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Differences in risk factors and chronic conditions between informal (family) carers and non-carers using a population-based cross-sectional survey in South Australia

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ABSTRACT

Background There is growing discussion on the impact of informal caregiving on the health status and morbidity of family carers. Evidence suggests a proportion of carers may be at risk of poor health outcomes. However, there are limited population-based studies that provide representative data on specific risk factors among carers (eg, blood pressure, cholesterol, smoking status, activity and body mass index) and major chronic conditions (eg, asthma, diabetes and arthritis). This study aimed to redress that imbalance.

Method Self-reported data were from the South Australian Monitoring and Surveillance System (SAMSS), a representative cross-sectional state-wide population-based survey of 600 randomly selected persons per month. SAMSS uses computer-assisted telephone interviewing (CATI) to monitor chronic health-related problems and risk factors and to assess health outcomes. In total, 2247 family carers were identified from 35 195 participants aged 16 years and older for the 5-year period from 2010 to 2015. Logistic regression analyses examined associations of being a carer with self-reported chronic diseases and health risk factors. In addition, the population attributable risk (PAR) of being a carer was examined for selected chronic conditions.

Results The prevalence of carers was 6.4%, and peak age group for carers was 50–59 years. Adjusted ORs for chronic conditions in carers were significant for all chronic conditions examined. Although there is a high prevalence of self-reported risk factors and chronic conditions among carers compared with non-carers at the population level, PAR findings suggest that caregiving is associated with a small to moderate increased risk of having these chronic conditions.

Conclusions Monitoring of carer health and morbidity particularly 'at risk' individuals such as female carers with asthma or diabetes remains important and provides an ongoing baseline for future surveys. To achieve this, caregiver-based studies need to become part of mainstream biomedical research at both epidemiological and clinical levels.

Strengths and limitations of this study

- This study used population attributable risk analysis to determine the contribution of caregiving to major chronic conditions in carers. To our knowledge, PAR has not been undertaken using carer data on health risk factors and chronic conditions before.
- As the study uses cross-sectional data, it describes associations between carers and major chronic illnesses and risk factors.
- The sampling process was part of ongoing representative state-wide surveys over a 5-year period so it did not limit the recruitment of carers to a specific type of caregiving or care recipient condition.
- The survey using telephone and computer-assisted telephone interviewing protocols was not conducive to in-depth interviewing of each participant; therefore, it limited information about the cared for persons, their diagnosis and disability or the duration or intensity of care provided.
- Questions about the carers' relationships (to the care recipient), carer lifestyles and environments were also limited.

BACKGROUND

Increasing demands for home-based informal care during the closing years of the 20th century have seen the transition of family members and close friends taking on increasingly demanding long-term physical caregiving roles in the home.[1–3] Some of these complex caring activities include tasks that medical and nursing professionals would normally perform in healthcare settings.[4–6] Multidisciplinary research has stimulated discussion on the impact of informal caregiving on carers' lives, health and well-being, morbidity and mortality, which has been comprehensively reviewed over recent years.[7–11]

International and national evidence suggests that due to the protracted periods

and intensity of caring for young or older persons with severe disability, chronic illness or dementia, a proportion of carers may be at risk of negative health outcomes.[12–16] Caregiving has been shown to be a risk factor for a range of chronic physical and mental health conditions, such as cardiovascular disease (CVD), coronary heart disease (CHD), psychological distress, stress and depression, which have been extensively investigated throughout the caregiving literature.[17–20] Lifestyle and health risk factors impacting on carer health have included hypertension, overweight, smoking and disturbed sleep.[19 21] Diabetes and other chronic health conditions have also been identified and investigated among carer populations.[22]

From these many examples of negative physical and psychological health outcomes reported to be linked to informal caregiving, most relate to well-established theoretical pathways of chronic stress or conceptual models of caregiving based on a stress-coping frameworks.[9 15 23 24] Other studies have reported carer morbidity in terms of the impacts of caring for longer hours per week, the greater intensity of caring activities and more years as a carer.[14] Kenny *et al*[25] also focused on the duration of caregiving that could exacerbate pre-existing (chronic) conditions in some carers. Another Australian study of older carers revealed most had a chronic illness themselves and was linked to the time they spent on caring activities.[26] This trend was not restricted to particular age groups. In a large population-based Canadian survey of caregivers of children with chronic health problems, the parent carers were shown to be twice as likely to report chronic conditions. They also had greater odds of experiencing poorer general health than carers of healthy children.[27]

Despite the predominance of literature highlighting deleterious consequences of caregiving, positive outcomes have been reported, acknowledging that a proportion of informal caregivers provide ongoing care and support without any detriment to their well-being.[28] For example, some studies show that carers can experience positive benefits and maintain an adequate quality of life and health status during their caregiving.[29 30] This may be influenced by what authors have referred to as 'the healthy carer effect'.[7 31 32] Focusing on mortality and the caring role, Roth *et al*[33] highlighted the need for a more balanced view when reporting the impact of caregiving on carer health with greater rigour in research methodology and definition of caregivers.

