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Impact of lifestyle risk factors on admission to nursing home care: a cohort study of 127 108 people aged 60 years and over

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► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/jech-2023-220518).

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Received 28 February 2023
Accepted 4 June 2023
Published Online First
24 August 2023

ABSTRACT

Background Little is known on how lifestyle factors, individually or in combination, may relate to nursing home admission, an outcome of great societal and economic importance with increased population ageing. The aim of this study was to determine the association of lifestyle risk factors with nursing home admission.

Methods This prospective cohort study linked data from the 45 and Up Study, Australia, to health records. 127 108 men and women, aged ≥60 years, were recruited between 2006 and 2009. A healthy lifestyle score categorised participants into three risk groups based on five equally contributing risk factors: smoking status, physical activity, sedentary behaviour, sleep duration and diet quality. HRs for incident nursing home admission were estimated using multivariable Cox proportional hazards model.

Results One-quarter of participants were in the low-risk lifestyle group, 62% were in the medium-risk group and 14% in the high-risk (least healthy) group. During a median (IQR) follow-up of 11.3 years, 23 094 (18%) participants were admitted to a nursing home. Compared with those in the low-risk group, risk of nursing home admission was 43% higher among participants in the high-risk group (multivariable adjusted HR (aHR) 1.43; 95% CI 1.36 to 1.50); and participants in the medium-risk group had an intermediate 12% greater risk (aHR 1.12; 95% CI 1.08 to 1.16). Participants aged 60–64 years in the high-risk (aHR 2.15; 95% CI 1.82 to 2.54) lifestyle group had the greatest risk of nursing home admission.

Conclusion An unhealthy lifestyle was associated with a marked increased risk of admission to a nursing home in adults aged 60+ years. Interventions focused on lifestyle modifications may prevent or delay nursing home admission.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Modifiable lifestyle risk factors, including smoking, physical inactivity, unhealthy diet and sleep disorders, are associated with the development and progression of multiple chronic diseases such as diabetes, cardiovascular disease, cancer and dementia.

⇒ Little is known on how these lifestyle factors, individually or in combination, may relate to nursing home admission, an outcome of great societal and economic importance with increased population ageing.

WHAT THIS STUDY ADDS

⇒ Among older adults aged 60+ years, those with one or more high-risk lifestyle behaviours have a higher risk of admission to a nursing home. This association was strongest in men and women aged 60–74 years compared with those aged 75+.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Modifying lifestyle, especially reducing sitting time, increasing physical activity and improving sleep, should be explored as new public health measures to reduce the future risk of nursing home admission.

INTRODUCTION

Population ageing is one of the most significant social and economic changes affecting almost every country in the world.[1] By 2050, the number of people over the age of 65 is predicted to almost double, while the oldest-old group (aged >80 years) will triple globally.[1] In Japan and some European countries, about one in three people will be older than 65 years in less than 20 years.[1] With increasing age, many health conditions and associated disabilities become more common, resulting in older adults having the highest use of healthcare services[2] and greater likelihood of admission to public or private nursing home care. Australia, for example, already has a high proportion of older people receiving nursing home care compared with other Organisation for Economic Co-operation and Development nations.[3] Effective strategies to prevent or delay older adults entering nursing home care will help ensure society can adequately care for its increasing number of older people.

Nursing homes (also called care homes or aged care facilities) provide accommodation and care for people who can no longer live independently in the community because of physical and/or mental health conditions. There is strong evidence that lifestyle-related risk factors, such as poor diet, physical inactivity (including excessive sitting time), smoking and short or long sleep duration, are associated with the development and progression of multiple common debilitating chronic diseases such as cardiovascular disease, stroke, chronic nephropathy, cancer, dementia and frailty.[4–9] However, very

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To cite: Gibson AA, Gale J, Stamatakis E, *et al*. *J Epidemiol Community Health* 2023;**77**:744–751.

little is known about how lifestyle risk factors impact on long-term nursing home placement. Most older people have a clearly stated preference for remaining in their home, so interventions to postpone nursing home admission (or avoid it completely) would contribute to a higher quality of life, a more dignified ageing and reduce the need for costly provision of care.

