Research Paper

Self-reported incidence and age of onset of chronic comorbid medical conditions in adults aging with long-term physical disability

Amanda E. Smith, B.S.*, Ivan R. Molton, Ph.D., and Mark P. Jensen, Ph.D.

Department of Rehabilitation Medicine, University of Washington, Seattle, WA 98195, USA

Abstract

Background: Adults with long-term disability are living longer and may experience accelerated aging. More information is needed to understand the incidence of chronic comorbid medical conditions in this population.

Objective: To examine the incidence, prevalence, age of onset and predictors of five chronic conditions in a sample of adults with long-term physical disability.

Methods: Longitudinal self-report surveys were mailed to 1594 adults with multiple sclerosis, muscular dystrophy, post-polio syndrome or spinal cord injury twice, 3.5 years apart. Survey questions assessed demographics (date of birth, sex, income, disability type, height/weight), self-reported diagnosis of coronary heart disease, hypertension, arthritis, diabetes and cancer, and health behaviors (alcohol use, smoking, physical activity).

Results: Over the course of the study, the most commonly reported new onset chronic comorbid medical condition was arthritis (percent incidence = 14%), followed by hypertension (9%) and cancer (7%). Report of a new condition was greatest in adults aged between 56 and 65 years, and risk factors included greater BMI, waist circumference, and the presence of another chronic comorbid medical condition at baseline.

Conclusions: Chronic comorbid medical conditions are prevalent in persons with long-term physical disability. Midlife appears to be the period of greatest risk for onset of a new condition, and risk for incidence increases in the presence of other chronic comorbid medical conditions. Modifiable risk factors include BMI and waist circumference. Future research should explore whether changes in modifiable factors at midlife or earlier (e.g., diet, exercise) would help prevent or delay onset of comorbid conditions in this population. © 2016 Elsevier Inc. All rights reserved.

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The aging of the U.S. population puts considerable pressure on the health care system to manage chronic comorbid medical conditions. This is also true in persons aging with physical disabilities, typically acquired in young adulthood, including post-polio syndrome (PPS), multiple sclerosis (MS), spinal cord injury (SCI) and neuromuscular disease (MD). These individuals may experience increased longevity in combination with accelerated aging of organ systems.[1–4]

Although much is known about the prevalence of chronic comorbid medical conditions in the general population, less is known regarding the incidence of these conditions in adults aging with these long-term physical disabilities.

Knowledge regarding incidence, prevalence and predictors of these chronic comorbid conditions in individuals with disabilities is vitally important. Cardiovascular disease is the leading cause of death in the U.S., followed by cancer, while arthritis is the leading cause of disability. Hypertension and diabetes are both significant risk factors for cardiovascular disease, as are obesity and physical inactivity.[5] Adults with physical disabilities may be at an increased risk for the development of these chronic comorbid conditions, due to limited mobility, medication side-effects or secondary conditions related to their disability. Understanding the age of onset and risk factors for these conditions in adults with disabling conditions is also important in guiding the development of programs and services to reduce the risk of developing these conditions and improve health and wellness in this community.

Objective

To address the knowledge gap in this area, we sought to evaluate self-reported incidence and risk factors for developing five common chronic comorbid medical conditions in a national sample of adults with long-term physical disability (SCI, MD, PPS, and MS).

Methods

Procedures

Participants were recruited into the study through invitations to disability specific research registries (the University of Washington Department of Rehabilitation Research Registry, the Northwest Spinal Cord Injury Model Systems, and the University of Rochester Muscular Dystrophy Registry), as well as through print and web advertisements. Eligible participants were 18 years or older with a self-reported physician's diagnosis of MS, MD, PPS or SCI, and were able to read and understand English. Paper surveys and consent forms were mailed to 2041 interested and eligible participants across the United States. Upon receipt of a signed consent and completed survey, staff reviewed the survey for missing data, and followed up by phone as needed. Non-responders were sent a reminder letter 4 weeks after their survey mailing and an additional follow-up phone call if the survey was still not received 6 weeks after mailing. All participants were sent $25 for their time and effort.