Rationale, research question and objective

Many studies, particularly earlier research, are limited by non-representative samples as described by Taylor *et al*.[34] As such, the rationale of this study was to assess self-reported health characteristics and status of adult carers from a large, population-based, random sample of South Australian adults. The research question for this study was: is there an association between the caregiving role as a risk factor for chronic disease and the health status of informal/family carers? Therefore, the study objective was to compare carer health status with adults who did not identify as carers in a population, adjusting for age and gender and determining population attributable risk (PAR) to ascertain the contribution of caring to major chronic conditions. The rationale for examining gender differences was considered important as research consistently shows up to two-thirds more carers are females than males, who may not necessarily share the same health profiles.

METHODS

This representative cross-sectional study obtained data from an ongoing state-wide population-based survey (the South Australian Monitoring and Surveillance System (SAMSS)). SAMSS is an epidemiological monitoring system established in 2002 to detect and facilitate understanding of trends in the prevalence of chronic conditions, risk and protective factors and other determinants of health within the state of South Australia (SA).[35]

Sampling frame and recruitment

SAMSS is based on self-reported data, which is systematically collected from a minimum of 600 randomly selected people each month on persons of all ages in the SA community. This risk factor surveillance system uses computer-assisted telephone interviewing (CATI) to monitor chronic health-related problems and risk factors that can assess health outcomes and provide programme and policy information.[36] All households in SA with a telephone number listed in the electronic white pages of the telephone directory are eligible for selection in the sample. Additional information is available on sampling issues in telephone surveys.[37]

A letter introducing SAMSS is sent to the household of each selected telephone number. The letter informs people of the purpose of the survey and indicates that they can expect a telephone call within the time frame of the survey. Data are collected by a contracted agency, and interviews are conducted in English. At least six call-backs are made to the telephone number selected to interview household members. Where a refusal is encountered, another interviewer generally (at the discretion of the supervisor) calls later, in an endeavour to obtain the interview(s). Replacement interviews for persons who cannot be contacted or interviewed are not permitted. Additional details on SAMSS methodology are available.[36] This study used aggregated data from January 2010 to December 2015. Response rates over the period of 2010–2015 varied between 54.1% and 64.4% (mean 59.8%). Family carers were identified from adults aged 16 years and over for the period 2010–2015. The question asked was 'Do you provide long-term care at home for a parent, partner, child, other relative or friend who has a disability, is frail, aged or who has a chronic mental or physical illness?'.

Outcome variables

The selection of SAMSS outcome variables related to national determinants of health, namely diet, blood

pressure, cardiac, respiratory and metabolic diseases and a range of chronic conditions.[36] During interviews, all respondents were asked if a doctor had ever told them they had diabetes, CVD (heart attack, angina, heart disease and/or stroke), arthritis and osteoporosis. Asthma was defined as self-reported doctor-diagnosed asthma and had experienced asthma symptoms in the previous 12 months. In addition, respondents were asked if they had ever been diagnosed by a doctor in the last 12 months with depression, anxiety, a stress-related or other mental health problem.

Respondents were also asked if a doctor had ever told them they have and/or were currently receiving treatment or medication for high blood pressure (HBP) or high cholesterol. They were asked to provide the time they spent undertaking walking, moderate or vigorous physical activity over the past week. The time was summed, with the time spent undertaking vigorous activity multiplied by a factor of two to account for its greater intensity. This provided an indication as to whether respondents are undertaking a sufficient level of physical activity to provide a health benefit. This is defined as 150 min or more of activity each week and has been categorised into insufficient inactivity (no activity and active but not sufficient) and sufficient activity.[38] Body mass index (BMI) was derived from self-reported weight and height and classified as underweight (<18.5 kg/m^2), normal (≥18.5<25.0 kg/m^2), overweight (≥25.0<30.0 kg/m^2) and obese (≥30 kg/m^2).[39] Data were also collected on smoking status (current ex or non), short-term and long-term alcohol risk (derived from the number of alcoholic drinks per day and the number of times per week alcohol was consumed)[40] and how many serves of fruit and how many serves of vegetables they ate each day with the recommendation being at least two serves of fruit and five serves of vegetables per day.[41]

An indicator of overall health status, the Short Form (SF-1) was determined by asking how they would rate their overall health (excellent, very good, good, fair and poor).[42] Psychological distress was determined using the Kessler 10 (K10) scale, which consists of 10 questions, all of which have the same response categories.[43] To score the K10, 'all of the time' was scored as a 5 and none of the time as 1. The 10 items were summed to provide a score of between 10 and 50, with scores over 22 indicating levels of psychological distress. Disability was defined as physical, mental or emotional problems or limitations that the respondent reported having in their daily life.[44 45]

Data analysis

Demographic variables included in the analyses were age, gender, educational attainment, income and work status. Frequencies and χ^2 tests were determined using SPSS V.24. Univariable and multivariable regression was undertaken using the 'svy' commands in STATA V.14 to determine crude and adjusted ORs. In the univariable analyses, carer status was assessed in association with gender, age, health status, risk factors and chronic conditions variables. Multivariable logistic regression was undertaken to determine the OR associated with carer status and the range of health-related variables adjusted for age and gender.

PAR was calculated using STATA and the '*punaf* add-in command to examine risk of caregiving to six chronic conditions (diabetes, asthma, CVD, arthritis, osteoporosis and mental health).[46] For each of the chronic conditions, five models were created to determine the relative risk (RR) and subsequently calculate the Population Attributable Risk (PAR) of being a carer. Model 1 was unadjusted, model 2 controlled for gender and age, model 3 additionally controlled for educational attainment, income and work status, model 4 additionally controlled for HBP and high cholesterol and model 5 further adjusting for sufficient fruit consumption, sufficient vegetable consumption, smoking status, BMI and sufficient physical activity. The PAR analysis was repeated for both males and females separately.