The aim of this study was to investigate the independent and combined associations of five established and prevalent lifestyle risk factors—smoking, physical inactivity, sitting time, sleep duration and diet quality—with the risk of first nursing home admission. Evidence about how potentially modifiable lifestyle-related risks factors can impact on long-term nursing home placement would be an important contribution to aged care policy and might also serve as a personal motivator for lifestyle changes among younger at-risk individuals who do not want to lose their future independence and to remain in their homes for as long as possible.[10 11]

METHODS

Study sample and data sources

We used data from the *The Sax Institute's 45 and Up Study*, a large prospective cohort of 267 153 men and women aged over 45 years residing in the State of New South Wales (NSW), Australia. This cohort represents approximately 11% of the NSW population aged over 45. People who were aged over 80 years and those from rural and remote areas were oversampled. For this study, only participants aged 60 years and over were included as this is the age where nursing home admissions start to increase among both men and women.[12] In deciding to include those aged 60 years and over at baseline, we also considered that by the end of follow-up (31 December 2019), these individuals could be up to 14 years older. The cohort profile and research protocol have been published in detail previously.[13] Briefly, participants of the 45 and Up Study were randomly sampled from Australia's universal health insurance scheme, the Services Australia Medicare enrolment database, between January 2006 and December 2009. Participants were invited by mail and agreed to participate by completing a sex-specific self-administered baseline questionnaire and providing written informed consent for participation and long-term follow-up, including data linkage of their survey responses to administrative health data collections. The estimated response rate was 18%. In 2010, the Social, Economic and Environmental Factors (SEEF) Study questionnaire was distributed to the first 100 000 participants in the 45 and Up Study, of whom 60 404 returned the completed questionnaire (response rate 60%)[14] (online supplemental figure 1). The first follow-up questionnaire was sent to all participants in 2012–2015 with 142 548 completed (response rate 58%).

For this study, we used data from participants' baseline questionnaires that were linked to their corresponding Medicare Benefits Schedule (MBS) data, supplied by Services Australia. Linkage of the 45 and Up cohort data to the MBS data is facilitated by the Sax Institute using a unique identifier provided by Services Australia. NSW Admitted Patient Data Collection (APDC) and the NSW Registry of Births, Deaths and Marriages death registrations (2006–2019) were also linked and was conducted by the NSW Centre for Health Record Linkage (http://www.cherel.org.au/) using probabilistic linkage. The Secure Unified Research Environment provided secure data access. The 45 and Up Study was approved by the University of NSW Human Research Ethics Committee and use of linked data for this study was approved by the NSW Population and Health Services Research Ethics Committee (Cancer Institute NSW reference: 2017/HRE0206).

Patient and public involvement

Members of the public were not involved in the design of the study or interpretation of the findings. There are plans to disseminate the results of the research to study participants and the community.

Study outcomes

Incident admission to a nursing home was ascertained from two data sources, hospital (APDC) and MBS claims data. For hospital data, we used the following variables in the APDC data set to indicate whether the patient had been admitted from or discharged to a nursing home: 'facility type', 'mode of separation', 'facility transferred from', 'facility transferred to' and 'financial class code'. For MBS records, we used item numbers shown in online supplemental table S1, which correspond to claims for consultations with a general practitioner (GP), pathology collection or telehealth items specifically for patients living in a residential aged care facility. A participant was considered admitted to a nursing home from the first-recorded MBS claim or hospital admission. In Australia, nursing homes (also called residential aged care facilities) are for older people who can no longer live independently at home and need ongoing help with everyday tasks or healthcare.[15] Younger people are also eligible if they have a disability, dementia or other special care needs that cannot be met through other specialist services.[15] As places in nursing home are subsidised by the Australian Government, eligibility is based on need, which is determined through an independent assessment.[15]

Exposures

Information on five lifestyle risk factors (smoking, physical activity, sitting time, sleep duration and diet) was ascertained from the baseline data collection. The full list of questions used to assess lifestyle risk factors and response options is provided in online supplemental table S2. The full baseline survey is available at https://www.saxinstitute.org.au/our-work/45-up-study/questionnaires/. As shown in table 1, participant responses were classified as low, medium or high risk, depending on levels of adherence to national preventative health guidelines for smoking, physical activity and diet.[16–18] In the absence of broadly agreed quantitative guidelines for sleep and sitting, we selected a categorisation based on current research.[7 8 19 20] Australia's national guidelines for physical activity and sitting are almost identical to the 2020 WHO Guidelines on physical activity and sedentary behaviour and do not specify thresholds for sleep and sitting.[9] Alcohol consumption was not included in the overall lifestyle score as the question used in the questionnaires did not allow us to separate those who never drank alcohol, from those who are ex-drinkers who might have given up alcohol due to ill health or because of prior addiction or misuse. Such a misclassification has been shown to lead to spurious beneficial associations of alcohol drinking with health outcomes.[21] To obtain an overall lifestyle score, responses to each lifestyle risk factor were categorised as the low (healthiest), medium and high (least healthy)-risk groups and were allocated a score of 2, 1 and 0, respectively. The resultant overall lifestyle score had a range 0–10—with a higher score indicating a healthier lifestyle. Overall lifestyle score was then categorised into three groups: low risk (score 9–10), medium risk (score 6–8) and high risk (score 0–5). The rationale for these categories was based on the most plausible and clinically relevant distribution of lifestyle behaviours that could be achieved for each risk category. For instance, those in the low-risk group would need to score in the lower risk for all

