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Aging with a disability: A systematic review of cardiovascular disease and osteoporosis among women aging with a physical disability

Andrea L. Rosso, MPH^a, Jennifer Pelt Wisdom, PhD MPH^b, Willi Horner-Johnson, PhD^c, Marjorie G. McGee, MS^d, and Yvonne L. Michael, ScD SM^e

Andrea L. Rosso: alr44@drexel.edu; Jennifer Pelt Wisdom: jwisdom@pi.cpmc.columbia.edu; Willi Horner-Johnson: hornerjo@ohsu.edu; Marjorie G. McGee: marjoriemcgee@msn.com; Yvonne L. Michael: ylm23@drexel.edu

^aDrexel University School of Public Health, Department of Epidemiology and Biostatistics, Philadelphia, PA, USA

^bColumbia University and New York State Psychiatric Institute, New York, NY, USA

^cOregon Health & Science University, Portland, OR, USA

^dSchool of Social Work, Portland State University, Portland, OR, USA

^eDrexel University School of Public Health, Department of Epidemiology and Biostatistics, Philadelphia, PA, USA

Abstract

Compared to men, women live longer but experience greater morbidity as they age. However, little is known about the rapidly growing population of women aging with disability. Women aging with disabilities may encounter barriers that increase risk of morbidity, including lack of access to medical care or inadequate assistance, equipment, or services. To evaluate risks of morbidity in this group, we conducted a systematic review focused on two important and prevalent conditions: cardiovascular disease (CVD) and osteoporosis. MEDLINE was searched for reports published between January 1, 1990 and August 6, 2010 and additional studies were identified through searches of bibliographies. 9,156 abstracts and 93 articles were reviewed to identify empirical studies of women with physical disability who were 45 years or older and that reported CVD or osteoporosis as an outcome and not a cause of the disability. Articles meeting inclusion criteria were then critically appraised to exclude poor quality studies. In seven articles that evaluated CVD outcomes, we found limited evidence to support an increased risk of prevalence of CVD or risk factors for CVD in women aging with physical disabilities compared to non-disabled control populations. The literature is limited by small sample sizes that reduced statistical power to detect true differences. No articles meeting inclusion criteria were identified to evaluate osteoporosis risk

Corresponding Author: Andrea L. Rosso, Drexel University School of Public Health, Department of Epidemiology and Biostatistics, 1505 Race Street, Mail Stop 1033, Bellet 6th Floor, Philadelphia, PA, 19102 USA, ; Email: alr44@drexel.edu, phone: 001-215-546-0130, fax: 001-215-762-1174

Conflicts of Interest

No author has any conflict of interest to disclose.

Contributions

All authors contributed to study design and manuscript writing. Andrea Rosso completed abstract and article review and data abstraction. Jennifer Wisdom, Willi Horner-Johnson and Yvonne Michael contributed to abstract review.

in this group. This review is limited by the narrow focus on physical disabilities and two health outcomes. Additional high quality empirical research is necessary to understand the risks to health of women aging with disabilities.

Keywords

physical disability; women; aging; cardiovascular disease; osteoporosis

1. INTRODUCTION

Medical management of disabling conditions has greatly improved in the past several decades, resulting in greater likelihood of women with physical disabilities reaching midlife and beyond. An estimated 11.3 million women aged 18 years and older in the United States have a physical disability (1). Need for assistance in daily activities among women increases with age; 1.7% of women age 18 to 44 need assistance compared to 46.4% of women aged 45 and older (2). The Institutes of Medicine (IOM) defines disability as “inability or limitation in performing socially defined activities and roles expected of individuals within a social and physical environment” (3). In turn, a functional or physical limitation is a “restriction or lack of ability to perform an action or activity in the manner or within the range considered normal that results from impairment” (3). However, operational definitions of disability and limitations used in much of the existing literature are inconsistent (4).

Women live longer but face a greater risk of morbidity and disability as they age compared to men (5–6). Heart disease is the leading cause of death among women, accounting for a quarter of deaths among women of all ages (7). In addition, cerebrovascular disease or stroke is the third most common cause of death, responsible for 6.7 percent of deaths among women (7). Osteoporosis is a major health burden and cause of morbidity among aging women. Approximately one-third of post-menopausal women in the US have osteoporosis (8). Prevalence of osteoporosis is higher among women compared to men and increases with age (8).