All participants were sent a survey in year 1 (T1) and approximately 3.5 years later (T2). In year 1, 1877 surveys were returned between July, 2009 and April, 2010. After accounting for missing consent or data, fifteen surveys were excluded, resulting in a final T1 data set of 1862 surveys. Two hundred seventy participants withdrew from the study by T2 or submitted incomplete data, yielding a final data set for this longitudinal analysis of 1594 participants (data collection from August, 2012 through March, 2013). All procedures were approved by the University of Washington Institutional Review Board.

Measures

Demographic and medical descriptive variables

Participants reported their date of birth, sex, height, weight, waist circumference, household income, highest level of completed education, race, and disability type (MS, MD, PPS or SCI).

Presence of comorbid conditions

Questions taken from the 2009 National Health Interview Survey (NHIS)[6] were used to collect information on self-reported diagnoses of coronary heart disease, hypertension, cancer, diabetes or arthritis. Participants were asked whether they had "… ever been told by a doctor or other health professional that [they had]" any one of the chronic comorbid conditions, by responding "yes," "no" or "don't know." These conditions were selected based on their high prevalence in older adults.[5,7–10]

Health risk factors

Participants were also asked to report on their alcohol consumption, use of smoking tobacco, and physical activity. Problematic alcohol use was screened using the 3-item Alcohol Use Disorders Identification Test (AUDIT-C). This is a well validated 3-item screening measure, with a higher score indicating greater risk of hazardous consumption and possible active alcohol use disorder.[11] Smoking (tobacco) was assessed using questions taken from the 2009 National Health Interview Survey.[6] Participants were categorized into smokers (1) if they endorsed currently smoking some days or every day or non-smokers (0) if they did not endorse smoking on at least some days. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ) short form, which assesses time spent walking or engaging in moderate and vigorous physical activity.[12] The IPAQ generates total metabolic equivalent counts (METs), with higher scores indicating greater engagement in physical activity.

Analytic approach

To describe the sample, we first computed means and standard deviations (or rates, as appropriate) of age, sex, ethnicity, disability type, and education level. Prevalence of comorbid conditions was based on reported endorsement of each chronic comorbid condition at T1 and T2, including only participants who completed both surveys ($n = 1594$). Significant differences in prevalence rates from T1 to T2 were assessed by computing the McNemar's statistic for each condition. For purposes of analysis, self-reported incidence was established by identifying participants who a) did not endorse diagnosis of a particular condition at T1, and b) did endorse a diagnosis of that same condition at T2 (3.5 years later). For these participants, the mean age at T2 represented the approximate average age by which these conditions emerged. Participants who reported conflicting information (e.g. reporting "yes" to ever being diagnosed with cancer at T1 and "no" at T2) and who could not be contacted for follow-up were not included in the analyses.

The effect of behavioral or demographic risk factors measured at T1 on incidence by T2 was evaluated by comparing those who did, versus those who did not, develop a new condition over the 3.5 year period. Participants who developed a new onset were participants who did not endorse a condition at T1, but did endorse that same condition at T2. Those considered "non-developers" were defined as participants who did not endorse the condition at either T1 or T2. Risk factors were evaluated using independent sample *t*-tests (for continuous predictors) and

Table 1
Incidence of conditions reported at the initial assessment (T1) and 3.5 years later (T2)

| Condition | Incidence from T1−T2 (new conditions: $N = 427$) | | Prevalence N (% of total sample) | | McNemar's test |
	N (% of total new conditions)	% incidence[a]	T1[b] ($N = 1594$)	T2 ($N = 1594$)	$N = 1594$
Hypertension	92 (22%)	92/984 = 9%	610 (38%)	702 (44%)	90.0*
Coronary heart disease	37 (9%)	37/1513 = 2%	81 (5%)	117 (7%)	32.2*
Cancer	89 (21%)	89/1371 = 7%	223 (14%)	312 (20%)	87.0*
Diabetes	39 (8%)	39/1468 = 3%	126 (8%)	160 (10%)	31.6*
Arthritis	170 (40%)	170/1036 = 16%	558 (35%)	727 (46%)	165.1*

*$p < 0.001$.
[a] Percent Incidence is defined as the portion of participants who reported a new condition from T1−T2/all participants who did not endorse the condition at T1.
[b] T1 prevalence includes only participants who participated in both survey time points.