Table 1 Distribution of lifestyle risk factors and scoring of overall lifestyle score

Lifestyle factor	Description	Low risk=2	Medium Risk=1	High risk=0
Smoking	**Smoking history**	**Non-smoker**	**Previous smoker**	**Current smoker**
	N (%)	72 770 (57.3)	48 431 (38.1)	5 901 (4.6)
Physical activity	**Minutes of MVPA per week**	**≥300**	**150–299**	**≤149**
	N (%)	57 955 (51.4)	17 868 (15.9)	36 904 (32.7)
Sleep	**Hours per day**	**7–9**	**>5–7 or >9–11**	**<5 or >11**
	N (%)	91 598 (74.6)	27 276 (22.2)	3 864 (3.1)
Sitting	**Hours per day**	**<7**	**7–9**	**>9**
	N (%)	86 596 (75.5)	17 991 (15.7)	10 163 (8.9)
Diet score *	**Out of 10**	**>7**	**>3–7**	**0–3**
	N (%)	43 437 (34.9)	69 648 (56)	11 266 (9.1)
Fruit*	**Serves per day**	**≥2**	**1**	**0**
	N (%)	74 567 (61.1)	39 000 (32)	8 497 (7)
Vegetable	**Serves per day**	**≥5**	**3–4**	**0–2**
	N (%)	43 506 (35)	38 398 (30.9)	42 459 (34.1)
Red meat	**Serves per week**	**0–2**	**3–4**	**≥5**
	N (%)	40 670 (33.2)	51 472 (42)	30 495 (24.9)
Processed meat	**Serves per week**	**0**	**1–2**	**≥3**
	N (%)	24 717 (23.7)	60 328 (57.8)	19 368 (18.5)
Fish	**Serves per week**	**≥3**	**1–2**	**0**
	N (%)	25 481 (21.2)	86 972 (72.4)	7 713 (6.4)
Overall lifestyle score†	**Out of 10**	**9–10**	**6–8**	**0–5**
	N (%)	29 638 (24.5)	74 794 (61.9)	16 448 (13.6)

*Composite score based on response to the five diet questions.
†Composite score based on response to lifestyle questions and diet score.
MVPA, moderate to vigorous physical activity.

but one of the lifestyle factors and, conversely, those in the high-risk group could not be in the low-risk group in more than two of the lifestyle factors.

Covariates

Self-reported sociodemographic characteristics, chronic health conditions and health status were identified from the baseline survey. Sociodemographic characteristics included age (60–64, 65–74, 75–84, 85+ years), sex, highest level of education (up to school or intermediate certificate, higher school to diploma, University degree or higher), country of birth (Australia, other), marital status (married or living with a partner, no partner), residential area (major city, inner/outer regional, remote/very remote) and socioeconomic background (Index of Relative Socio-economic Disadvantage (IRSD) quintile). Baseline residential area was based on the 2006 Accessibility and Remoteness Index of Australia Plus score of participants' residential postcode. Socioeconomic background was measured as the 2006 IRSD quintile of participants' residential postcode.[22] The IRSD is derived from income, education, unemployment and other census data.[22]

Chronic health conditions and health status included self-reported history of diabetes, cardiovascular disease (including heart disease and stroke), depression and BMI (18.5–22.49, 22.5–24.99, 25.0–29.99, ≥30, kg/m^2). Physical impairment was assessed using items from the physical functioning scale of the short form health survey[23] and categorised as no/mild impairment (score 75–100), moderate impairment (score 50–75) or severe/very severe impairment (score 0–50).

Statistical analysis

Baseline self-reported sociodemographic characteristics and lifestyle factors were cross-tabulated with each of the three lifestyle groups (low, medium and high risk). Multiple imputation was performed using the full conditional imputation method and incorporating all relevant lifestyle, demographic and outcome variables. Thirty imputations were conducted and the estimates across the imputed data sets were combined by calculating the mean of the parameter of interest and SEs adjusted for the uncertainty produced by the imputation process. The Missing at Random assumption required for imputation was considered to be reasonable based on the missingness patterns in the data (tables 1 and 2) and the large number of variables included in the imputation process.[24] A sensitivity analysis using only the complete case data set was conducted to investigate any large differences in parameter estimates between the complete case and multiple imputation approaches. The PROC MI and MIANALYSE functions in SAS V.9.4 were used to conduct the multiple imputation process.

