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Original Research

# The Long-Term Health and Economic Value of Improved Mobility among Older Adults in the United States

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ABSTRACT

**Background:** Mobility impairments have substantial physical and mental health consequences, resulting in diminished quality of life. Most studies on the health economic consequences of mobility limitations focus on short-term implications. **Objectives:** To examine the long-term value of improving mobility in older adults. **Methods:** Our six-step approach used clinical trial data to calibrate mobility improvements and estimate health economic outcomes using a microsimulation model. First, we measured improvement in steps per day calibrated with clinical trial data examining hylan G-F 20 viscosupplementation treatment. Second, we created a cohort of patients 51 years and older with osteoarthritis. In the third step, we estimated their baseline quality of life. Fourth, we translated steps-per-day improvements to changes in quality of life using estimates from the literature. Fifth, we calibrated quality of life in this cohort to match those in the trial. Last, we incorporated these data and parameters into The Health Economic Medical Innovation Simulation model to estimate how mobility improvements affect functional status limitations, medical expenditures, nursing home utilization, employment, and earnings between 2012 and 2030. **Results:** In our sample of 12.6 million patients, 66.7% were female and 70% had a body mass index of more than 25 kg/m$^2$. Our model predicted that a 554-step-per-day increase in mobility would reduce functional status limitations by 5.9%, total medical expenditures by 0.9%, and nursing home utilization by 2.8%, and increase employment by 2.9%, earnings by 10.3%, and monetized quality of life by 3.2% over this 18-year period. **Conclusions:** Interventions that improve mobility are likely to reduce long-run medical expenditures and nursing home utilization and increase employment.

*Keywords:* mobility, osteoarthritis, quality of life, health economic outcomes.



## Introduction

By 2030, mobility impairments in older persons are projected to affect 25 million Americans, or 9.3% of the population [1], and cause reductions in physical activity. Lack of physical activity often leads to greater frailty in older persons that may lead to falls [2], frequently resulting in fractures, head trauma, soft tissue injuries, or severe lacerations, and even an increased risk of death [3–5]. Oftentimes, patients develop a fear of falling [6] and experience depression, feelings of helplessness, and social isolation that ultimately reduce their quality of life [7–9]. More generally, mobility is commonly considered a key component of quality of life. For example, the EuroQol five-dimensional questionnaire (EQ-5D) [10], a widely used survey instrument, incorporates mobility as one of its five determinants of quality of life.

Although the burden and clinical consequences of reduced mobility on patient health outcomes and quality of life have been well established, the effect of mobility on health economic outcomes is often overlooked or largely focuses on short-term economic outcomes. Studies of disability trends among the elderly and the near-elderly found that mobility limitations increased between 1996 and 2010 [11]. Evidence on the short-term implications of mobility limitations has demonstrated their negative impact on various economic outcomes. For instance, an

Conflict of Interest Disclosures: All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr. Kabiri, Ms. Brauer, Mr. Sullivan, Dr. Shafrin are employees of Precision Health Economics, a consultancy to life sciences companies. Dr. Goldman reported receiving personal fees from Precision Health Economics. Dr. Shafrin and Dr. Goldman also reported owning equity in Precision Medicine Group, the parent company to Precision Health Economics. Dr. Gill had nothing to disclose.

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analysis of data from the National Health Interview Survey demonstrated that decreased physical function reduced the likelihood of employment, decreased household income, and increased missed work days for employed patients with osteoarthritis [12]. In addition, those with at least one limitation in activities of daily living (ADL), such as walking, had double the risk of admission to a nursing home [13]. Despite the well-known risks and consequences of reduced mobility, to our knowledge, no study has examined the long-term impact of maintained improvements in mobility on health economic outcomes among the older population. To address this limitation, our study examined the long-term effect of improved mobility on health economic outcomes projected through 2030. Because osteoarthritis of the knee is a common contributor to decreased mobility, we focused our analysis on a nationally representative population of patients with osteoarthritis and calibrated mobility improvements for all patients with osteoarthritis by using hylan G-F 20 viscosupplementation. The specific type of intervention chosen, however, was not a major consideration of this study because we aimed to quantify the benefits of mobility improvements generally rather than examine the cost effectiveness of a particular intervention. Using The Health Economic Medical Innovation Simulation (THEMIS) [14–18], we assessed the impact of improved mobility on functional status limitations, medical expenses, nursing home utilization, monetized quality-adjusted life-years (QALYs) (assuming $150,000/QALY [19]), employment, and earnings.