As the lifespan of women with disabling conditions has increased, it is important to understand the risk of experiencing CVD and osteoporosis among women with physical disabilities. Women with physical disabilities may face an increased burden of these conditions compared to women without disability due to reduced physical activity, economic and social stress, or health care disparities (4). This review evaluated the burden of CVD and osteoporosis among women with physical disabilities. Specifically, we developed three key questions to evaluate how these two common conditions among aging women may be affected by the process of aging with a physical disability:

- a. What is the prevalence of the condition among women with physical disabilities and how does this differ from the prevalence for women without disability?
- b. How common are risk factors for the condition among women with physical disabilities and is this different from women without disability?

- c. Are there factors that modify the relation between physical disability and the condition?

2. METHODS

Articles were identified through a search of MEDLINE between January 1, 1990 and August 6, 2010. Two searches were conducted including terms for physical or mobility disabilities; the first search also included terms for cardiovascular disease and the second included terms related to osteoporosis (see supplementary table 1). The focus of these searches was the presence of documented disability rather than the presence of potentially disabling conditions. Both searches were restricted to English language articles and to those including human adults aged 45 or older.

Abstracts identified in these searches were reviewed by one of the research team members with 10% of abstracts selected randomly for dual review. Inclusion and exclusion criteria were used to determine eligibility of abstracts for further review. Inclusion criteria were 1) the study sample included women with a documented chronic physical disability and female-specific assessments were presented; 2) the mean age of the sample was ≥ 45 years; 3) cardiovascular or osteoporosis outcomes were identified and were not the cause of disability; 4) the study was empirical (reviews, editorials, commentaries and theory-only articles were excluded) and was not a case study; and 5) the study was conducted in a country on the US Central Intelligence Agency Factbook (9) list of developed countries. Abstracts were excluded from further consideration if they did not meet one or more of the inclusion criteria. If it was unclear whether an abstract met inclusion criteria, it was accepted for further review at the article level.

Full text articles were obtained and evaluated using the same inclusion criteria as for the abstract review with the addition of the Newcastle-Ottawa quality assessment criteria (10). Articles were assessed for criteria pertaining to selection of subjects, comparability of study groups and measurement of exposure or outcome and points were assigned based on adequacy of methods. Articles with the lowest quality scores were reevaluated on an individual basis and those articles with substantial bias that compromised the study validity were excluded. Reference sections of accepted articles were reviewed for potentially relevant articles not previously identified. These references then underwent the same abstract and full article review.

3. RESULTS

The searches yielded 7,396 unique abstracts related to cardiovascular disease and 1,747 unique abstracts related to osteoporosis. Figure 1 illustrates the flow of article selection. Inter-rater reliability for dual review was 97.1%. Discrepancies were resolved through consensus. The final yield of full text articles for evidence review was 7 CVD studies and no osteoporosis studies.

The majority of articles were excluded due to lack of relevance to the key questions, primarily because disability did not precede the health condition (n = 7240, 97.9% for CVD;

n = 1693, 96.9% for osteoporosis; see details about the excluded articles and the reason for exclusion in supplementary tables 2 and 3).

3.1 Cardiovascular Disease

The physical disabilities evaluated as part of the included articles were spinal cord injuries (n=3) (11–13), rheumatoid arthritis (RA) (n=3) (14–16), and general or undefined (n=1) (9). Results are summarized in Table 1.

3.1.1 Key Question 1a: What is the prevalence of CVD among women with physical disabilities?—Five articles were identified that addressed occurrence of CVD among women with physical disabilities (11–14, 16). In general, the prevalence of CVD among women with physical disabilities was similar to comparison groups (11–13), although some evidence supported a positive association between disability and CVD (11, 16).

Wahman and colleagues (13) performed a small (n=31), cross-sectional study among women who use wheelchairs because of paraplegia from a spinal cord injury. Prevalence for both myocardial infarction (MI) and hypertension was 3.1%, which represented only one case each. These estimates were not statistically significantly different from the estimated prevalence of 0.7% for MI and 10% for hypertension among women in the overall population (13). Small numbers in the spinal cord injury group reduced statistical power available to detect true differences between the groups.