We used Cox proportional hazard models to estimate crude and adjusted hazard ratios (aHR) to test for any association between each of the independent lifestyle risk variables and composite lifestyle risk score and time to first nursing home admission. The models for each outcome were conducted adjusting for other factors in a sequential process; unadjusted, adjusted for age and sex, adjusted for age, sex and physical impairment and finally adjusted for all demographic and health-related factors. For the models where an individual lifestyle risk factor was the outcome, the fully adjusted model was also adjusted for the other four lifestyle risk factors. Eligible study participants contributed person-years from the date of their baseline survey (between January 2006 and December 2009) until first nursing home admission, death or end of follow-up (December 2019). All models accounted for the competing risk of death before nursing home admission. Proportionality assumptions were verified based on the methods on Lin *et al*.[25] Interaction by age, sex and chronic

Table 2 Baseline characteristics by overall lifestyle score category

Characteristic	Lifestyle score (n, %)		
	Low risk (9-10) n=29 638	Medium risk (6-8) n=74 794	High risk (0–5) n=16 448
Sex			
Male	10 939 (17.2)	39 152 (61.5)	10 860 (17.1)
Female	18 699 (29.5)	35 642 (56.2)	5 588 (8.8)
Age group			
60–64	9 749 (25.3)	22 531 (58.4)	5 200 (13.5)
65–74	13 615 (24.9)	32 379 (59.3)	6 299 (11.5)
75–84	5 651 (19.1)	17 491 (59.2)	4 166 (14.1)
85+	623 (14.3)	2 393 (55)	783 (18)
Education status			
Up to school or intermediate certificate	11 240 (22)	29 576 (57.8)	6 918 (13.5)
Higher school to diploma	12 147 (23.9)	30 421 (59.9)	6 373 (12.6)
Degree or higher	5 799 (25.8)	13 367 (59.5)	2 800 (12.5)
Missing	452 (16.7)	1 430 (53)	357 (13.2)
Remoteness			
Major cities	14 320 (22)	38 392 (59.1)	8 995 (13.8)
Other	14 801 (24.7)	35 086 (58.5)	7 205 (12)
Missing	517 (23.8)	1 316 (60.6)	248 (11.4)
SEIFA quintile			
First (most disadvantaged)	5 500 (19.6)	16 392 (58.3)	4 377 (15.6)
Second	6 318 (22.8)	16 232 (58.5)	3 706 (13.4)
Third	5 626 (24.1)	13 815 (59.1)	2 852 (12.2)
Fourth	5 111 (25)	12 035 (58.9)	2 404 (11.8)
Fifth (least disadvantaged)	6 275 (25.9)	14 411 (59.4)	2 739 (11.3)
Missing	808 (25.2)	1 909 (59.5)	370 (11.5)
Marital status			
Married/defacto	22 751 (24.5)	55 174 (59.4)	11 135 (12)
Single/divorced/ separated/widowed	6 759 (20.2)	19 166 (57.3)	5 208 (15.6)
Missing	128 (16.2)	454 (57.6)	105 (13.3)
Country of birth			
Australia	22 328 (24)	54 550 (58.7)	11 535 (12.4)
Other	7 310 (21.3)	20 244 (59.1)	4 913 (14.3)
BMI (kg/m^2)			
18.5–22.49	4 705 (28.9)	9 047 (55.5)	1 734 (10.6)
22.5–24.99	7 081 (26.9)	15 186 (57.7)	2 862 (10.9)
25.0–29.99	11 286 (23)	29 561 (60.3)	6 163 (12.6)
≥ 30	4 719 (17.9)	15 885 (60.3)	4 513 (17.1)
Missing	1 847 (20.3)	5 115 (56.1)	1 176 (12.9)
Physical impairment			
No/mild impairment	22 130 (27.6)	47 750 (59.5)	7 998 (10)
Moderate impairment	2 940 (18.4)	9 831 (61.5)	2 590 (16.2)
Severe/very severe impairment	1 540 (11)	7 762 (55.2)	3 859 (27.4)
Missing	3 028 (18)	9 451 (56)	2 001 (11.9)
Self-report CVD at baseline			
Yes	6 223 (19.3)	19 189 (59.4)	221 (16.2)
No	23 415 (24.7)	55 605 (58.6)	11 227 (11.8)
Self-reported diabetes at baseline			
Yes	2 518 (17)	8 810 (59.4)	2 613 (17.6)
No	27 120 (24.2)	65 984 (58.8)	13 835 (12.3)
Self-reported depression at baseline			
Yes	2 989 (20.5)	8 481 (58.1)	2 490 (17.0)
No	26 649 (23.7)	66 313 (58.9)	13 958 (12.4)

BMI, Body mass index; CVD, Cardiovascular disease; SEIFA, Socio-Economic Indexes for Areas.

