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DEPARTMENT OF HEALTH AND HUMAN SERVICES

DIVISION OF HEALTH CARE FINANCING AND POLICY

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Administrator

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Notice of Meeting to Solicit Public Comments and Intent to Act Upon Amendments to the State Plan for Medicaid Services

Public Hearing November 28, 2023
Summary

Date and Time of Meeting:	November 28, 2023, at 10:02 AM
Name of Organization:	State of Nevada, Department of Health and Human Services (DHHS), Division of Health Care Financing and Policy (DHCFP)
Place of Meeting:	DHCFP 1100 E. William Street First Floor Conference Room Carson City, Nevada 89701

Teleconference and/or Microsoft Teams Attendees
(Note: This List May Not Include All Participants, Just Those Who Identified Themselves)

Malinda Southard, Deputy Administrator, DHCFP
Karen Griffin, Senior Deputy Attorney General
Casey Angres, DHCFP
Evette Cullen, DHCFP
Elizabeth Scott, DHCFP
Lisa Dyer, DHCFP
Tanya Benitez, DHCFP
Kayla
Marcel Brown, DHCFP
Julie Gwin, Northern Nevada HOPES
Dr. Susan Priestman, American Physical Therapy Association of Nevada
Christina Gaglione
Ferrari Reeder Public Affairs (FRPA)
Dev Bararia
Ariana Sherman, Clark County Nevada
Basil Dibsie, Wellpoint
Areli Alarcon
Jessica Vannucci, DHCFP
Angel-Leigh Fischer, Washoe County School District
Michelle Soule, Division of Welfare and Supportive Services (DWSS)
April Caughron, DHCFP
Kimberly Adams, DHCFP
Sean Linehan, DHCFP
Stephanie Sadabseng, DHCFP
Candace McCLain-Williams, DHCFP
Alicia Roman, DHCFP
Carin Hennessey, DHCFP
Alexandra Garcia, DHCFP
Brooke Gruger, Liberty Dental Plan
Daniel H. Stewart, Brownstein Hyatt Farber Schreck, LLP
Belz & Case Government Affairs Scribe by Rewatch
Rianna White, Fidelis-Rx
Cheri Glockner, Silver Summit Health Plan (SSHP)
Nancy Kane, CCDS
Michael Gorden, DHCFP
Sabrina Schnur, Belz & Case

Laura Kniola, Clark County School District
Carissa Pearce, Health Policy Manager, Children's Advocacy Alliance
Zach R.
Kaelyne Day, DHCFP
Kenneth Kunke, Roseman University of Health Sciences
Lucille Wroldsen, DHCFP
Nancy Kuhles, NV Speech, Language, Hearing Association
Elyse Monroy-Marsala, Belz & Case
Travis Walker, Community Health Alliance (CHA)
Ivan Chatterley, Myriad
Tashanae Glass, DHCFP
Luke Lim, Anthem
Sherron Dickenson, CCSD
Amy Shogren, Black & Wadhams
Dawnesha Powell, Silver Summit Health Plan (SSHP)
Shirish S. Limaye, SSHP
Morgan Biaselli, SSGR
Stephanie Pocchia, Nevada Department of Education
Ivy Y. Burns, CCSD
Meskerem Kassa, CCSD
Paula Konomos, Evergreen HealthCare
Holly Long, CHA
Stephanie Cook, Department of Health and Human Services, (DHHS)
Keith Benson, DHCFP
Keri Kelley, Silver Summit Health (SSH)
Ryan Studebaker,
Breana Taylor, Department of Education
Jeana C. Piroli, Washoe Schools
JoAnne DeFoe, Absolute Dental
Joy Thomas, Anthem
Kurt Karst, DHCFP
Amy Levin, MD, Anthem
Mary Wherry, CHA
Catherine Vairo, DHCFP
Tarsha L. Austin, Clark County School District (CCSD)
Verona M. Sutton-Dunn
Mark Rosenberg, Fidelis-Rx
Mary Gilbertson, UCare
Sandra Stone, Division of Child and Family Services (DCFS)
Rachael Devine, DHCFP
Brian Evans, The Perkins Company
Chris Bosse, Renown
Angela Mangum, MBA-HCM. CBCS, WestCare
Laurie Curfman, Liberty Dental Plan
Sheri Gaunt, DHCFP
Ellen Flowers, DHCFP
Alex Tanchek - Silver State Government Relations
Serene Pack, DHCFP
Ester Quilici, Vitality Unlimited
Briza Virgen, DHCFP
Amber
Regina C. De Rosa, Anthem
Margaret L. Keteian, Anthem
Lori Follett, DHCFP
Keiko Duncan, DHCFP
Maria Reyes, Fidelis-Rx
Francisco J. Morales-Sánchez, Brownstein Hyatt Farber Schreck
Jackie Matter, Anthem
Katie M. Nease, United Healthcare (UHC)
Beth Slamowitz, Department of Health and Human Services (DHHS)
Amy Roukie
Christy Nguyen, Fidelis-RX
Trey Delap
Theresa Carsten, DHCFP
Vickie S. Ives, Division of Public and Behavioral Health (DPBH)
Ky Plaskon, DHCFP
Dawn Tann, DHHS
Lovia “Vi” Larkin, Vitality Unlimited
Skyler Basanez
Brooke Greenlee, Elevance Health
Celina
Dr. Ken Higbee-ECSD
Jessica Medulla, Washoe County School District