Lavela and colleagues reported the prevalence of MI, hypertension, stroke and coronary heart disease (CHD) for US women veterans with spinal injury or disease (11). Except for CHD, prevalence was comparable to those reported in the US Behavioral Risk Factor Surveillance System (BRFSS) data for women veterans. Prevalence of CHD among the national sample of US veterans (8.0%) was about half that reported for women veterans with spinal cord injury (17.1%; $p<0.0001$) (11).

McDermott and colleagues conducted a medical record review of women with trauma-related disabilities resulting from either spinal cord injury or traumatic brain injury for lifetime prevalence of CHD, congestive heart failure (CHF), transient ischemic attacks and hypertension (12). CHD prevalence among women with trauma-related disabilities (15.87%) was more than twice that in women with no disabilities (6.65%). Prevalence of transient ischemic attacks was higher among women with disabilities, but statistical comparisons were not provided. Hazard ratios for incidence of these conditions during the patient's stay in the practice were provided comparing women with trauma-related disabilities to those with no disabilities. Wide confidence intervals reflecting small sample sizes indicated a lack of statistical power to detect true differences between the two groups; however, CHD and hypertension may be elevated in women with trauma-related disabilities (12). Notably, hazard ratios presented were adjusted for severity of disability which may be in the biologic pathway between disability and disease, thus the magnitude of the estimates may be reduced due to “over control” of the model.

Bergstrom and colleagues (16) compared rates of CHD, stroke and peripheral artery disease among women with RA to the rates experienced by the general population based on a population registry. No prevalence was reported; age-standardized mortality (SMR) and morbidity (SMoR) rates were presented. SMRs were not stratified by gender but female-specific SMoRs indicated a significantly elevated morbidity from all CVD, CHD, and peripheral artery disease among women with RA compared to the general population (16).

Krishnan and colleagues used prospective data from a cohort of men and women with RA from multiple US clinical sites to report gender-specific incidence rates of fatal acute MIs (14). SMRs were provided, but not for women alone. The gender and age standardized mortality rate indicates an increased risk of fatal MI among those with RA (SMR = 1.59 (1.36, 1.86)), but it is impossible from the reported results to determine if this applies equally across sexes (14).

3.1.2 Key Question 1b: What is the prevalence of risk factors for CVD among women with physical disabilities?—Five articles reported on prevalence of risk factors for CVD among women with physical disabilities (11–13, 15, 17). We found limited evidence supporting an increased prevalence of risk factors for CVD among women with physical disabilities compared to non-disabled women.

One article addressed CVD risk factors among women who had any form of physical functioning limitation (17). Chevarley and colleagues used the US nationally representative National Health Interview Survey (NHIS) and its disability supplement. For women age 45–64, prevalence of smoking and overweight were provided for those with no physical limitations, 1–2 limitations and 3 or more limitations. Smoking prevalence was higher among either group of women with limitations compared to the no limitations group ($p = 0.05$) but there were no differences between the two groups with limitations. Prevalence of overweight was significantly different between all groups ($p = 0.01$) indicating increasing body mass with increasing limitations (17).

Wahman and colleagues (13) assessed CVD risk factors among women with spinal cord injury. Prevalence of diabetes and dyslipidemia were higher in women with spinal cord injury, with marginal statistical significance ($p = 0.07$ and $p = 0.09$, respectively). Prevalence of overweight was 10 percentage points higher among women with spinal cord injury, though this was not significant ($p = 0.21$), and prevalence of smoking was about equal in the two groups (13). Statistical comparisons in this study were limited due to a low number of women with spinal cord injury ($n=31$).

Lavela and colleagues reported prevalence of diabetes, dyslipidemia and receipt of a cholesterol screening for US women veterans with spinal cord injury and those who had participated in the BRFSS (11). None of the risk factors was more common in the group of women with spinal cord injury, though dyslipidemia was 7 percentage points higher in women with spinal cord injury with marginal statistical significance ($p = 0.087$) (11).

McDermott and colleagues (12) found no difference between prevalence of diabetes or in obesity among women in their clinical practices with trauma-related disabilities compared to women with no disabilities.

Kao and colleagues reported the amount of coronary artery calcification (CAC), a marker of atherosclerosis, among women with RA of varying lengths of duration (15). Prevalence of CAC among women with RA in this study ranged from 47–64%.