Table 3 Survival analysis results modelling overall lifestyle score and individual lifestyle variables against risk of nursing home admission

Factor	Lifestyle risk category	Event frequency	Lifestyle risk group	HR (unadjusted)	HR (adjusted for age and sex only)	HR (adjusted for age, sex and physical impairment only)	HR (fully adjusted)*
Smoking	Non-smoker	13 671 (18.8)	Low risk	1.00	1.00	1.00	1.00
	Previous smoker	8479 (17.5)	Medium risk	0.96 (0.93–0.99)	1.11 (1.08–1.15)	1.09 (1.06–1.13)	1.09 (1.06–1.12)
	Current smoker	973 (16.5)	High risk	0.93 (0.87–0.99)	1.79 (1.68–1.91)	1.65 (1.55–1.76)	1.55 (1.45–1.66)
Physical activity	≥300 min MVPA/week	8074 (13.9)	Low risk	1.00	1.00	1.00	1.00
	150–299 min MVPA/week	2892 (16.2)	Medium risk	1.06 (1.02–1.11)	1.08 (1.03–1.12)	1.07 (1.03–1.12)	1.08 (1.03–1.12)
	≤149 min MVPA/week	8317 (22.5)	High risk	1.51 (1.47–1.55)	1.34 (1.3–1.38)	1.21 (1.17–1.24)	1.19 (1.16–1.23)
Sleep	7–9 hours/day	14 594 (15.9)	Low risk	1.00	1.00	1.00	1.00
	>5–7 or >9–11 hours/day	5931 (21.7)	Medium risk	1.47 (1.43–1.51)	1.21 (1.18–1.25)	1.13 (1.10–1.17)	1.11 (1.08–1.15)
	<5 or >11 hours/day	1255 (32.5)	High risk	2.48 (2.34–2.63)	1.61 (1.51–1.71)	1.35 (1.27–1.43)	1.29 (1.22–1.38)
Sitting	<7 hours/day	14 426 (16.7)	Low risk	1.00	1.00	1.00	1.00
	7–9 hours/day	3299 (18.3)	Medium risk	1.14 (1.10–1.18)	1.10 (1.06–1.14)	1.05 (1.01–1.09)	1.05 (1.01–1.09)
	>9 hours/day	2073 (20.4)	High risk	1.32 (1.26–1.38)	1.31 (1.25–1.37)	1.16 (1.11–1.21)	1.12 (1.07–1.17)
Diet	Diet score>7 (healthiest)	7610 (17.5)	Low risk	1.00	1.00	1.00	1.00
	Diet score>3–7	12 727 (18.3)	Medium risk	1.07 (1.04–1.10)	1.05 (1.01–1.08)	1.01 (0.98–1.04)	1.00 (0.97–1.03)
	Diet score 0–3 (least healthy)	1993 (17.7)	High risk	1.09 (1.04–1.15)	1.15 (1.09–1.21)	1.08 (1.03–1.14)	1.02 (0.97–1.08)
Overall lifestyle†	Lifestyle score 9-10 (healthiest)	3973 (13.4)	Low risk	1.00	1.00	1.00	1.00
	Lifestyle score 6–8	13 226 (17.7)	Medium risk	1.30 (1.25–1.34)	1.21 (1.17–1.26)	1.13 (1.09–1.17)	1.12 (1.08–1.16)
	Lifestyle score 0–5 (least healthy)	3900 (23.7)	High risk	1.88 (1.80–1.96)	1.79 (1.71–1.87)	1.46 (1.39–1.53)	1.43 (1.36–1.50)

Results are based on multiple imputation strategy N=127 108.
*Adjusted for age, sex, education, remoteness, Socio-Economic Indexes for Areas (SEIFA), marital status, country of birth, body mass index (BMI), physical impairment and other lifestyle variables.
†Not adjusted for other lifestyle scores since the lifestyle score is a composition of these.

health conditions and baseline health status were also assessed. When we found evidence of statistical interaction (ie, p value <0.05) for a given interaction between the factor and lifestyle outcome, we carried out further stratified analyses.

RESULTS

After exclusions, our final sample included 127 108 participants (online supplemental figure S1). A quarter of the sample (25%) was in the low risk (healthiest) lifestyle group, 62% were in the medium risk group and 14% in the high risk (least healthy) group (table 1). Baseline characteristics of the cohort by overall lifestyle score group are presented in table 2. Compared with those with the healthiest lifestyle, a higher proportion of those with the least healthy lifestyle were men with obesity, aged >85 years, from most disadvantaged backgrounds, and had multiple chronic conditions and/or severe impairment (table 2).