Pearson's chi-squares (for categorical predictors). Based on previous research, risk factors examined in the present study were: body mass index (calculated from height and weight), waist circumference, physical activity (IPAQ Total METs), sex, age, annual household income, smoking, alcohol consumption, disability diagnostic group, and the reported diagnosis of at least one other chronic comorbid condition at T1.

Results

Study participants

The mean age of participants at T2 was 56 (SD 13.0) years, and 64% of the sample was female ($n = 1016$). On average, participants completed their T2 survey approximately 3.5 years after completing their T1 survey. Thirty two percent of participants were living with MS ($n = 509$), 26% with SCI ($n = 414$), 24% with PPS ($n = 389$), and 18% with MD ($n = 282$). Just over half of the participants had received at least a bachelor's degree (57%; $n = 904$), and the sample identified primarily as White/Caucasian (91%; $n = 1454$).

Prevalence of chronic comorbid medical conditions

Prevalence findings and tests for significant differences in prevalence from T1 to T2 are presented in Table 1. The most commonly endorsed chronic comorbid conditions were hypertension ($n = 702$, 44% of the total sample at T2) and arthritis ($n = 727$, 46% of the total sample at T2), followed by cancer ($n = 312$, 20% of the total sample at T2), diabetes ($n = 160$, 10% of the total sample at T2) and coronary heart disease ($n = 117$, 7% of the total sample at T2). Regarding comorbidity at T2, 1116 participants reported having at least one CCMC. Of those, 623 participants (56%) reported having two or more CCMCs, 212 (19%) reported having at least three conditions, and 60 participants (5%) reported 4 conditions or more.

Incidence and age at onset

Incidence findings for all five chronic comorbid conditions are presented in Table 1. Arthritis was the most commonly reported new condition, making up 40% of all newly reported conditions. Among those who did not report arthritis at T1 ($N = 1036$), 170 reported having this condition it at T2, suggesting an incidence rate of 16% in the sample during the 3.5 year study period. The average age of those reporting new onset of arthritis during the study period was 61 years (at T2). Hypertension was the second most commonly reported new onset condition (22% of all newly reported conditions). Of the 984 who did not report hypertension at T1, 92 reported a new onset by T2 (new incidence rate of 9%). The average age at T2 for individuals reporting a new onset of hypertension was 59. Cancer was the third most common new diagnosis, and made up 21% of all newly reported diagnoses. Of 1371 individuals who did not report a history of cancer at T1, 89 reported it at T2 (7% new incidence rate, with an average age of 65 at T2). Less commonly reported new conditions included coronary heart disease (9% of all newly reported conditions, $n = 37/1513$; 2% incidence, with an average age of 66 at T2) and diabetes (8% of all newly reported conditions; $n = 39/1468$; 3% incidence, with an average age of 63 at T2).

Predictors of new onset chronic comorbid condition

Results of t-test comparisons are presented in Table 2 and chi square comparison results are presented in Table 3. Overall, age, the presence of at least one other chronic comorbid condition at T1, and waist circumference were significant predictors for most conditions. Age was significantly related to the new onset of coronary heart disease and cancer. To further explore this relationship, we computed Pearson's chi-square statistics between the new onset of a chronic comorbid condition and age, subdivided into cohorts (≤35, 36−45, 46−55, 56−65, 66−75, and ≥76). Participants between the ages of 56 and 65 were significantly more

Table 2
Continuous predictors of new onset hypertension, coronary heart disease, cancer, diabetes and arthritis

