
Rubayyat.Hashmi@usq.edu.au

Bolaji Samson Aregbeshola
bolaji.aregbeshola@uon.edu.au

Tracy Comans
t.comans@uq.edu.au

[1] Centre for Health Services Research, Faculty of Medicine, The University of Queensland, Brisbane, QLD, Australia

[2] School of Business, The University of Southern Queensland, Toowoomba, Australia

[3] School of Medicine and Public Health, College of Health, Medicine and Wellbeing, The University of Newcastle, Newcastle, NSW, Australia