Among the 127 108 participants with a mean follow-up of 10.3 (2.8) years, (1 313 771 person-years), 23 094 (18%) were admitted to a nursing home. Nursing home admissions increased with age up until 85 years and were only slightly higher among women than men (online supplemental figure S2). Table 3 shows the HRs for the association of each of the five lifestyle factors and the overall lifestyle score category with nursing home admission. After adjustment of covariates, all lifestyle factors except diet were each associated with an increased risk of nursing home admission. Compared with the low-risk group of each behaviour, the mutually aHR for nursing home admission among people in the high-risk group was 1.55 (95% CI 1.45 to 1.66) for smoking, 1.29 (95% CI 1.22 to 1.38) for sleep, 1.19 (95% CI 1.16 to 1.23) for physical activity and 1.12 (95% CI 1.07 to 1.17) for sitting. The risk of nursing home admission was elevated, although lower among those in the medium-risk of each lifestyle risk factor compared with the low-risk group (table 3).

In terms of overall lifestyle, compared with individuals in the low-risk (most healthy) lifestyle group, those in the high-risk (least healthy) group, the aHR for nursing home admission was 1.43 (95% CI 1.36 to 1.50). While for those in the medium-risk group, it was 1.12 (95% CI 1.08 to 1.16) (table 3). The risk of nursing home admission increased linearly, on average, by 19% (aHR 1.19, 95% CI 1.16 to 1.22) with every unit decrease in healthy lifestyle score (figure 1). Specifically, those with the lowest lifestyle score (≤2 out of 10) had an over twofold (aHR 2.01 95% CI 1.60 to 2.53) increase in the risk of nursing home admission compared with those with a lifestyle score of 10, while there was no association for those with a lifestyle score of 8 or more.

After assessing interaction in the fully adjusted models (online supplemental table S3), we found age group and physical impairment modified the association between lifestyle risk groups and nursing home admission (p=0.001). In the age-stratified analyses, individuals aged 60–64 years in the medium (aHR 1.33; 95% CI 1.15 to 1.54) and high-risk (aHR 2.15; 95% CI 1.82 to 2.54) lifestyle groups had the greatest risk of nursing home admission (figure 2). This risk declined with age but was still elevated for 65–74 and 75–84 year olds (figure 2). There was no association between lifestyle risk groups and nursing home admission for those aged 85+ years. For individuals with mild and moderate physical impairment at baseline, the association

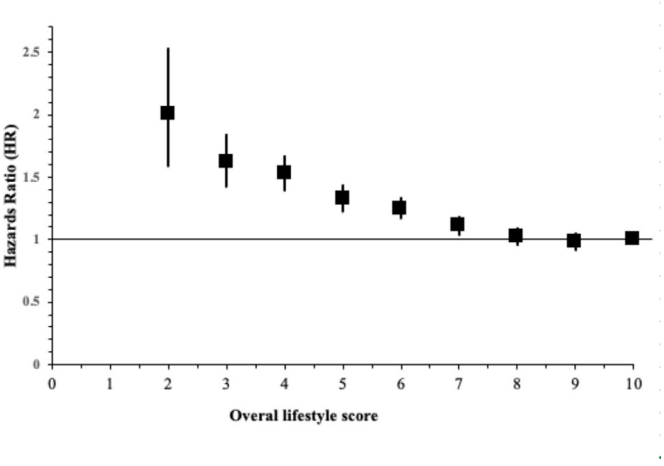

Figure 1 Association between overall lifestyle score and nursing home admission. Lifestyle score of 10 (most healthy) as the reference. Hazard ratios are calculated from Cox proportional hazard models based on multiple imputed data adjusted for remoteness, Socio-Economic Indexes for Areas (SEIFA) quintiles, marital status, country of birth, physical impairment, body mass index (BMI.) Note those with a lifestyle score of ≤2 are grouped together due to small number of participants with a score<2.

between medium and high-risk lifestyle groups and nursing home admission was similar to our main results. However, for those with severe impairment at baseline, people in the medium or high-risk lifestyle groups had 1.18 (95% CI 1.09 to 1.27) and 1.59 (95% CI 1.46 to 1.74) increased risk of nursing home admission, respectively (online supplemental table S4). Risk estimates of individuals with obesity, diabetes, cardiovascular disease and depression, the association between lifestyle risk groups and nursing home admission was similar to the main results (online supplemental table S4).