Predictor	Hypertension new onset	Coronary heart disease new onset	Cancer new onset	Diabetes new onset	Arthritis new onset
Age	Yes: 56.1 (12.0)	Yes: 62.5 (11.3)	Yes: 61.6 (10.9)	Yes: 60.0 (12.0)	Yes: 57.4 (11.3)
	No: 56.0 (13.0)	No: 55.9 (12.9)	No: 55.7 (13.0)	No: 55.9 (12.9)	No: 55.8 (13.1)
	t(df) = −0.05 (1592)	t(df) = −3.1 (1592)**	t(df) = −4.26 (1592)***	t(df) = −1.93 (1592)	t(df) = −1.49 (1592)
BMI	Yes: 26.4 (5.3)	Yes: 26.3 (5.2)	Yes: 27.2 (7.7)	Yes: 30.4 (6.4)	Yes: 26.4 (7.2)
	No: 26.4 (6.3)	No: 26.4 (6.3)	No: 26.3 (6.2)	No: 26.3 (6.2)	No: 26.4 (6.2)
	t(df) = −0.09 (1585)	t(df) = 0.08 (1585)	t(df) = −1.23 (1585)	t(df) = −4.07 (1585)***	t(df) = −0.04 (1585)
Waist circumference	Yes: 35.3 (6.0)	Yes: 35.8 (5.3)	Yes: 36.8 (6.9)	Yes: 39.6 (5.6)	Yes: 35.6 (6.6)
	No: 35.3 (5.9)	No: 35.3 (6.0)	No: 35.2 (5.9)	No: 35.2 (5.9)	No: 35.3 (5.9)
	t(df) = 0.03 (1518)	t(df) = −0.56 (1518)	t(df) = −2.35 (1518)*	t(df) = −4.61 (1518)***	t(df) = −0.58 (1518)
Income	Yes: 3.9 (2.2)	Yes: 3.5 (2.1)	Yes: 3.6 (2.1)	Yes: 3.2 (2.1)	Yes: 3.5 (2.1)
	No: 3.6 (2.1)	No: 3.6 (2.1)	No: 3.6 (2.1)	No: 3.6 (2.1)	No: 3.6 (2.2)
	t(df) = −1.16 (1520)	t(df) = 0.36 (1520)	t(df) = 0.17 (1520)	t(df) = 1.14 (1520)	t(df) = 0.77 (1520)
Alcohol use	Yes: 2.0 (2.1)	Yes: 1.9 (2.0)	Yes: 1.5 (1.9)	Yes: 1.0 (1.3)	Yes: 1.6 (1.9)
	No: 1.7 (2.0)	No: 1.7 (2.0)	No: 1.7 (2.0)	No: 1.7 (2.0)	No: 1.7 (2.0)
	t(df) = −1.4 (1589)	t(df) = −0.8 (1589)	t(df) = 0.8 (1589)	t(df) = 3.2 (1589)**	t(df) = 0.9 (1589)
IPAQ METs	Yes: 1857.8 (1756)	Yes: 1317.0 (1134)	Yes: 1705.6 (1818)	Yes: 1478.7 (1617)	Yes: 1608.5 (1819)
	No: 1669.5 (1806)	No: 1689.6 (1815)	No: 1679.4 (1802)	No: 1685.5 (1807)	No: 1608.5 (1668)
	t(df) = −0.85 (1173)	t(df) = 1.69 (1173)	t(df) = −0.11 (1173)	t(df) = 0.59 (1173)	t(df) = 0.49 (1173)

*$p \leqslant 0.05$; **$p < 0.01$; ***$p < 0.001$.