Introduction:

Casey Angres, Chief of Division Compliance, DHCFP, opened the Public Hearing introducing herself, Malinda Southard, Deputy Administrator, DHCFP, and Karen Griffin, Senior Deputy Attorney General.

Casey Angres – The notice for this public hearing was published on October 26, 2023, and revised on November 9, 2023, in accordance with Nevada Statute 422.2369.

1. **Public Comments:** Nancy Kuhles' comments have been entered in the Medicaid Services Manual (MSM) Public Hearing Summary for Item 9.

2. **Discussion of Amendments to the State Plan for Medicaid Services and Solicitation of Public Comments**

Subject: Supplement 2 to Attachment 3.1-A – Medication-Assisted Treatment (MAT)

Sarah Dearborn, Behavioral Health Benefits Coverage Chief, DHCFP, presented DHCFP is proposing a State Plan Amendment (SPA) to Supplement 2 to Attachment 3.1-A – Medication-Assisted Treatment (MAT) on Pages 3, 4, and 8. These proposed amendments will allow for services of a pharmacist to assess a patient to determine if the patient has an Opioid Use Disorder (OUD), determine whether MAT is appropriate, counsel the patient, and prescribe and dispense a drug for MAT at a rate equal to the rate of reimbursement provided to a Physician provider type (PT 20), Physician Assistant (PT 77), or an Advanced Practice Registered Nurse (PT 24) as required through the passing of Assembly Bill (AB) 156 of the 82nd Legislative Session.

This proposed change affects all Medicaid-enrolled providers delivering MAT services for OUD. Those PTs include, but are not limited to: Physician, M.D., Osteopath, D.O., (PT 20), Advance Practice Registered Nurse, (PT 24), Nurse Midwife, (PT 74), Physician's Assistant, (PT 77), Pharmacist (PT 91), Methadone Clinic, (PT 17, Specialty 171), and Substance Use Agency Model (PT 17, Specialty, 215).

There is an estimated increase in annual aggregate expenditures for State Fiscal Years (SFY) 2024 and 2025.

SFY 24	$1,926
SFY 25	$4,016

The effective date of this change is January 1, 2024.

At the conclusion of Sarah Dearborn's presentation, Casey Angres asked Malinda Southard and Karen Griffin if they had any questions or comments, they had none.

Public Comments: There were none.

Casey Angres – closed the Public Hearing for State Plan for Supplement 2 to Attachment 3.1-A – Medication-Assisted Treatment (MAT).