DISCUSSION

In this population-based prospective cohort study of Australians aged 60+, we found that one in seven older adults were in the high risk, least healthy lifestyle group, and had a 43% greater risk of nursing home admission compared with those in the healthiest lifestyle group. The association between lifestyle score and risk of nursing home admission followed a linear relationship with a 19% increased risk for each unit increment of unhealthy lifestyle score with a 101% increase in risk between the least and most healthy lifestyle score groups. Four of the five lifestyle factors (the exception being diet) were independently associated with nursing home admission, which was highest among current smokers. The association was modified by age and physical impairment. People in the youngest 60–64 year age group at baseline, and those with severe physical impairment and in the high-risk lifestyle group, had the greatest risk of nursing home admission. These findings highlight that lifestyle factors are important in relatively younger age group of 60–64 years and have less of an impact on nursing home admission in older age groups where other comorbidities may be driving nursing home admissions. It also highlights that even people with severe physical impairment can benefit from adherence to a healthy lifestyle.

Comparison with other studies

There are no previous data quantifying the individual and combined association of lifestyle factors with nursing home admission. Only one other previous study investigated the individual association of smoking and physical inactivity only with nursing home admission using the US National Health and Nutrition Examination Survey data and found similar results.[26] Smoking was associated with an increased risk of nursing home admission among both 45–64-year and 65–74-year olds. However, the association for inactivity was positive only among 45–64-year olds. However, other lifestyle factors investigated in the present study, including diet, sitting and sleep were not assessed in this previous study.

Our findings add to the growing body of work supporting healthy lifestyle factors as strong contributors of metabolic and cognitive health, successful and independent ageing, resulting in reduced likelihood of nursing home admission. For instance, Dhana *et al* reported that adhering to four or five healthy lifestyle factors for brain health (diet, cognitive activities, physical activity, smoking and alcohol intake) was associated with a 70% (95% CI 0.41 to 0.68) lower risk of Alzheimer's dementia in men and 66% (95% CI 0.53 to 0.81) lower risk in women, compared with participants who adhered to zero or one healthy lifestyle factor.[27] Li *et al* showed that a low-risk healthy lifestyle was associated with a longer life expectancy free of major chronic

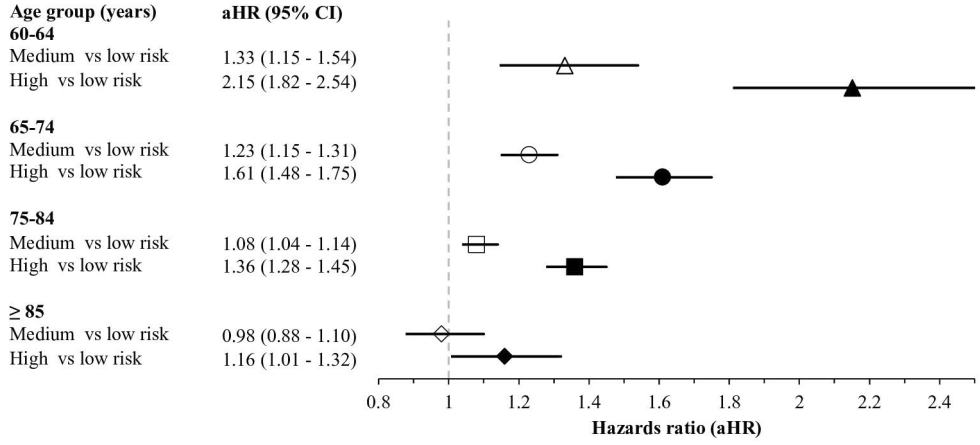

Figure 2 Association between overall lifestyle score and nursing home admission, stratified by age group. Hazard ratios are calculated from Cox proportional hazard models based on multiple imputed data adjusted for remoteness, SEIFA quintiles, marital status, country of birth, physical impairment, BMI. Hazard ratios (95% CIs) are for admission to nursing homes according to individual lifestyle variables and overall lifestyle score in an Australian population of people over 65 years, compared with low-risk groups.

diseases of 7.6 years in men and 10 years in women.[5] May *et al* reported that people who adhered to four healthy lifestyle factors (non-smoking, BMI <25 kg/m^2, physically active and adhered to Mediterranean diet) lived at least 2 years longer in good health compared with those who did not adhere to any.[28]

Given that just over half of people in residential aged care in Australia have dementia and most have high care needs in multiple domains, including activities of daily living, cognition and behaviour or complex healthcare,[29] the association of lifestyle risk factors with dementia is important.[30 31] There is recent evidence that frailty can contribute to dementia severity, and this might be driven by these underlying lifestyle risk factors.[32] Specific lifestyle factors such as poor sleep have been identified as a risk factor for cognitive decline.[33] However, the relationship appears to be bidirectional as older adults with dementia also exhibit sleep disturbances, including shorter sleep duration.[33] Therefore, we cannot rule out reverse causality in our study, whereby those who were in the high-risk group for sleep were affected as a result of cognitive decline.