likely to report a new onset of coronary heart disease ($x^2 = 11.74$; $p = 0.04$) or cancer ($x^2 = 16.53$; $p = 0.01$). In addition, participants who endorsed at least one other chronic comorbid condition at T1 were more likely to report an incidence of hypertension ($x^2 = 45.69$; $p = 0.000$), coronary heart disease ($x^2 = 4.90$; $p = 0.03$), cancer ($x^2 = 32.13$; $p = 0.000$), diabetes ($x^2 = 9.46$; $p = 0.002$), and arthritis ($x^2 = 61.93$; $p = 0.000$) at T2. Waist circumference was significantly related to new onset of cancer [$t(1518) = −2.35$; $p = 0.02$] and diabetes [$t(1518) = −4.61$; $p = 0.00$], such that those who endorsed

a new onset reported a larger waist circumference. In addition, and consistent with this finding, participants reporting a larger BMI were more likely to report a new onset of diabetes [$t(1585) = −4.07$; $p = 0.00$]. Diagnostic group was significantly related to new onset of coronary heart disease ($x^2 = 16.76$; $p = 0.001$) and cancer ($x^2 = 8.68$; $p = 0.03$). A greater percentage of participants with muscular dystrophy reported a new onset of coronary heart disease, while a greater percentage of participants with post-polio syndrome reported a new onset of cancer. Alcohol use was significantly associated with a reported new onset of

Table 3
Categorical predictors of new onset hypertension, coronary heart disease, cancer, diabetes and arthritis

	Hypertension new onset		Coronary heart disease new onset		Cancer new onset		Diabetes new onset		Arthritis new onset	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Gender										
Men	41 (7%)	536 (93%)	19 (3%)	558 (97%)	32 (5%)	545 (95%)	18 (3%)	559 (97%)	52 (9%)	525 (91%)
Women	51 (5%)	965 (95%)	18 (2%)	998 (98%)	57 (6%)	959 (94%)	21 (2%)	995 (98%)	117 (12%)	889 (88%)
	$x^2 = 2.94$		$x^2 = 3.75$		$x^2 = 0.00$		$x^2 = 1.71$		$x^2 = 2.43$	
≥1 other CCMC										
Yes	46 (13%)	301 (87%)	27 (3%)	851 (97%)	67 (9%)	669 (91%)	30 (4%)	809 (96%)	83 (21%)	305 (79%)
No	46 (4%)	1201 (96%)	10 (1%)	706 (99%)	22 (3%)	836 (97%)	9 (1%)	746 (99%)	87 (7%)	1119 (93%)
	$x^2 = 45.69$***		$x^2 = 4.90$*		$x^2 = 32.13$***		$x^2 = 9.46$**		$x^2 = 61.93$***	
Currently smoking										
Yes	13 (8%)	153 (92%)	4 (2%)	162 (98%)	11 (7%)	155 (93%)	3 (2%)	163 (98%)	17 (10%)	149 (90%)
No	79 (6%)	1342 (94%)	33 (2%)	1388 (98%)	78 (5%)	1343 (95%)	36 (2%)	1385 (98%)	153 (11%)	1268 (89%)
	$x^2 = 1.41$		$x^2 = 0.01$		$x^2 = 0.36$		$x^2 = 0.33$		$x^2 = 0.04$	
Diagnostic group										
MS	38 (8%)	471 (92%)	6 (1%)	503 (99%)	24 (5%)	485 (95%)	6 (1%)	503 (99%)	56 (11%)	453 (89%)
MD	13 (5%)	269 (95%)	14 (5%)	268 (95%)	15 (5%)	267 (95%)	11 (4%)	271 (96%)	29 (10%)	253 (90%)
PPS	15 (4%)	374 (96%)	13 (3%)	376 (97%)	33 (9%)	356 (91%)	13 (3%)	376 (97%)	44 (11%)	345 (89%)
SCI	26 (6%)	388 (94%)	4 (1%)	410 (99%)	17 (4%)	397 (96%)	9 (2%)	405 (98%)	41 (10%)	373 (90%)
	$x^2 = 6.21$		$x^2 = 16.76$**		$x^2 = 8.68$*		$x^2 = 7.36$		$x^2 = 0.53$	

*$p \leqslant 0.05$; **$p < 0.01$; ***$p < 0.001$.

diabetes, such that individuals reporting an incidence of diabetes reported less alcohol consumption [$t(1589) = 3.2$; $p = 0.003$]. The measures of physical activity and smoking were not significantly related to the new onset of any chronic comorbid condition over the 3.5 year time period.