3. **Discussion of Amendments to the State Plan for Medicaid Services and Solicitation of Public Comments**

Subject: 12 Month Postpartum

Stephanie Sadabseng, Social Services Program Specialist in the Medical Benefits Coverage Unit, DHCFP, presented a Nevada Medicaid SPA is being proposed to State Plan Attachment 2.2-A Page 24, Attachment 2.2-A Page 5, Attachment 3.1-A Page 8, and Attachment 3.1-B Page 7 as a result of the passage of Senate Bill (SB) 232 during the 82nd Legislative Session. The proposed amendment is to update the postpartum period from 60 days to 12 months.

This proposed SPA may affect but is not limited to the following PTs as listed on the agenda.

There is an estimated increase in annual aggregate expenditures for State Fiscal Years (SFY) 2024 and 2025.

SFY 24	$5,332,398
SFY 25	$10,419,149

The effective date of this new policy is January 1, 2024, pending CMS approval of the SPA.

At the conclusion of Stephanie Sadabseng's presentation, Casey Angres asked Malinda Southard and Karen Griffin if they had any questions or comments, they had none.

Public Comments: Casey Angres advised there was written comment on this item from Dr. Susan Priestman. Dr. Susan Priestman also read part of the letter which is attached.

Carissa Pearce, Health Policy Manager, Children's Advocacy Alliance, advised they advocate and support for the expansion of postpartum coverage from 65 days to 12 months of continuous coverage during the 82nd Legislative Session. They are very excited this policy is being discussed and really appreciate the state's action to implement. Carissa Pearce said they wanted to reiterate the services that are expected to be provided as in the bill text. They recognize the medical care following the pregnancy should include the creation of a plan for the postpartum care and a comprehensive postpartum visit, and the postpartum person should be communicated with throughout this period of time. The expected services should align with current standards of care. The postpartum visit is expected to include screenings for physical, social, and psychosocial wellbeing of the person following pregnancy with any necessary referrals for further assessment and treatment. Treatment is expected for any complications from pregnancy and childbirth, such as the pelvic floor disorders and postpartum depression. All necessary referrals should be included. The care should also include a screening for cardiovascular disease and any necessary referrals. Finally, postpartum care is expected to include resources and care related to the loss of a pregnancy. They recognize that expanding postpartum coverage will have a profound effect on Nevada's pregnant population, families, and children by reducing the need for emergency services and ensuring access to essential resources. Most pregnancy associated deaths in the postpartum period happen after 65 days and over 60 percent of the total maternal deaths related to pregnancy are preventable with support from medical services and preventive measures. This policy will likely have a huge impact on saving postpartum, pregnant people's lives. As we can imagine, maternal death affects the entire family as partners become widowed parents and children are losing a parent, increasing their risk of detrimental health outcomes and poor development. The expansion of postpartum coverage will save lives and ensure coverage during a highly vulnerable period so families can focus on healing and bonding. Carissa Pearce advised they are very passionate about the health and wellbeing of our children, families, and pregnant people in Nevada, and they see this expansion as a necessary step in creating a healthier tomorrow.

Casey Angres – closed the Public Hearing for State Plan for Medicaid Services – 12 Month Postpartum.

4. Discussion of proposed Amendments to the State Plan for Medicaid Services and solicitation of public comments

Subject: Eligibility Groups

Michelle Soule, Nevada Check Up Program Specialist, DWSS, presented the State's authority per 81st Legislative Session, Senate Bill 420. DWSS is proposing to increase the income limit for pregnant women applying for Medicaid from the current limit of 165% of the Federal Poverty Level (FPL), to 185% of the FPL. This increase will expand the number of women who could qualify for Medicaid during their pregnancy.

The following PTs listed on the agenda may be affected by this change.

An estimated increase in annual aggregate expenditures has been amended since the agenda was posted, the new amounts are:

For SFY 2024: $4,266,669
For SFY 2025: $10,518,658

The effective date of change is January 1, 2024, pending CMS approval.