Prolonged sitting has also been associated with all-cause and cardiovascular disease mortality. However, in contrast to a previous study using the same cohort which found that sufficient moderate to vigorous physical activity (equivalent to meeting current public health guidelines) offset the premature mortality risk of prolonged sitting,[34] in our study, sitting was independently associated with nursing home admission. Such a finding suggests that although sitting is not independently associated with premature death, it may have implications for independence into old age.

Strengths and weaknesses of the study

The strengths of our study include the large population-based sample and use of objective linked data to identify nursing home admission, avoiding issues of loss to follow-up and self-report. The use of administrative data to identify nursing home admission is novel, yet robust. Residents of a nursing home in Australia are usually assigned a GP (or maintain their usual GP) on admission. A recent report by the Australian Institute of Health and Welfare into health services usage among aged care residents in Australia found that, on average, a person in aged care has two GP visits per month.[35] The NSW APDC is a statutory state-wide, administrative data collection of all public and private hospital in-patient admissions. Therefore, the use of MBS and hospitalisation records to identify incident nursing home admission in this study affords a high degree of confidence. A weakness of this study is that we were not able to determine the reason for nursing home admission or the presence of comorbidities at the time of admission, which may provide valuable insights into the mechanisms by which unhealthy lifestyle factors increase the risk of nursing home admission. In addition, we did not take into account social isolation and loneliness, which has been recognised as an important determinant of mental and physical health in older adults.[36] Another limitation is that the lifestyle factors were self-reported and only measured at baseline, precluding a more granular assessment of the potential impact of trajectories of lifestyle behaviours. Furthermore, our dietary measure was not comprehensive and may be why we found no association with diet. It should also be noted that the overall response rate for the 45 and Up Study was 18%; however, estimates from the 45 and Up Study are consistent with other population-based studies, including the NSW Population Health Survey, which had a response rate of approximately 60%.[37] Finally, Australia's health and aged systems comprise a complex mix of service providers and funders, which may limit the generalisability of our findings.

Implications for practice and policy

Our findings highlight the potential of preventing or delaying nursing home admission among at-risk individuals during ageing with interventions that promote a healthy lifestyle. Although the long-term health benefits of lifestyle interventions in terms of chronic disease prevention are well known,[38 39] our data suggest that promoting a healthy lifestyle may also reduce the risk of nursing home admission. This could be a powerful motivator for many individuals to adopt or maintain a healthier lifestyle. Furthermore, our findings may also incentivise government investment in preventative healthcare and health promotion given the greater cost associated with caring for people in institutions. This will require a shift in health policy towards preventative health.

Conclusion

Lifestyle factors are strongly associated with the risk of long-term nursing home admission in men and women older than 60 years in an Australian setting. Taking into account the social and economic context of settings, strategies to improve lifestyle factors, including smoking cessation, reducing sitting time, increasing physical activity and improving sleep, should be explored as new public health measures to help reduce the future risk of nursing home admission.

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Acknowledgements This research was completed using data collected through the 45 and Up Study (www.saxinstitute.org.au). The 45 and Up Study is managed by the Sax Institute in collaboration with major partner Cancer Council NSW; and partners: the Heart Foundation; NSW Ministry of Health; NSW Department of Communities and Justice; and the Australian Red Cross Lifeblood. We thank the many thousands of people participating in the 45 and Up Study. We also acknowledge the support of the NSW Centre for Health Record Linkage (CHeReL; http://www.cherel.org.au).

Contributors AAG conceived the idea for the study. AAG, NN, JG, ES, LF, PAC, RIL contributed intellectual content to the study design and interpretation of the findings. JG conducted the analysis. AAG, JG and NN drafted the manuscript and all authors provided edits and comments. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. AAG is the guarantor.

Funding A.A.G, N.N, ES and L.F. are supported by Investigator Grants from the Australian National Health and Medicare Research Council (AAP1173784, APP1197940, APP1194510, APP1177797, respectively). L.F is also supported by the Australian Youth and Health Foundation, and the Philip Bushell Foundation. NN is also supported by the Financial Markets Foundation for Children. Funding bodies were not involved in the study design, data collection, analysis and interpretation of the data, the writing of the report, and in the decision to submit the paper for publication.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval The 45 and Up Study was approved by the University of NSW Human Research Ethics Committee and use of linked data for this study was approved by the NSW Population and Health Services Research Ethics Committee (Cancer Institute NSW reference: 2017/HRE0206). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

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