Weighting was used to correct for disproportionality of the sample with respect to the population of interest. Data were weighted using raking, by area (metropolitan/rural), age, gender, marital status, country of birth, educational attainment and dwelling status (rented property vs other) to the most recent SA population data and probability of selection in the household so that the results are representative of the SA population.[47]

Patient and public involvement statement

This population-based survey is conducted based on the health priorities identified by the South Australian Department of Health and Ageing (SA Health). Patients are not involved in the design of the study. Results are disseminated using publications and policy development, where applicable by SA Health (www.sahealth.sa.gov.au).

RESULTS

Of the 35 195 participants, 6.4% (95% CI 6.0% to 6.8%) identified as carers. Overall, 64.1% of carers were female. The peak age group for carers was 50–59 years with rates declining after this age.

Table 1 presents overall carer/non-carer prevalence comparisons for health status, risk factors and chronic disease variables. The overall health status of carers was lower than non-carers, with 10.2% more carers reporting their health as only fair or poor. The prevalence for disability was 9.9% and psychological distress 5.0% higher in carers than non-carers. Comparing carer health risk factors with non-carers, the prevalence estimates for HBP and high cholesterol were higher in carers, and more carers were current smokers. Carers were less likely to be at risk from alcohol-related risk or injury. Carers were also more likely to have all chronic conditions except osteoporosis.

Table 2 highlights the unadjusted and adjusted OR comparing carers with non-carers on their health status, health risks and chronic conditions. After adjustment for

Table 1 Demographic and health variable comparison between carers and non-carers

Demographic variables	Non-carers n	Non-carers %	Carers n	Carers %	P values χ^2 test
Gender					
Males	15998	48.6	806	35.9	
Females	16949	51.4	1441	64.1	<0.001
Age group (years)					
16–39	12758	38.7	474	21.1	
40–49	5823	17.7	468	20.9	
50–59	5511	16.7	513	22.8	
60–69	4341	13.2	395	17.6	
70–79	2766	8.4	242	10.8	
80 and over	1746	5.3	153	6.8	<0.001
Health status					
Short Form (SF-1)					
Excellent, very good, good	27466	83.4	1644	73.2	
Fair or poor	5481	16.6	602	26.8	<0.001
Disability					
No	25510	77.4	1515	67.5	
Yes	7437	22.6	731	32.5	<0.001
Psychological distress (K10)					
No	29496	90.1	1898	85.1	
Yes	3249	9.9	333	14.9	<0.001
Health risk factors					
Alcohol-related lifetime risk					
Does not drink	7562	23	657	29.4	
No risk	14257	43.4	1077	48.2	
Lifetime risk of harm	11005	33.5	499	22.4	<0.001
Alcohol-related injury					
Does not drink	7562	23	657	29.4	
No risk	20538	62.6	1376	61.6	
Alcohol-related injury risk	4725	14.4	200	9	<0.001
Body mass index					
Underweight	621	2.1	59	2.9	
Normal	11252	38.2	649	31	
Overweight	10235	34.8	701	33.5	
Obese	7323	24.9	381	32.6	<0.001
Fruit					
1 or less serves/day	17238	52.3	1158	51.5	
2 or more serves/day	14059	42.7	965	42.9	
None/does not eat fruit	1585	4.8	119	5.3	
Don't know	64	0.2	4	0.2	0.714
Vegetables					
1 or less serves/day	7946	24.1	444	19.8	
2–4 serves/day	21072	64	1488	66.2	
5 or more serves/day	3441	10.4	272	12.1	
None/does not eat vegetables	259	0.8	23	1	

Continued

Table 1 Continued

Demographic variables	Non-carers n	Non-carers %	Carers n	Carers %	P values χ^2 test
Don't know	227	0.7	18	0.8	<0.001
Physical activity					
No activity	4245	16.4	322	19.2	
Activity – not sufficient	7663	29.6	591	35.3	
Sufficient activity	14004	54	761	45.5	<0.001
High blood pressure					
No	26258	79.7	1600	71.2	
Yes	6689	20.3	647	28.8	<0.001
High cholesterol					
No	27604	83.8	1701	75.7	
Yes	5343	16.2	545	24.3	<0.001
Smoking status					
Non/ex	27792	84.4	1797	80	
Current	5151	15.6	449	20	<0.001
Chronic conditions					
Arthritis					
No	26279	79.8	1542	68.7	
Yes	6668	20.2	704	31.3	<0.001
Asthma					
Don't know/no	28638	86.9	1832	81.5	
Yes	4309	13.1	414	18	<0.001
Chronic obstructive pulmonary disease					
Don't know/no	31543	95.7	2093	93.2	
Yes	1404	4.3	153	6.8	<0.001
Cardiovascular disease (CVD)					
Don't know/no	30487	93.8	2002	6.2	
Yes, CVD	2460	7.5	245	10.9	<0.001
Diabetes					
Don't know/no	30274	91.9	1953	86.9	
Yes	2673	8.1	294	13.1	<0.001
Osteoporosis					
Don't know/no	31481	95.5	2099	93.4	
Yes	1467	4.5	147	6.6	<0.001
Mental health problems					
No	27082	82.2	1723	76.7	
Yes	5865	17.8	523	23.3	<0.001

Data source: South Australian Monitoring and Surveillance System 2010–2015.
K10, Kessler 10.

age and sex, the prevalence of fair/poor health status (SF-1), disability, psychological distress, HBP, raised cholesterol and current smoking all remained significant. Carers were less likely to have lifetime risk of alcohol-related harm and risk of alcohol-related injury. Adjusted ORs for all the selected chronic conditions in carers were significant (arthritis, asthma, COPD, CVD, diabetes, mental health and osteoarthritis, except for osteoporosis).

