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The association between social participation and lower extremity muscle strength, balance, and gait speed in US adults

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ABSTRACT

Social participation is associated with healthy aging, and although associations have been reported between social participation and demographics, no published studies have examined a relationship between social participation and measures amenable to intervention. The purpose was to explore the association between self-reported social participation and lower extremity strength, balance, and gait speed. A cross-sectional analysis of US adults ($n = 2291$; $n = 1{,}031$ males; mean ± standard deviation age 63.5 ± 0.3 years) from the 2001–2 National Health and Nutrition Examination Survey was conducted. Two questions about self-reported difficulty with social participation were categorized into limited (yes/no). The independent variables included knee extension strength ($n = 1537$; classified as tertiles of weak, normal, and strong), balance ($n = 1813$; 3 tests scored as pass/fail), and gait speed ($n = 2025$; dichotomized as slow [less than 1.0 m/s] and fast [greater than or equal to 1.0 m/s]). Logistic regression, accounting for the complex survey design and adjusting for age, sex, physical activity, and medical conditions, was used to estimate the odds of limitation in social participation with each independent variable. Alpha was decreased to 0.01 due to multiple tests. Slower gait speed was significantly associated with social participation limitation (odds ratio = 3.1; 99% confidence interval: 1.5–6.2). No significant association was found with social participation and lower extremity strength or balance. The odds of having limitation in social participation were 3 times greater in those with slow gait speed. Prospective studies should examine the effect of improved gait speed on levels of social participation.

1. Introduction

Healthy or active aging has been studied and promoted, with the World Health Organization (WHO) defining active aging as "the process of optimizing opportunities for health, participation, and security in order to enhance quality of life as people age" (World Health Organization, 2002a, p.12). Participation, defined as involvement in a life situation by the International Classification of Functioning, Disability, and Health (ICFDH), is an important component of biopsychosocial models of health and disability (World Health Organization, 2002b). Social participation is one component in the broader category of participation, and has been defined by interpersonal interactions with friends or family, membership in community groups (Minagawa and Saito, 2014) or social interactions in work environments (Hsu, 2007). High social participation and active engagement are often included in the discussion of healthy aging (Fuchs et al., 2013; Bowling and Dieppe, 2005). In fact, social participation, as measured by the SF-36 Social Functioning Scale, was associated with healthy aging in community-dwelling older adults (Wang et al., 2013; Li et al., 2014). Social participation is also a common factor associated with high quality of life in studies of American older people, as well as several European countries (Netuveli, 2006). Since social participation tends to decline with increasing age (Mendes de Leon et al., 2003; Desrosiers et al., 2009), and limited social participation may have negative effects on mortality (Glass et al., 1999), and physical (Mendes de Leon et al., 2003) and cognitive (Krueger et al., 2009) morbidity, it is important to identify means through which social participation might be maintained.

Associations between social participation and demographic characteristics (e.g., sex, marital status) (Mendes de Leon et al., 2003; Desrosiers et al., 2009; Krueger et al., 2009), and healthy behaviors (e.g., physical activity, nutrition) (Wang et al., 2013) have been established. There is, however, a paucity of evidence on the association between physical impairments and mobility deficits and social participation. Previous studies have small sample sizes (Samuel et al., 2012) or assessed strength (Beauchamp et al., 2015) and gait speed (Fairhall et al., 2014) with a more global measure of participation rather than focused analysis of social participation, and no consistent results were reported. Inconsistency in the previous studies, coupled with the lack of

Abbreviations: NHANES, National Health and Nutrition Examination and Survey; LE, lower extremity; NCHS, National Center for Health Statistics.

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population-based studies identifying relationships between social participation and isolated impairments or mobility deficits, suggest a need for further research.

The purpose of this paper is to explore the association between self-reported social participation and lower extremity strength, balance, and gait speed in order to better understand relationships that may be amenable to intervention. We hypothesized that decreased social participation would be associated with decreased lower extremity muscle strength, standing balance, and gait speed.

2. Methods

2.1. Study design and population

Conducted by the National Center for Health Statistics (NCHS), the cross-sectional National Health and Nutrition Examination Survey (NHANES) uses a stratified, multi-stage, probability design to assess health of American adults and children. Details of NHANES methodology are available at: http://wwwn.cdc.gov/nchs/nhanes/search/nhanes01_02.aspx. NHANES consists of a detailed home interview and examination conducted in a mobile examination center. NHANES continually samples a nationally representative cohort of the US civilian, non-institutionalized population. The present study (analyzed 2015) uses 2001–2 NHANES data from individuals 50 years and older; this was the most recent NHANES data with lower extremity strength and timed walking test. Informed consent was obtained for all participants and the Institutional Review Board of the NCHS approved the protocol prior to data collection.

From a potential sample of 2563 participants age 50 years and older, 2291 completed the interview and appropriate examination components of NHANES. Each examination component had different exclusions (see below under Measurements); participants were also excluded if there was equipment failure, communication problems, mobility problems, or participant refusal. 1487 (64.9%) completed the lower extremity strength testing, 1813 (79.1%) completed the balance testing, and 2025 (88.4%) completed the timed walking test.