At the conclusion of Michelle Soule's presentation, Casey Angres asked Malinda Southard and Karen Griffin if they had any questions or comments, they had none.

Public Comments: There were none.

Casey Angres – closed the Public Hearing for Payment for Eligibility Groups.

5. Adjournment

There were no further comments and Casey Angres closed the Public Hearing at 10:22 AM.

An Audio (CD) version of this meeting is available through the DHCFP Compliance office. For more detailed information on any of the handouts, submittals, testimony and or comments please contact Jenifer Graham at documentcontrol@dhcfp.nv.gov ***with any questions.***

Public Comment on State Plan Amendments for Medicaid Services
November 28, 2023
Dr. Susan Priestman, Physical Therapist
Board-Certified Specialist in Orthopedic PT
President of the American Physical Therapy Assoc.- Nevada

First off, I'm thrilled for the passage of SB232 for the post-partum women of Nevada as this truly will alleviate so many un-necessary sequala from pregnancy and childbirth.

Pelvic health PTs that specialize in the postpartum population treat a variety of diagnoses that can range from SIJ dysfunction, pubic symphysis dysfunction, stress incontinence and other urinary symptoms, pelvic organ prolapse, and painful vaginal penetration. The physical therapy community that specializes in the care for post-partum patients have developed tests and protocols to safely return postpartum patients to running, lifting and other more physical exercise.

Postpartum patients typically are not given detailed instruction from their obstetricians on how to return to these activities but physical therapists can ensure that a patient has sufficient strength and flexibility required for heavier impact. Oftentimes, the postpartum time period may be a turning point in a patient's relationship with health and exercise and physical therapy can help ensure the relationship will continue to improve and avoid becoming a burden on the healthcare system in the future.
We have good data that states children will exercise more if their mothers have increased levels of physical activity. Pelvic floor PTs treating postpartum patients are not only treating the issues a patient is currently having, we are also setting them up for a lifetime of health, and likely improving the overall health of their children.

I would like to submit for your review a very important study entitled "The Economic Value of Physical Therapy in the United States". This recently published report scrutinizes many common health conditions that when managed by physical therapy not only saves healthcare dollars but also provides healthy, more permanent, effective, and less invasive treatments to patients seeking a cure.

Part of this report focuses on stress urinary incontinence, a common and potentially lifelong consequence of childbearing if left untreated. Choosing physical therapy over injections to treat urinary incontinence results in an average net benefit of $10,129 per episode of care. Thus, PT for this condition and many others I have mentioned should be a first line of care for patients suffering from these conditions. Physical therapists are direct access practitioners and do not need referral from physicians but are excellent at triaging and referring patients as necessary.

I submitted this statement as well as the aforementioned reports to your work group and also entertain any questions you may have.

Attachments:
Value of PT_SUI.pdf
economic_value_pt_u.s._report_from_apta-report.pdf
Impact of parents physical activity.pdf

The Economic Value of Physical Therapy in the United States

A Report From the American Physical Therapy Association

September 2023

APTA
American
Physical Therapy
Association

Foreword

The American Physical Therapy Association's vision is "transforming society by optimizing movement to improve the human experience." All our efforts — whether through advocacy on Capitol Hill, federal agencies, payors, or state legislatures, as well as leadership in setting professional standards, or increasing consumer awareness of the benefits of physical therapy — focus on achieving this vision.

Physical therapists and physical therapist assistants provide undisputed value to individuals in their health journey and toward their quality of life, delivering cost-effective services within the U.S. health care system. Collectively, healthier individuals result in a healthier society, which delivers value to individuals, communities, and countries. A commitment to this ideal is central to who we are and what we do as the American Physical Therapy Association and as physical therapists and physical therapist assistants.