Table 3 presents the PAR of being a carer for six chronic conditions for each of the five different models described above. In the unadjusted model, being a carer was associated with higher RR for all the chronic conditions.

Table 2 Unadjusted and adjusted associations between carers and non-carers health-related variables

Health variables	Carers n	Carers %	Unadjusted OR	P values	Adjusted OR	P values
Health status						
Short Form (SF-1)						
Excellent/very good/good	1644	5.7	1		1	
Fair/poor	603	9.9	1.84 (1.59–2.12)	<0.001	1.62 (1.39–1.89)	<0.001
Disability						
No/don't know	1516	5.6	1		1	
Yes	732	9	1.65 (1.45–1.89)	<0.001	1.44 (1.25–1.66)	<0.001
Psychological distress (K10)						
No	1898	6.1	1		1	
Yes	334	9.3	1.60 (1.32–1.92)	<0.001	1.63 (1.35–1.98)	<0.001
Risk factors						
Alcohol-related lifetime risk						
Does not drink alcohol	657	8	1		1	
No risk	1078	7	0.87 (0.75–1.00)	0.056	0.82 (0.71–0.95)	0.009
Lifetime risk of harm	499	4.3	0.52 (0.43–0.63)	<0.001	0.64 (0.52–0.78)	<0.001
Alcohol-related injury risk						
Does not drink alcohol	657	8	1		1	
No risk	1376	6.3	0.77 (0.67–0.89)	<0.001	0.77 (0.66–0.88)	<0.001
Risk of alcohol related injury	201	4.1	0.49 (0.37–0.64)	<0.001	0.71 (0.53–0.95)	0.019
Body mass index						
Underweight	60	8.8	1		1	
Normal	650	5.5	0.60 (0.38–0.96)	0.033	0.60 (0.37–0.96)	0.035
Overweight	701	6.4	0.71 (0.45–1.14)	0.156	0.69 (0.43–1.12)	0.134
Obese	682	8.5	0.97 (0.60–1.54)	0.886	0.87 (0.54–1.41)	0.582
Vegetables						
1 or less	445	5.3	1		1	
2 or more	1488	6.6	1.26 (1.07–1.49)	0.005	1.17 (1.00–1.38)	0.056
5 or more	272	7.3	1.41 (1.13–1.77)	0.002	1.23 (0.99–1.54)	0.065
None	24	8.3	1.62 (0.81–3.26)	0.176	1.68 (0.82–3.42)	0.156
Don't know	19	7.6	1.47 (0.80–2.70)	0.209	1.26 (0.69–2.29)	0.456
Fruit						
1 or less	1158	6.3	1		1	
2-4	965	6.4	1.02 (0.90–1.15)	0.742	0.95 (0.84–1.08)	0.425
5 or more	119	7	1.12 (0.81–1.54)	0.483	1.16 (0.85–1.59)	0.349
None	5	6.5	1.03 (0.33–3.26)	0.954	0.92 (0.29–2.86)	0.88
Don't know	4					
Physical activity						
No activity	322	7.1	1		1	
Activity but not sufficient	591	7.2	1.02 (0.82–1.26)	0.886	1.07 (0.86–1.33)	0.549
Sufficient activity	762	5.2	0.72 (0.58–0.88)	0.001	0.87 (0.70–1.07)	0.176
High blood pressure						
No/don't know	1600	5.7	1		1	
Yes	647	8.8	1.59 (1.40–1.79)	<0.001	1.22 (1.06–1.40)	<0.001
High cholesterol						

Continued

Table 2 Continued

Health variables	Carers n	Carers %	Unadjusted OR	P values	Adjusted OR	P values
No/don't know	1702	5.8	1		1	
Yes	546	9.3	1.66 (1.46–1.88)	<0.001	1.29 (1.13–1.47)	<0.001
Smoking status						
Non/ex	1798	6.1	1		1	
Current	450	8	1.35 (1.14–1.60)	0.001	1.43 (1.20–1.71)	<0.001
Chronic conditions						
Arthritis						
No/don't know	1543	5.6	1		1	
Yes	705	9.6	1.80 (1.59–2.04)	<0.001	1.34 (1.16–1.55)	<0.001
Asthma						
No/don't know	1833	6	1		1	
Yes	414	8.8	1.50 (1.27–1.78)	<0.001	1.49 (1.26–1.76)	<0.001
Chronic obstructive pulmonary disease						
No/don't know	2094	6.2	1		1	
Yes	154	9.9	1.65 (1.27–2.14)	<0.001	1.40 (1.07–1.83)	0.014
Cardiovascular disease						
No/don't know	2002	6.2	1		1	
Yes	245	9.1	1.52 (1.28–1.80)	<0.001	1.29 (1.06–1.56)	0.009
Diabetes						
No/don't know	1953	6.1	1		1	
Yes	294	9.9	1.71 (1.43–2.03)	<0.001	1.43 (1.19–1.72)	<0.001
Osteoporosis						
No/don't know	2100	6.3	1		1	
Yes	148	9.1	1.51 (1.26–1.81)	<0.001	1.02 (0.84–1.23)	0.835
Mental health conditions						
No	1724	6	1		1	
Yes	523	8.2	1.40 (1.21–1.63)	<0.001	1.34 (1.15–1.56)	<0.001

