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Body mass index and socioeconomic position are associated with 9-year trajectories of multimorbidity: A population-based study☆

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ABSTRACT

Multimorbidity is a growing public health problem and is more common in women than men. However, little is known about multimorbidity trajectories, in terms of the accumulation of disease over time, or about the determinants of these trajectories. We sought to identify lifestyle and socioeconomic factors related to multimorbidity trajectories in mid-aged women. Participants were from the Australian Longitudinal Study on Women's Health, a nationally representative population-based study. We included 4865 women born 1946–51, without chronic disease in 1998, followed triennially for 12 years. We used latent class growth analysis to identify 9-year multimorbidity trajectories and multinomial regression to calculate relative risk ratios (RRRs) for associations between baseline lifestyle and socioeconomic factors and trajectories. We identified five multimorbidity trajectories: 'no morbidity, constant'; 'low morbidity, constant'; 'moderate morbidity, constant'; 'no morbidity, increasing'; and 'low morbidity, increasing'. Overweight and obesity were associated with an increased risk of the 'no morbidity, increasing' (RRR 1.70, 95% CI 1.16 to 2.50 and 2.69, 95% CI 1.69 to 4.28, respectively) and the 'low morbidity, increasing' (RRR 2.57, 95% CI 1.56 to 4.24 and 4.28, 95% CI 2.41 to 7.60, respectively) trajectories, as compared to the 'no morbidity, constant' group. Low education and difficulty managing on income were also associated with trajectories of poorer health. Among mid-aged women, overweight/obesity and lower socioeconomic status are major risk factors for trajectories characterised by accumulation of chronic disease. These highlight key target areas for preventive approaches aimed at reducing the risk of accumulation of morbidities in mid-aged women.

Introduction

The prevalence of chronic disease is increasing worldwide (Lozano et al., 2012; Murray et al., 2012). Together with increasing longevity (Christensen et al., 2009) this is leading to a growing burden of multimorbidity among mid-aged and older adults, which is more common in women (Barnett et al., 2012; Taylor et al., 2010).

The understanding of how multimorbidity – the presence of co-existing diseases – relates to health service use, management of disease and health outcomes has been a target of research over the past decade (Marengoni et al., 2011). In contrast, there has been little longitudinal research on the progression of multimorbidity over time, by which we mean the prospective study of the accumulation of multiple diseases as identified by repeat measuring of chronic disease occurrence over time (Hsu, 2015; Nagel et al., 2008; van den Akker et al., 2001). Furthermore, most studies of the determinants of multimorbidity have been cross-sectional (Marengoni et al., 2011), with few studies prospectively examining the effect of risk factors on the accumulation of conditions over time (Hsu, 2015). The development of, or increase in, multimorbidity will vary between individuals, with different profiles, or trajectories, likely to be differentially associated with service use, health outcomes and/or pre-morbid risk factors. For example, a particular risk factor may contribute to whether an individual develops no disease, develops a single disease without accumulation of additional diseases, or becomes progressively more multimorbid due to the accumulation of additional diseases. To our knowledge, only three studies have investigated multimorbidity trajectories to date. One assigned individuals to particular trajectory groups based on a multimorbidity index before relating trajectories to health service utilisation (Chang et al., 2011). A second compared trajectories, identified from hierarchical linear models, across ethnic groups (Quinones et al., 2011) and a third study used a multiple group-based trajectories approach to relate trajectories to baseline factors and successful ageing outcomes (Hsu, 2015). Therefore, few studies have prospectively investigated whether lifestyle or socioeconomic position (SEP) prior to the development of chronic diseases is associated with future multimorbidity trajectory as identified by repeat measure of chronic disease over time. Improved understanding of factors associated with accumulation of morbidities

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could identify high-risk individuals and inform preventative and management measures.

We therefore aimed to identify multimorbidity trajectories in a cohort of mid-aged women using an objective statistical method, and investigate how baseline lifestyle and socioeconomic factors relate to these trajectories.

Methods

Study setting and population

Participants were from the Australian Longitudinal Study on Women's Health (ALSWH), a national population-based study of women born in 1921–26, 1946–51 and 1973–78. Women were randomly selected from the Medicare database, which covers all citizens and permanent residents of Australia, including refugees and immigrants. We included women from the 1946–51 cohort who were surveyed using self-administered questionnaires in 1996 (survey 1 (S1), $N = 13{,}715$), 1998 (survey 2 (S2), $N = 12{,}338$ (90% response rate)), and triennially until 2010 (survey 6 (S6), $N = 12{,}023$ (83% response rate)). Full details of recruitment and response rates for all surveys are reported elsewhere (Lee et al., 2005).

Multimorbidity outcome

We included women free from chronic conditions at S2. Disease status was determined from a question that asked "Have you ever been told by a doctor that you have?" to a list of 18 conditions, to which the women completed two response columns. The first asked "Yes, in the last 2 years" the second "Yes, more than 2 years ago". A briefer question about a smaller list of chronic conditions was also asked 2 years earlier, at S1, and these data were used to verify the women's responses to some of the items at S2. The ALSWH surveys are available at http://www.alswh.org.au/for-researchers/surveys.

We used women's responses at S3 to S6 to determine the total number of conditions at each time point, including only those conditions that were enquired about at all four surveys. Women were asked if they had been diagnosed with or treated for each of the following conditions in the past 3 years: diabetes; impaired glucose tolerance; osteoarthritis; rheumatoid arthritis; other arthritis; heart disease; hypertension; stroke; asthma; bronchitis or emphysema; osteoporosis; breast cancer; cervical cancer; other cancer; depression; anxiety or nervous disorder; other psychiatric condition and chronic fatigue syndrome. We grouped all cancers together. Women were also asked about the occurrence of symptoms of depression and anxiety, and asked to indicate whether symptoms had occurred 'never', 'rarely', 'sometimes' or 'often' in the past 12 months. If women reported that they had experienced depression or anxiety 'often' this was incorporated into the 'depression' or 'anxiety or nervous disorder' disease variables. From S5 onwards the occurrence of specific types of arthritis was collected, whereas in earlier surveys we enquired about arthritis in general, therefore we created a category of 'any arthritis' for S5 and S6, to maintain consistency.