## Methods

Our analytic approach relied on a six-step process to model the effect of improved mobility, measured by increased steps per day, on health economic outcomes for older persons (Fig. 1). This process aligned data from multiple sources because no single source of data included steps per day, health-related quality of life, and measures of the downstream effects of increased mobility (e.g., functional status, medical expenditures, and labor force participation). First, we searched for a study that showed mobility improvements with an osteoarthritis mobility-improving treatment. We identified mobility improvements on the basis of a clinical trial, MARCHE, that estimated the impact of treating patients with osteoarthritis with a hylan G-F 20 viscosupplementation injection on mobility, measured as steps per day, after 90 days [20,21]. Second, we selected a nationally representative cohort of patients 51 years and older with osteoarthritis using the 2012 Medical Expenditure Panel Survey (MEPS) data. Third, we estimated a model to predict patient utility based on EQ-5D data of the osteoarthritis cohort as a function of individual characteristics, including functional status as assessed by ADL and instrumental activities of daily living (IADL) limitations. Fourth, to translate improvements in steps per day to changes in health economic outcomes, we identified models in the literature that estimated patient quality of life using the EQ-5D among patients in different steps-per-day groups. Using these models, we extrapolated changes in steps per day from the clinical trial to changes in EQ-5D for the nationally representative osteoarthritis cohort. Fifth, we identified the levels of functional status limitations (ADL and IADL limitations) in the osteoarthritis cohort that would represent the mobility levels observed in the pre- and post-treatment populations from the trial. Last, we simulated two populations (with and without treatment) using THEMIS, allowing us to estimate the effect of improved functional status on health economic outcomes.

We estimated the effect of changes in improved mobility by comparing the results from the "status quo" population (pretreatment mobility levels) with the "mobility improvement" population (mobility levels consistent with hylan G-F 20 treatment), assuming that all patients with osteoarthritis pursued mobility-improving treatment and maintained their improved mobility relative to their mobility trend over time through recurrent treatments. Each methodology step is described in more detail in the next sections.

### *Step 1: Measure Mobility Improvements*

We obtained the effect of osteoarthritis treatment on patient mobility using data on steps per day from the MARCHE trial (see Appendix 1 in Supplemental Materials found at https://doi.org/10.1016/j.jval.2017.12.021). The trial was a pre-post cohort study that measured the effect of using hylan G-F 20 on patient mobility as measured by steps per day. We selected this trial because the number of steps per day captured patient mobility, irrespective of speed and endurance. Steps per day also incorporates the patients' lifestyle choices in addition to their physical ability to move—which is commonly assessed through other tests such as the 6-minute walk distance [22]. Before treatment, patients in the study walked between 643 and 9,242 steps per day with a median of 4,125 (interquartile range 3,000–5,449). After treatment, patients walked between 812 and 15,939 steps per day with a median of 4,919 steps per day (interquartile range 3,089–7,640). On average, patients treated with hylan G-F 20 walked 554 more steps per day ($P = 0.001$).

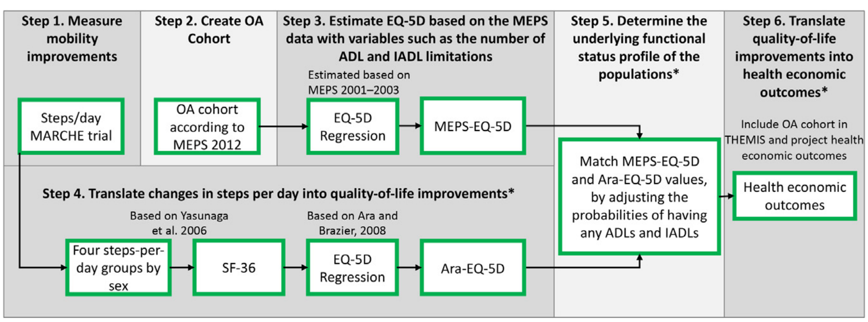


**Fig. 1 – Steps to estimate the impact of improved mobility on health-related economic outcomes. *Steps 4–6 were performed separately for each simulation scenario—standard of care (status quo) and mobility improvement—by steps-per-day group and sex. The proportions of males and females in each steps-per-day group in each scenario were obtained from the MARCHE trial. ADL, activities of daily living; EQ-5D, EuroQol five-dimensional questionnaire designed to measure quality of life; IADL, instrumental activities of daily living; MEPS, Medical Expenditures Panel Survey; OA, osteoarthritis; THEMIS, The Health Economics Medical Innovation Simulation.**