Adjusted for age and sex.
Data source: South Australian Monitoring and Surveillance System 2010–2015.
K10, Kessler 10.

After adjustment for demographic and health risk factors (model 5), only asthma (RR=1.26) and diabetes (RR=1.19) remained statistically significant (p<0.05). The PAR associated with being a carer for each condition was low.

To determine if there were any differences for males and females, the PAR analysis was then stratified by sex (tables 4 and 5). In the unadjusted model, being a male carer was associated with diabetes (RR=1.79), CVD (RR=1.87), arthritis (RR=1.69) and mental health conditions (RR=1.32). After adjustment (model 5), all associations for male carers disappeared. In table 5, in the unadjusted model, being a female carer was associated with all the selected chronic conditions: diabetes (RR=1.53), asthma (RR=1.42), CVD (RR=1.26), arthritis (RR=1.39), osteoporosis (RR=1.30) and mental health (RR=1.23). After adjustment (model 5), all associations for female carers disappeared except for asthma (RR=1.33) and diabetes (RR=1.21). For both males and females, the PAR associated with being a carer in relation to the range of chronic conditions remained small.

DISCUSSION

This representative population-based study of carer health characteristics estimated there were 6.4% (95% CI 6.0 to 6.8) of the SA population aged 16 years and older, who were informal carers. It shows that carers were more likely to report chronic conditions, psychological distress and disability and to perceive their health status as poor to fair. In terms of their risk factor status, after controlling for age and sex, carers were more likely to

Table 3 PAR of being a carer associated with six chronic conditions, unadjusted, and four multivariable models

	Model 1: unadjusted		Model 2		Model 3		Model 4		Model 5	
	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)
Diabetes	1.61 (1.38 to 1.88)	3.77 (2.29 to 5.22)	1.32 (1.14 to 1.52)	2.35 (0.98 to 3.69)	1.23 (1.07 to 1.42)	1.86 (0.46 to 3.23)	1.19 (1.02 to 1.38)	1.58 (0.12 to 3.01)	1.19 (1.02 to 1.39)	1.67 (0.09 to 3.22)
Asthma	1.41 (1.23 to 1.62)	2.55 (1.37 to 3.72)	1.41 (1.23 to 1.62)	2.58 (1.38 to 3.77)	1.32 (1.15 to 1.52)	2.16 (0.94 to 3.36)	1.30 (1.13 to 1.49)	2.02 (0.84 to 3.18)	1.26 (1.10 to 1.46)	1.94 (0.64 to 3.22)
Cardio vascular disease	1.46 (1.25 to 1.70)	2.85 (1.50 to 4.19)	1.13 (1.00 to 1.29)	1.02 (–0.10 to 2.12)	1.12 (0.96 to 1.30)	0.96 (–0.37 to 2.28)	1.07 (0.93 to 1.24)	0.61 (–0.71 to 1.91)	1.05 (0.91 to 1.22)	0.47 (–0.91 to 1.83)
Arthritis	1.55 (1.42 to 1.69)	3.39 (2.59 to 4.17)	1.19 (1.10 to 1.30)	1.55 (0.77 to 2.33)	1.13 (1.04 to 1.22)	1.07 (0.29 to 1.85)	1.12 (1.03 to 1.21)	1.00 (0.22 to 1.76)	1.08 (0.99 to 1.18)	0.71 (–0.10 to 1.52)
Osteoporosis	1.48 (1.25 to 1.75)	2.95 (1.44 to 4.43)	1.06 (0.90 to 1.24)	0.51 (–0.94 to 1.95)	0.99 (0.84 to 1.17)	–0.05 (–1.57 to 1.45)	0.99 (0.84 to 1.17)	–0.10 (–1.62 to 1.40)	0.98 (0.82 to 1.17)	–0.16 (–1.87 to 1.52)
Mental health	1.31 (1.17 to 1.47)	1.93 (1.00 to 2.85)	1.25 (1.12 to 1.41)	1.65 (0.71 to 2.58)	1.10 (0.98 to 1.23)	0.72 (–0.23 to 1.67)	1.08 (0.96 to 1.21)	0.62 (–0.32 to 1.55)	1.03 (0.90 to 1.19)	0.28 (–0.93 to 1.47)

Data source: South Australian Monitoring and Surveillance System 2010–2015.
PAR was deemed to be significant when the CI for the RR does not include 1.00.
For each of the six chronic conditions listed above, five models were created.
Model 1: unadjusted PAR.
Model 2: adjusted PAR controlling for sex and age.
Model 3: adjusted PAR controlling for age, sex, educational attainment, income and work status.
Model 4; adjusted PAR controlling for age, sex, educational attainment, income, work status, HBP and high cholesterol.
Model 5: adjusted PAR controlling for age, sex, educational attainment, income, work status, HBP, high cholesterol, sufficient fruit consumption, sufficient vegetable consumption, smoking status, BMI and sufficient physical activity.
BMI, body mass index; HBP, high blood pressure; PAR, population attributable risk; RR, relative risk.