3.1.3. Key Question 1c: Are there factors that modify the relation between physical disability and CVD?—Only two studies addressed modifying factors for the relation between a physical disability and CVD or its risk factors (15, 17). Based on these limited results, age and duration of disease may modify the association between physical disability and CVD risk factors in aging women.

Chevarley and colleagues (17) reported reduced differences in smoking and overweight among women with and without functional limitations after age 65, whereas differences were substantial and significant for women age 45–64.

Among women with RA, Kao and colleagues demonstrated a significant difference in extensive CAC by duration of disease (15). Those in the three longest quartiles of duration were 2–3 times as likely to have extensive CAC as women in the shortest quartile.

3.2 Osteoporosis

No articles were identified that met our inclusion criteria regarding osteoporosis outcomes in women aging with a physical disability; this is addressed further in the discussion section.

4. DISCUSSION

We identified 7 articles addressing the prevalence of CVD and its risk factors among women aging with a physical disability and no articles pertaining to osteoporosis in this group. Studies of CVD were inconsistent regarding the definition of disability and reporting of the outcomes. However, three studies that assessed CHD reported elevated risk among women with a physical disability (11, 16) although results were not statistically significant in one (12). A single study indicated a significantly increased risk of peripheral artery disease and all cause CVD morbidity (16). Results in multiple studies assessing hypertension or stroke either indicated a non-significant increase in risk or no association (11–13, 16). No elevated risk of MI or CHF was observed in any study in which it was reported (11–14).

Results for CVD risk factors were also inconsistent. Smoking was more common among women with a physical disability in one study (17) but only slightly elevated in another (13). Overweight was strongly associated with disability in one study (17), non-significantly increased in another (13), and not associated in a third (12). One study reported a greater prevalence of diabetes (13), but two others did not confirm this (11–12). Finally, dyslipidemia was non-significantly elevated in two separate studies (11, 13). CAC, a marker of atherosclerosis, was elevated in one study in which it was assessed (15); the prevalence reported in this study was approximately 20–30 percentage points higher than reported for

white women enrolled in a nationally representative cohort of older women (18). Few factors were assessed that could modify the association between physical disability and CVD in women. Increasing age was shown to mitigate the association of disability with both overweight and smoking (17). Also, duration of RA was found to increase the risk of CAC (15). (15). It is noteworthy that many of these CVD risk factors are commonly associated with the social determinants of health, such as poverty (19). Disability is often viewed as causally associated with ill health without consideration for the underlying social causes and resulting health inequities(20).

No articles met our inclusion criteria for osteoporosis among women with physical disabilities. Low physical activity, particularly weight-bearing activity, is a well known risk factor for osteoporosis (21). Therefore, women with physical impairments, particularly those using wheelchairs, may have a higher risk for osteoporosis. In addition, vitamin D insufficiency is a known risk factor for osteoporosis (8) and occurrence of vitamin D deficiency may be higher among women with disabilities (22). Research suggests that osteoporosis risk is elevated among those with physical disabilities and that onset may occur earlier than among non-disabled persons (23). Therefore, our age restrictions may have inadvertently led to rejection of articles that would have otherwise been accepted. In addition, a number of articles reviewed at the full text level were excluded based on the lack of results specific to women. As estrogen plays such a strong role in the etiology of osteoporosis (8), there is a need for sex-specific results.

Several aspects of the existing body of literature became apparent during this review. First, most articles addressed aging *into* a disability rather than aging *with* a disability. There is a need for more information on how having an existing disability may alter the experience of aging. Second, many of the studies focused on a potentially disabling condition, such as RA or multiple sclerosis, without considering the presence of physical disability. This is consistent with the emphasis on disease-centered research that characterizes the way health research is funded and conducted in the United States and other countries. Some studies excluded individuals who had a physical disability; for example, including only ambulatory patients. Support and policy are needed to increase the conduct of research that evaluates risk factors and sequelae of non-disease conditions, such as physical disability. Finally, the definition and measurement of disability in these studies was highly inconsistent, a problem plaguing most disability research (4, 23). A common definition of disability as proposed by the IOM would strengthen this field of study (23).