In recent years, the physical therapy profession, along with our colleagues in other areas of health care, has weathered particularly difficult times. A global pandemic and the ensuing economic crisis disrupted the already fluctuating environment of a continuing transformation of the health care system. The result has been continued cuts in payment and a growing administrative burden that make it increasingly challenging to provide quality patient care. Throughout this ongoing evolution, and particularly during the public health emergency, physical therapists and physical therapist assistants have stepped up and provided heroic care. It is critical, now more than ever, to act with intention to show just how valuable physical therapy is, not only to individuals but also to the health care system and our national economy. It is imperative that we make clear the important role physical therapists and physical therapist assistants play in providing access to quality health care and why coverage for physical therapist services is essential.

Demonstrating value in health care and in physical therapy is not new. In 2006, Porter and Teisberg published the landmark article "Redefining Health Care: Creating Value-Based Competition on Results" in the Harvard Business School Press, which is widely credited with initiating the current value-based era. The article aligned with the federal Tax Relief and Health Care Act passed that same year. This law initiated value-based purchasing under Medicare through a program to incentivize payment for outcomes, and physical therapists were eligible to participate. A 2013 article by Jewell, et al., "Delivering the Physical Therapy Value Proposition: A Call to Action," published in PTJ: Physical Therapy and Rehabilitation Journal, further expanded the value proposition for the physical therapy profession.

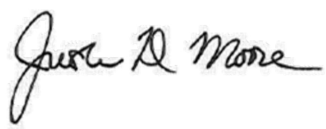
For decades, our profession has delivered cost-effective care and engaged in efforts to demonstrate this to policymakers and the public. Researchers have shown the effectiveness of our practice through a growing body of evidence that supports the high-value, lower-cost interventions physical therapy offers the health care system and patients. Our new report, "The Economic Value of Physical Therapy in the United States," is based on this body of evidence. It consolidates the case we are building into one resource and illustrates the incredible value of physical therapy. This report is intended to be disseminated, discussed, and accepted by the public, policymakers, and payers for a healthier health care system for patients and populations.

While we cannot eliminate risk or fully address the challenges in front of us, the physical therapy profession can take steps to exercise our unique position of leadership to drive change and empower our members to be recognized as the outstanding health care professionals they strive to be. “The Economic Value of Physical Therapy in the United States” is the next step toward this goal.

Not only do these evidence-based findings demonstrate the value that physical therapists and physical therapist assistants provide today, but “The Economic Value of Physical Therapy in the United States” is a dynamic resource that will evolve over time and, more importantly, empowers APTA and its members, to tell our story, to engage policymakers, payers, employers, and consumers, and to begin to re-shape the ways in which those outside the profession understand and implement policies and programs to best leverage the value of physical therapy.

Do not just read this report — join us in sharing it and using it to its full potential to benefit the physical therapy profession and society for today and in the future.

Roger Herr, PT, MPA
President



Justin D. Moore, PT, DPT
Chief Executive Officer

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Executive Summary

The American Physical Therapy Association engaged Nous, an international management consultant, to examine the costs and benefits of eight condition-based physical therapist services, each of which was chosen based on the prevalence of the condition and its associated level of healthcare spending across the United States.

This report presents the results of this analysis by synthesizing the available clinical research on services delivered for each of the eight conditions and drawing comparisons between physical therapist services and non-physical therapist treatments, based on the costs associated with providing care and the benefits generated within the American health care system.

Physical therapy was found to have a net economic benefit over the alternative treatment for each of the conditions.

To create a robust basis for all claims of cost-effectiveness, we took a conservative approach to assess the net benefit of each course of care. Potential indirect, or flow-on, benefits, such as marginal productivity increases, were therefore left out of the calculations. The cost of care delivered comprised the cost of the services rendered as well as the potential cost of the patient's time spent attending physical therapy sessions (including estimated travel time to and from appointments) and, when applicable, performing their prescribed exercises.

The results show that the suite of physical therapist services investigated were clinically effective and delivered net economic benefits, with improvements in patients' quality of life exceeding the net cost of the care delivered

The eight conditions analyzed for this report, and the average net benefit of physical therapist services per episode of care, are summarized below.