Table 4 PAR of being a carer associated with six chronic conditions, unadjusted and four multivariable models, males

	Model 1: unadjusted		Model 2		Model 3		Model 4		Model 5	
	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)
Diabetes	1.79 (1.41 to 2.72)	3.64 (1.71 to 5.53)	1.35 (1.08 to 1.67)	2.10 (0.36 to 3.82)	1.22 (0.98 to 1.52)	1.49 (–0.29 to 3.25)	1.16 (0.93 to 1.46)	1.17 (–0.71 to 3.02)	1.18 (0.93 to 1.50)	1.33 (–0.70 to 3.32)
Asthma	1.17 (0.89 to 1.55)	0.83 (–0.73 to 2.35)	1.25 (0.94 to 1.66)	1.11 (–0.47 to 2.66)	1.13 (0.86 to 1.50)	0.66 (–0.91 to 2.20)	1.13 (0.86 to 1.48)	0.63 (–0.91 to 2.14)	1.07 (0.80 to 1.44)	0.38 (–1.29 to 2.02)
Cardiovascular disease	1.87 (1.51 to 2.32)	4.01 (2.21 to 5.77)	1.20 (1.01 to 1.43)	1.36 (–0.04 to 2.74)	1.18 (0.96 to 1.45)	1.33 (–0.44 to 3.07)	1.10 (0.97 to 1.34)	0.79 (–0.97 to 2.52)	1.11 (0.90 to 1.37)	0.86 (–0.98 to 2.67)
Arthritis	1.69 (1.43 to 2.01)	3.21 (1.90 to 4.51)	1.20 (1.04 to 1.39)	1.25 (0.21 to 2.29)	1.15 (0.98 to 1.36)	1.03 (–0.26 to 2.31)	1.14 (0.97 to 1.34)	0.96 (–0.34 to 2.24)	1.11 (0.94 to 1.32)	0.79 (–0.52 to 2.08)
Osteoporosis	1.19 (0.75 to 1.89)	0.90 (–1.73 to 3.46)	0.83 (0.53 to 1.30)	–1.18 (–3.80 to 1.37)	0.70 (0.44 to 1.13)	–2.39 (–5.27 to 0.41)	0.69 (0.43 to 1.12)	–2.51 (–5.42 to 0.31)	0.47 (0.15 to 1.53)	–5.36 (–12.55 to 1.37)
Mental health	1.32 (1.04 to 1.66)	1.50 (0.07 to 2.91)	1.37 (1.09 to 1.74)	1.70 (0.25 to 3.13)	1.08 (0.86 to 1.35)	0.44 (–0.98 to 1.84)	1.07 (0.86 to 1.34)	0.42 (–0.98 to 1.80)	1.01 (0.77 to 1.31)	0.04 (–1.70 to 1.74)

Data source: South Australian Monitoring and Surveillance System 2010–2015.
PAR was deemed to be significant when the CI for the RR does not include 1.00.
For each of the six chronic conditions listed above, five models were created.
Model 1: unadjusted PAR.
Model 2: adjusted PAR controlling for sex and age.
Model 3: adjusted PAR controlling for age, sex, educational attainment, income and work status.
Model 4: adjusted PAR controlling for age, sex, educational attainment, income, work status, HBP and high cholesterol.
Model 5: adjusted PAR controlling for age, sex, educational attainment, income, work status, HBP, high cholesterol, sufficient fruit consumption, sufficient vegetable consumption, smoking status, BMI and sufficient physical activity.
BMI, body mass index; HBP, high blood pressure; PAR, population attributable risk; RR, relative risk.

Table 5 PAR of being a carer associated with six chronic conditions, unadjusted and four multivariable models, females