Differences between women with and without disabilities may reflect inequities in ability to access services and quality of care (24–25); improvements in physical access and attitudinal barriers among physicians may also be needed (24). However, addressing health access disparities is not sufficient to address health inequities (26). Social determinants of health among women with disabilities must also be addressed. Poverty rates are three times higher than for women without disabilities (2) and discriminatory attitudes are common (24). The coping response to these stressors, which includes many of the risk factors mentioned above, affect the health of women with disabilities.

There are several limitations to this review. We focused solely on women with physical disabilities. Women with intellectual, sensory and other disabilities may also experience an increased risk of adverse health outcomes with age (12, 23, 27). We also limited our review to two common and important outcomes among aging women: CVD and osteoporosis. However, women with physical disabilities may experience a greater burden of other health outcomes not identified here, for example respiratory illnesses, depression, and lower usage of preventative and screening resources (11–12, 17, 27). A majority of the articles included in this review were cross-sectional, limiting temporal inferences; we cannot determine whether presence of disability increases CVD and its risk factors or if the presence of CVD increases disability. Finally, articles' statistical power to detect differences was often hindered by small sample sizes. Even in cases where initial sample sizes were large, there were often too few cases of CVD to provide meaningful comparisons.

5. CONCLUSIONS

We found limited evidence of an increased risk in prevalence of CVD and its risk factors among women aging with a physical disability compared to control populations. The literature reviewed was primarily cross-sectional, had low statistical power, and defined disability inconsistently. High quality empirical research is needed to understand the health risks and possible disparities faced by the growing population of women aging with disabilities.

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Figure 1.
Flow diagram of study selection process

Table 1

Summary of evidence^{*}

Key Question 1a: What is the prevalence of CVD among women with physical disabilities and how does this differ from the prevalence for women without disability?						
Reference	Study Size	Sampling and setting	Age	Disability	CVD prevalence/rate in women with and without disability ^a	Comparisons between women with and without disability
Wahman, 2010 (13)	31 women with SCI 769 in comparison group	SCI registry in Stockholm, Sweden Comparison group from national survey matched on sex, age and region of residence	Mean (SD) = 47.8 (13.7) – For total, sex-stratified not provided	Wheel-chair dependent paraplegia	Women with SCI: MI = 3.1% HTN = 3.1% Comparison: MI = 0.7% HTN = 10%	Comparisons not statistically significant (p>0.05) but small number of cases resulted in low statistical power – 1 MI and 1 HTN among women with SCI
Lavelle, 2006 (11)	115 women with SCI 478 in comparison group	US women veterans with SCI who responded to a mailed survey Comparison group composed of veterans included in a national survey (BRFSS)	Mean (SD) = 53.0 (NR)	Spinal cord injury or disease	Women with SCI: MI = 10.5% Stroke = 6.7% CHD = 17.1% HTN = 33.6% Comparison: MI = 6.9% Stroke = 8.0% CHD = 8.0% HTN = 33.7%	CHD prevalence was significantly higher (p<0.0001) in disabled group
McDermott, 2007 (12)	63 women with trauma-related disability 1186 women without any disability	Clinic based review of medical records for disabled and non-disabled women in a large urban family practice and small rural practice in Southeastern US	Mean (SD) = 48.9 (NR)	Trauma-related disability including SCI and TBI with limitations (mobility or ADL)	Women with trauma-related disability: CHD = 15.87% CHF = 4.76% TIA = 3.17% HTN = 49.21% Women without disability: CHD = 6.65% CHF = 4.56% TIA = 1.73% HTN = 43.94%	Adjusted ^b hazard ratios comparing women with trauma-related disability to non-disabled women: CHD = 1.54 (0.61, 3.88) CHF = 0.64 (0.09, 4.75) TIA = NR HTN = 1.21 (0.77, 1.91)
Bergstrom, 2009 (16)	125 women in cohort	Clinic based recruitment in Malmö, Sweden, but large coverage expected; standard population was city population based on population registry	Mean (SD) at onset = 48.3 (16.4) Mean (SD) years duration = 13.38 (11.5) Mean while in study NR	RA with majority having functional disability at baseline	Clinically significant CHD, stroke, PAD – mortality and morbidity; prevalence not reported	SMRs not reported by gender SMoR calculations ^c (95% CI): all CVD = 1.86 (1.24, 2.69) CHD = 2.24 (1.30, 3.59) Stroke = 1.53 (0.76, 2.74) PAD = 4.85 (1.57, 11.33)