Discussion

Costs associated with chronic comorbid medical conditions exceed $100 billion annually.[5] Effective prevention and treatment efforts are crucial to the health and wellness of the population. It is important to understand the incidence of these conditions in adults with long-term physical disability and the age at which they present in order to provide adequate treatment and understand when prevention efforts are most needed.

Consistent with data taken from the general U.S. population, the most prevalent chronic comorbid medical conditions in our sample of people with long-term physical disabilities were arthritis and hypertension. Nearly two-thirds of our participants reported having one of those 2 conditions. Arthritis and hypertension were also the most common conditions to be reported as having new onset over course of the study, followed closely by cancer. Cancer was the third most prevalent condition, followed by diabetes and coronary heart disease. The rank order of these conditions in terms of prevalence was broadly consistent with the general population.[5,10] However, prevalence rates of common chronic comorbid conditions were slightly higher in our sample of persons with long-term physical disabilities,[7,9] consistent with the findings of other researchers.[2,13] These findings speak to a greater need for public health attention focused on chronic disease prevention for individuals with disabilities.

Even during the relatively short span of data collection in the initial waves of this ongoing long-term longitudinal survey study, we were able to see the emergence of a number of new comorbid conditions during middle-age in persons with disabilities. Among those who entered the study without a condition, when new chronic comorbid conditions did appear, they did so most often between the ages of 53 and 62 years. Specifically, participants who were between the ages of 56 and 65 at T2 were significantly more likely than those who were younger or older to report a new incidence of coronary heart disease or cancer within the last 3.5 years of the study. This finding is broadly consistent with data from the general U.S. population.[7,8,10]

Importantly, the presence of one or more chronic comorbid medical conditions at T1 was a significant predictor of the onset for additional chronic comorbid medical conditions during the study period. This was true for all 5 chronic comorbid conditions studied, and was by far the strongest predictor of incidence. Larger waist circumference or greater BMI were also significant predictors for the onset of cancer or diabetes. These findings add to the growing literature emphasizing the importance of targeting modifiable health risk factors during midlife in people with disability, especially among those who have already developed a chronic comorbid medical condition. Though a significant relationship was found between alcohol use and those reporting an incidence of diabetes, this relationship was in the opposite direction as expected by researchers. Adults who reported an incidence of diabetes were consuming significantly less alcohol than those who did not report an incidence. This finding may be in agreement with other studies reporting a protective factor among moderate alcohol consumption, but this finding merits further analysis to study the differences in diabetes incidence among light, moderate and heavy drinkers.[14,15]

Limitations

This study is limited in its self-reported nature. Because of this, it is possible that some of the participants misreported their diagnosis at either time point, or that participants were living with a condition before a physician's diagnosis. The majority of the responders in our sample also identified as Caucasian/White, and a subset of participants were recruited through research registries, comprised of adults who are willing to participate in research trials. These factors may subsequently reflect a responder bias. Future research should examine incidence and predictors of chronic comorbid medical conditions reported by non-white responders. This study would also benefit from an extended longitudinal design (the current study is ongoing), as 3.5 years was a relatively short time period in which to measure new onset of conditions and risk factors associated with new onset. Finally, the chronic comorbid medical conditions and risk factors assessed in this study were by no means comprehensive, and greater specificity (i.e., more indepth investigations of the relationships among predictors for particular conditions in specific disability groups) is warranted.

Conclusion

Taken together, the findings highlight the need for clinicians and service providers to intervene during midlife for persons with long-term physical disability, especially when that individual presents with another chronic comorbid condition. While several risk factors are not modifiable, others (such as BMI and waist circumference) may be viable targets for behavioral intervention. A number of programs are available to prevent the development of chronic comorbid conditions in able-bodied older adults.[16] These could potentially be modified and tested to develop an evidence base for preventing (or delaying the onset of) new chronic comorbid conditions in middle-aged individuals with long-term physical disability. Future research should also address potential onset and prevalence differences between sex and disability type in adults with long-term physical disability.

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