	Model 1: unadjusted		Model 2		Model 3		Model 4		Model 5	
	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)	RR (95% CI)	PAR % (95% CI)
Diabetes	1.53 (1.25 to 1.87)	3.97 (1.73 to 6.16)	1.32 (1.09 to 1.59)	2.70 (0.59 to 4.77)	1.27 (1.04 to 15.4)	2.38 (0.22 to 4.50)	1.22 (1.01 to 1.47)	2.06 (–0.11 to 4.17)	1.21 (1.00 to 1.47)	2.16 (–0.16 to 4.43)
Asthma	1.42 (1.22 to 1.66)	3.21 (1.56 to 4.83)	1.46 (1.24 to 1.71)	3.39 (1.71 to 5.04)	1.38 (1.18 to 1.63)	3.00 (1.30 to 4.68)	1.36 (1.16 to 1.59)	2.83 (1.17 to 4.46)	1.33 (1.13 to 1.56)	2.84 (1.02 to 4.63)
Cardiovascular disease	1.26 (1.02 to 1.55)	1.97 (–0.03 to 3.94)	1.09 (0.90 to 1.31)	0.75 (–1.04 to 2.51)	1.09 (0.88 to 1.34)	0.78 (–1.25 to 2.77)	1.05 (0.86 to 1.29)	0.48 (–1.52 to 2.44)	1.01 (0.82 to 1.24)	0.12 (–1.96 to 2.15)
Arthritis	1.39 (1.26 to 1.53)	2.96 (1.95 to 3.96)	1.15 (1.05 to 1.26)	1.39 (0.42 to 2.34)	1.11 (1.02 to 1.22)	1.09 (0.12 to 2.05)	1.10 (1.01 to 1.21)	1.00 (0.04 to 1.95)	1.06 (0.97 to 1.17)	0.65 (–0.39 to 1.67)
Osteoporosis	1.30 (1.09 to 1.55)	2.29 (0.53 to 4.01)	1.09 (0.93 to 1.29)	0.86 (–0.73 to 2.42)	1.05 (0.88 to 1.26)	0.51 (–1.24 to 2.23)	1.05 (0.88 to 1.25)	0.48 (–1.28 to 2.20)	1.01 (0.70 to 1.46)	0.17 (–4.59 to 4.71)
Mental health	1.23 (1.07 to 1.40)	1.74 (0.51 to 2.95)	1.22 (1.06 to 1.39)	1.68 (0.44 to 2.91)	1.11 (0.97 to 1.27)	0.92 (–0.34 to 2.17)	1.09 (0.95 to 1.24)	0.77 (–0.48 to 1.99)	1.05 (0.89 to 1.23)	0.43 (–1.18 to 2.02)

Data source: South Australian Monitoring and Surveillance System 2010–2015.
PAR was deemed to be significant when the CI for the RR does not include 1.00.
For each of the six chronic conditions listed above, five models were created.
Model 1: unadjusted PAR.
Model 2: adjusted PAR controlling for sex and age.
Model 3: adjusted PAR controlling for age, sex, educational attainment, income and work status.
Model 4: adjusted PAR controlling for age, sex, educational attainment, income, work status, HBP and high cholesterol.
Model 5: adjusted PAR controlling for age, sex, educational attainment, income, work status, HBP, high cholesterol, sufficient fruit consumption, sufficient vegetable consumption, smoking status, BMI and sufficient physical activity.
BMI, body mass index; HBP, high blood pressure; PAR, population attributable risk; RR, relative risk.

report smoking, raised cholesterol and HBP than the non-carer population. The PAR of being a carer was minimal suggesting that informal caregiving does not appear to have contributed to the proportion of chronic disease in the sampled population, indicating that if there were no carers in the population, there would only be a small reduction in the number of cases of those with the specified chronic conditions. However, in the SA sample, carers reported more chronic illness than found in other large international studies.[48 49]

Despite much published literature discussing chronic illness in carers, there remains a lack of details about specific chronic conditions among carers, except for CVDs and psychological conditions like stress and depression. Our current study of self-reported carer health in SA included a range of major chronic conditions in adult carers of all ages. The presence of asthma or other respiratory conditions is rarely demonstrated in other studies, although it is acknowledged that carers in this survey are living in Australia, which has one of the highest rates of asthma in the world.[50] Other chronic conditions such as diabetes have been evident in a small number of population and clinical studies about informal caregivers.[22] In the biomedical literature, authors have described the link between long-term informal caregiving, chronic stress and physiological changes including the metabolic syndrome and other endocrine and immune conditions.[24 51] Some of these studies have investigated the impact of caring for a spouse with dementia or a child with a disability where carers were seen to be more at risk of serious chronic physical conditions (such as CHD) or mental health conditions.[52]

There are interesting similarities and contrasts between SA and international surveys of carers. For example, two large population-based surveys exploring the characteristics of informal carers have some relevance to our research.[48 49] The 2011/2012 Spanish population-based national survey, although limited to informal carers in households with a disabled resident, explored associations between the carers, disease and risk factors and compared them with matched controls.[48] Variables included diabetes, HBP, cholesterol, smoking, physical activity and drinking alcohol. Results indicated there was some evidence of depression and anxiety among female carers, but it was gender and the caring role that was seen to mediate chronic diseases in the Spanish carers.[48] Our survey results showed carers were more likely to have diabetes, asthma and arthritis, plus major risk factors such as smoking, raised cholesterol and HBP.

A Swedish population survey collected self-reported data between 2004 and 2013, with the aim of analysing associations between caregiving and health outcomes. The study also investigated carer self-rated health, the presence of long-term illness in carers and their psychological well-being.[49] Comparisons with non-carers showed that carers had lower psychological well-being, which was also reported in the Spanish Survey.[48] The self-rated

perceptions of health in Swedish carers were worse than non-carers and adversely associated with carer health.[49]

Psychological distress has been consistently reported in caregiver research spanning at least three decades.[53 54] A British survey found there was a progressive increase of distress in carers as the amount of caregiving increased each week.[14] There are also well-documented links between psychological distress and lower perceived health status, as well as associations between distress and the presence of chronic illness.[54 55] Although it is reported that women are statistically more likely to experience high psychological distress than men, the large volume of caregiving literature showing gender associated with distress may have more to do with the fact that more women are in caregiving roles. As two-thirds of carers from our survey were female, it may explain the finding of higher distress, which supports that trend. Previous research undertaken by the current authors highlighted major demographic trends in SA carers.[56]

The greater likelihood of carers in our sample reporting risk factors of smoking, raised cholesterol and HBP when compared with non-carers is interesting and highlights important issues for assessment of carer morbidity. Despite the wealth of information generated over past decades on the health impacts of smoking within various populations, discussions linking caregiving stress with smoking are few. Like the Spanish study and our own SAMSS surveys, some population surveys in recent years have included caregiving and smoking status in their questionnaires, for example, the Behavioral Risk Factor Surveillance System (BRFSS) state-based surveys being conducted across the USA.[57] Their results showed some similar characteristics to the SA survey in terms of gender and age distribution, but more of our carers reported disability or were current smokers.