Krishnan, 2004 (14)	3862 total men and women (76% women)	Multiple US locations participating in the ARAMIS cohort comprised of RA patients; comparison group from US national mortality data	Mean (SD) for men and women = 56 (14)	RA with results stratified by HAQ disability score	Mortality from acute myocardial infarction Rate/1000 person-years (95% CI) stratified by age: 40–49 = 1.08 (0.49, 2.41) 50–59 = 3.55 (2.43, 5.17) 60–69 = 5.97 (4.44, 8.02)	SMR to US population not provided for women only
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Key Question 1b: How common are risk factors for CVD among women with physical disabilities and is this different from women without disability?

Reference	Study Size	Sampling and setting	Age	Disability	Prevalence/rate of predisposing factor in women with disability ^a	Prevalence/rate in women without disability ^a
Chevarley, 2006 (17)	77,762 total; age-specific not reported	US nationally representative population from the National Health Interview Survey	Mean not reported; age-stratified results presented	Presence of functional limitations based on Nagi criteria	For women aged 45–64 with 1–2 limitations: Smoking = 29.2% Overweight (by BMI) = 43.5% For women aged 45–64 with 3 limitations: Smoking = 29.9% Overweight by BMI = 52.0%	For women aged 45–64 with 0 limitations: Smoking = 21.9% Overweight (by BMI) = 26.1%
Wahman, 2010 (13)	See above	See above	See above	See above	Diabetes = 6.5% Smoking = 19.4% Overweight by BMI = 38.7% Dyslipidemia = 6.5%	Diabetes = 1.8% Smoking = 16.3% Overweight by BMI = 28.3% Dyslipidemia = 2.0%
Lavela, 2006 (11)	See above	See above	See above	See above	Diabetes = 11.9% Dyslipidemia = 47.4% Received cholesterol screening in past 5 yrs = 98.7%	Diabetes = 9.2% Dyslipidemia = 39.5% Received cholesterol screening in past 5 yrs = 94.7%
McDermott, 2007 (12)	See above	See above	See above	See above	Diabetes = 17.46% Clinically defined obesity = 76.19%	Diabetes = 16.23% Clinically defined obesity = 74.66%
Kao, 2008 (15)	185	Clinic-based recruitment through the University of Pittsburgh's arthritis outpatient network	Mean (SD) reported by quartile of duration – ranged from 57.1 (13.3) to 59.5 (8.7)	RA with disability measured by mHAQ – mean mHAQ scores for all groups were above disability threshold	Prevalence of any coronary artery calcification by duration of RA: 2–7 years = 47% 8–13 years = 63% 14–23 years = 59% >23 years = 64%	No comparison group

Key Question 1c: Are there factors that are modifiers of the relation between physical disability and CVD?

Reference	Study Size	Sampling and setting	Age	Disability	Modifying factor and effect
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Chevarley, 2006 (17)	See above	See above	See above	See above	Overweight and smoking differences lessen or disappear after age 65
Kao, 2008 (15)	See above	See above	See above	See above	Duration of disease increases odds of extensive coronary artery calcification Adjusted ^d odds ratios: 2–7 years = reference 8–13 years = 2.76 (1.15, 6.66) 14–23 years = 2.35 (1.01, 5.46) >23 years = 3.14 (1.38, 7.17)

^a All figures are prevalence percents unless otherwise indicated

^b Adjusted for age, race, practice location (urban/rural), and severity of disability

^c Recalculated to standard SMR format from reported results

^d Adjusted for age, race, CHD/metabolic risk factors and RA-related factor

* ADL – activities of daily living; ARAMIS – Arthritis, Rheumatism, and Aging Medical Information System; BMI – body mass index; BRFSS – Behavioral Risk Factor Surveillance System; CHD – coronary heart disease; CHF – coronary heart failure; CI – confidence interval; HAQ – Health Assessment Questionnaire; HTN – hypertension; mHAQ – modified Health Assessment Questionnaire; MI – myocardial infarction; NR – not reported; PAD – peripheral artery disease; RA – rheumatoid arthritis; SCI – spinal cord injury; SD – standard deviation; SMoR – standardized morbidity rate; SMR – standardized mortality rate; TBI – traumatic brain injury; TIA – transient ischemic attack