2.2. Measurements

NHANES measurements were completed during an interview and an examination. Participants were asked about demographic information, as well as current medical conditions and frequency and duration of moderate or vigorous physical activity, which were assessed as confounders. The medical conditions assessed included pulmonary (i.e., "Has a doctor or other health care professional ever told you that you have and do you still have [asthma], [emphysema], or [chronic bronchitis]?"), cardiac (i.e. "Has a doctor or other health care professional ever told you that you have and do you still have [congestive heart failure], [angina], or [heart attack]?"), musculoskeletal conditions (i.e., "Has a doctor or other health care professional ever told you that you have and do you still have [arthritis] or [osteoporosis]?"), diabetes (i.e., "Other than during pregnancy, have you ever been told by a doctor or other health care professional that you have and do you still have diabetes or sugar diabetes?"), and cancer (i.e., "Have you ever been told by a doctor or other health care provider that you have cancer or malignancy of any kind?"), and were categorized as "yes" or "no." Participants were further asked about participation in moderate or vigorous physical activity for at least 10 min over the past 30 days, and these 2 questions (i.e., moderate or vigorous) were collapsed into a single variable with "yes" or "no."

2.3. Social participation

Two questions assessing social participation with leisure activities were phrased to measure the participant's level of difficulty in performing the task without using any special equipment. The questions asked about difficulty "going out to things like shopping, movies, or sporting events," and "participating in social activities [visiting friends, attending clubs or meetings or going to parties]." The possible answers were Likert-type responses with 4 levels (i.e., 'No difficulty,' 'Some difficulty,' 'Much difficulty,' and 'Unable to do'). Any participant who answered 'Some difficulty' or more with either of these questions was categorized as having limitation with social participation. Those with 'No difficulty' with both questions were categorized as no limitation. This is similar to the methods with other studies using the physical functioning measures from NHANES (Ettinger et al., 1994).

2.4. Lower extremity muscle strength

Before testing, participants were screened and excluded if there was a myocardial infarction within the past six weeks, chest or abdominal surgery within the past three weeks, knee surgery or knee replacement surgery, severe back pain, or a history of brain aneurysm or stroke. Knee extension peak torque was assessed using an isokinetic dynamometer (Kin Com, Chattex Corp., Chattanooga, TN). Maximal voluntary concentric muscle force was measured in Newtons in the right leg at a velocity of 1.05 rads/s (60 °/s); previous literature reported no difference in torque between the right and left leg for knee extension (Lindle et al., 1997). Each participant had a total of 6 trials: 3 submaximal trials for warm-up and 3 trials for maximal voluntary effort. The best maximal effort was used as peak force. Peak torque (N-m) was calculated as peak force (N) multiplied by the mechanical arm length (m), i.e., the distance from the ankle to the knee joint. Gravity corrections to peak torque were based on the measured leg weight at 150° (2.62 rads) using the formula by Nelson and Duncan (Nelson and Duncan, 1983). Additional information on the muscle strength testing procedures can be found at: http://www.cdc.gov/nchs/data/nhanes/ms.pdf. Peak torque was normalized to body weight, measured using standard procedures (Lohman et al., 1988) on a scale-mounted stadiometer. Percent of predicted normal strength was calculated using the formula from Neder, et al. (Neder et al., 1999). Due to missing variables for the strength prediction formula, data were available for 1488 (96.8%) of the 1537 who completed strength testing. Strength was then categorized to Weak (<75% of predicted; 0–25th percentile of the distribution), Normal (75–100% of predicted; 25th–75th percentile), and Strong (>100% of predicted, 75th–100th percentile).

2.5. Balance

Balance testing consisted of the modified Romberg Test of Standing Balance on Firm and Compliant Support Surfaces (Weber and Cass, 1993). Participants were excluded from balance testing if there was an inability to stand without external support, current dizziness sufficient to cause unsteadiness, foot or leg amputation, weight over 275 lb or size that was unable to accommodate safety equipment, or visual impairment or other medical contraindication to testing. The balance test examined the participant's ability to stand unassisted with arms folded across the waist using 4 test conditions designed specifically to test the sensory inputs that contribute to balance — the vestibular system, vision, and proprioception. The first condition consisted of standing with the feet together and eyes open, testing all systems contributing to balance. The second condition consisted of standing with the feet together and eyes closed, testing the vestibular system and proprioception. The third condition involved standing on a foam pad with eyes open, testing vision and the vestibular system. The fourth test condition involved standing on a foam pad with eyes closed, testing vestibular function exclusively. The second, third, and fourth conditions were used in these analyses.

Balance testing was scored on a pass/fail basis per the design of the test for NHANES. Passing for condition one and two required maintaining the position for 30 s each; passing for condition three and four required maintaining the position for 15 s each. Failing was defined as