In relation to smoking characteristics, studies were mostly limited to the smoking habits of caregivers of patients with Alzheimers Disease. For example, one project was part of the REACH II study (Resources for Enhancing Alzheimer's Caregiver Health, 2002–2004 in the USA). It showed that 40% of caregivers smoked which was higher than smoking in the general population (22%).[58] Findings indicated that nearly a quarter of the informal carers of patients with Alzheimer's disease reported increased smoking over the previous month, which was linked with age, ethnicity and employment. Younger carers were more likely to be smokers, with depression as the main stressor. The study suggested that the smoking increase in carers could be explained by less caregiving skills and fewer coping resources of the carers.[58] Evidence cited from other studies linked the caregiver role with higher distress and to smoking behaviours with subsequent impact on heart disease.[59]

Strengths and limitations

The strengths of this study are the large sample size, the use of standardised validated instruments and a well-established definition of carers that have not altered over the period of data collection and also the stability of the methodology over the research period. Our sample of carers was selected from part of a large representative state-wide surveys over a 5-year period, and therefore, results are applicable to the wider population. The use of PAR analysis to determine the contribution of caregiving to major chronic conditions in carers, to our knowledge, has not been undertaken using carer data before. Specific variables for this study included some of the major health risk factors and chronic conditions; however, as data were cross-sectional, only associations between carers and chronic illnesses and risk factors could be reported. The self-reported nature of the data collection is also acknowledged as a weakness of the study with the known subtleties associated with persons over-reporting or under-reporting their behaviours. For example, measurements to confirm the accuracy of each person's height and weight, blood pressure and cholesterol were not undertaken and so these may be underestimated.[60 61]

The structure of the data base and methodology also limits data collected to demographic questions and health indicators that are suited to telephone and CATI protocols.[62] We acknowledge that the relationship between caregiving and physical health is complex, bidirectional and can be mediated by several factors. For example, pre-existing health problems of the carers, diagnosis of the cared for person, duration and intensity of the caregiving and type of caring role (whether more physically oriented or emotionally demanding). Questions about carer lifestyles and environments, cultural, family and social characteristics were also very limited as the survey was not conducive to in-depth interviewing of each participant. Hence, it was not possible to gather additional information about the cared for persons, their diagnosis and disability or the duration or intensity of care provided. Despite that, the sampling process did allow for carer heterogeneity within the population as it did not limit the recruitment of carers to any one type of caregiving or care recipient condition. Additional information from carers on specific somatisation symptoms like sleeping disorders, musculoskeletal conditions, injuries, pain and general discomfort would have been valuable, but these would require a separate study. There may be opportunity for this research in the future. Lastly, it is acknowledged that the scope of health issues investigated in this study was limited partly due to lack of evidence between informal caring and health status after adjustments for various variables.

CONCLUSION

The profiles of carer health in this study highlight several aspects of caregiving in the South Australian population. This study shows that informal carers, now recognised as the partners in care, were in terms of their own health status, reporting a range of diagnosed diseases such as asthma, diabetes, arthritis, as well as risk factors of smoking, cholesterol and blood pressure. However, although carers

in this sample had higher prevalence of almost all conditions, this higher prevalence disappeared for male carers in the process of statistical adjustments. For female carers after adjustments, all associations with chronic conditions disappeared except for diabetes. Therefore, any excess prevalence of chronic conditions in the population that results from people providing care is small. The estimation of PAR associated with caregiving for these selected physical health conditions was not expected to be large, and this is indeed what was found. Overall, we concluded that our findings of small effect size differences in physical health outcomes between carers and non–carers was associated with small to moderate risk of informal carers having these chronic conditions.

This study is novel and useful, not just for demonstrating these differences in carer health status and morbidity, but rather to show that major health disorders are present within the carer population. These findings offer more detailed information on types of chronic physical health problems such as asthma, diabetes, arthritis and hypertension that need more appropriate disease management strategies that are specific to carers. Our results also provide a baseline for assessing and comparing trends across a range of chronic conditions and risk factors among future carers.

Therefore, monitoring of carer health and morbidity, particularly 'at risk' individuals such as female carers with asthma or diabetes, is important to track trends in chronic health conditions, distress and disability in informal caregivers. To achieve this, caregiver-based studies need to become part of mainstream biomedical research at both epidemiological and clinical levels.

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Patient consent Not required.

Ethics approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethics approval was obtained from the ethics committee of the Department of Health and Ageing, South Australia (SA) (436.02.2014 and HREC/14/SAH/200).

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Data sharing statement The data that support the findings of this study are available from SA Department of Health and Ageing, but restrictions apply to the availability of these data, which were used under licence for the current study and so are not publicly available. Data are, however, available from the authors on reasonable request and with permission of SA Department of Health and Ageing.

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