Exposures

Lifestyle exposure variables were derived from information provided at S2. Smoking was classified as never, ex-smoker or current smoker. Body mass index (kg/m^2) was computed as self-reported weight (kg)/height (m^2). We used the WHO international BMI classification to also categorise women as underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2) or obese (≥30 kg/m^2). Physical activity was assessed using a modified version of the Active Australia Physical Activity Survey (Brown et al., 2008). Women were asked to report frequency and total duration of walking, moderate, and vigorous intensity leisure time physical activity during the last week. A physical activity score in metabolic equivalent (MET) minutes per week was derived using the following formula: MET min/week = (walking minutes * 3.5 METs) + (moderate minutes * 4.0 METs) + (vigorous minutes * 7.5 METs). Physical activity was categorized as sedentary (0–39 MET min/week), low (40–599 MET min/week), moderate (600–1199 MET min/week) and high (≥1200 MET min/week). Alcohol intake was defined in light of the Australian National Health and Medical Research Council (NHMRC) guidelines with 'Risky drinkers' (15 to 28 drinks per week) and 'High risk drinkers' (more than 28 drinks per week) categorised accordingly (Australian National Health Medical Research Council, 2001). Given the low frequency of high-risk drinkers, the latter two groups were combined for analyses. For women identified as low risk by the NHMRC guidelines, we separately categorised women who reported that they drink only rarely (any alcohol consumption less than once a month) and non-drinkers, with the remainder classified as low-risk drinkers (up to 14 drinks per week).

SEP was determined using measures collected at S1 or S2. Education level, collected at S1, was classified as high (university degree or diploma), middle (trade/apprenticeship or high school qualification(s)) or low (no formal qualifications). Own occupation, also collected at S1, was categorised as high (manager/professional/paraprofessional), middle (trade/administrative service) or low (manual worker). For completeness, a fourth category of women who reported having never worked or having an 'other' occupation was included. At S2, women were also asked how well they managed on their income and could respond 'easy', 'not too bad', 'difficult sometimes', 'difficult all of the time' or 'impossible'; we combined 'easy' and 'not too bad' to give three categories. Area of residence at S2 (urban or rural/remote) was adjusted for in the statistical modelling since women from rural/remote areas were deliberately oversampled to ensure sufficient representation from less populated areas.

Statistical analyses

We used Mplus to perform latent class growth analysis (LCGA) to identify trajectories of multimorbidity from S3 to S6, based on the numerical total of the number of conditions reported at each survey (Muthén and Muthén, 2010). LCGA models were fitted successively, starting with a one-group model (which assumed that all women experienced the same multimorbidity pattern over time) and adding another group for each successive model (Muthén, 2002). The optimal number of clusters was determined using the Bayesian information criterion and the Lo–Mendel–Rubin statistic. The relative sizes and substantive meaningfulness of the latent classes and the degree of separation of the latent classes were also taken into consideration (Nylund et al., 2007). Mplus uses the full-information maximum likelihood algorithm for handling missing data (Muthén and Muthén, 2010). LCGA was performed using the following syntax in Mplus. Analysis: Type = mixture; starts 200 15 50 250; estimator = mlr; MODEL: %OVERALL i s q | s3tmultimorbidy@0 s4tmultimorbidy@1 s5multimorbidity@2 s6multimorbidy@3.

We used multinomial logistic regression to relate lifestyle and SEP factors to subsequent morbidity trajectories. The estimated population average relative risk ratios (RRRs), with accompanying confidence intervals (CIs) reflect the association between baseline risk factors and multimorbidity trajectory from S3 to S6. The RRRs are interpreted as the association between the risk factors and each multimorbidity trajectory as compared to a referent trajectory group ('no morbidity'). In adjusted analyses we controlled for age, all other risk factors and area of residence (urban, rural or remote). We included BMI in separate models as a continuous and categorical variable.

Given that exposure variables had some missing data, we performed a sensitivity analysis where we performed multiple imputation by chained equations for these missing values before performing the multinomial logistic regression. We obtained almost identical results and therefore presented the results of the primary analysis on complete cases (results of imputed data analyses available on request).

Results

Among 13,715 women recruited at S1, 12,338 (90%) returned S2. Of 12,329 with completed data on chronic conditions, 5137 were 'disease-free' at S2 and had a healthier lifestyle and higher SEP compared to those with one or more condition (and who were therefore not included) (Table 1). After excluding 272 women who did not return any of the subsequent surveys or returned incomplete data on disease occurrence, we included 4865 women with a mean age of 49.5 (±1.44) years in the latent class analysis (Fig. S1).

We identified five multimorbidity trajectories (Fig. 1), which we labelled as: 'no morbidity, constant' ($N = 3107$, 64%); 'low morbidity, constant ($N = 1139$, 23%); 'moderate morbidity, constant' ($N = 318$, 6.5%); 'no morbidity, increasing' ($N = 181$, 3.7%); and 'low morbidity, increasing' ($N = 120$, 2.5%). The latter two represent the trajectories characterised by accumulation of disease. The baseline prevalence of current smoking, physical inactivity, overweight and obesity, risky/high-risk alcohol intake and low education and difficulty managing on