Osteoarthritis of the knee	Carpal tunnel syndrome	Low back pain	Stress urinary incontinence
$13,981	$39,533	$4,160	$10,129
Lateral epicondylitis (tennis elbow)	**Vascular claudication**	**Falls prevention**	**Cancer rehabilitation**
$10,739	$24,125	$2,144	$3,514

The results in this report demonstrate that, where medically appropriate, more widespread use of the selected physical therapist services would deliver both health and economic benefits to patients and to the U.S. health care system.

A wider range of conditions initially was considered and then narrowed down to the eight in the report, based on specific economic evaluation criteria applied to the currently available research evidence base. As stronger evidence becomes available, additional conditions may be considered for analysis and inclusion in the future versions of this report. We have identified these potential conditions in the **Future Additions to the Report** chapter.

Glossary of Terms

Item	Description
Avoided costs	Avoided costs refer to a benefit assessed in terms of the costs not needing to be incurred in the alternative scenario.
Benefit-to-cost ratio	The benefit-to-cost ratio is the dollar value of economic benefit per dollar value of cost (not included where net costs are negative).
Confidence interval	The confidence interval is a range of values that is likely to include a population value with a certain degree of confidence.
Cost-effective	The World Health Organization defines an intervention as cost-effective if it costs three times the gross domestic product per capita to save a year of life. In many jurisdictions, government agencies use the value of a statistical life year, or VSLY (see definition below), in cost-benefit analyses to estimate the value of a healthy life year, which is based on observed marketplace risk valuations and is also around three times GDP per capita. Interventions that cost less in order to produce a quality-of-life year, or QALY (see definition below), gain are deemed highly cost-effective.
Efficacy	Efficacy is the ability of an intervention to produce an intended result, usually some improvement in length or quality of life. Efficacy is typically established in comparison with available alternatives. These types of comparisons are often made in randomized clinical trials.
Epidemiological/Markov modeling	An epidemiological model is a mathematical and/or logical representation of the epidemiology of disease. A Markov model is an epidemiological model that uses disease states to represent all possible consequences of a chosen intervention.
Incremental cost	Incremental cost is the cost added by an intervention above and beyond the alternative or current state.
Medicare Benefits Schedule	The Medicare Benefits Schedule, or MBS, is a list of the health care services covered by the federal government under Medicare for the program’s beneficiaries.
Manual Therapy	Also called manipulative therapy, it is a physical therapist intervention that uses specific, hands-on techniques without the assistance of devices or machines.
Meta-analysis	Meta-analysis is a category of systematic review that use a quantitative, formal, epidemiological study design to systematically assess the results of previous research and derive conclusions about that body of research. The benefits of meta-analysis include a

	consolidated and quantitative review of a large, often complex, and sometimes seemingly conflicting body of literature.
Net-benefit	Net benefit is the average net economic benefit delivered per episode of care, calculated as quality-of-life benefits minus net costs (which may be positive or negative).
Opportunity cost	Opportunity cost is the value of an activity forgone in order to pursue an alternative activity. Because resources are finite, every choice about how to use them is also a choice to forgo other options. In the case of health care interventions, the patient's time is considered an opportunity cost because time might have been spent otherwise.
QALY	The quality-adjusted life year, or QALY, is a measure of both length and quality of life for which years of life lived with less than full health are assigned a lower value than healthy life years. It is calculated by multiplying each life year by a number between 1 and 0, where 1 (full health) and 0 (death). The calculation considers dimensions such as mobility, self-care, ability to undertake usual activities, pain and discomfort, and anxiety and depression.
Randomized control trial	A randomized controlled clinical trial is a quantitative, comparative, controlled experiments in which investigators randomly allocate subjects to two or more groups, treating them differently (e.g., intervention and "usual care" or alternative care), and then comparing and measuring their responses to ascertain the efficacy of an intervention.
Systematic review	A systematic review attempts to collate existing empirical evidence that fits prespecified eligibility criteria to answer a specific research question. The key characteristics of a systematic review are a clearly stated set of objectives with predefined eligibility criteria for studies; an explicit, reproducible methodology; a systematic search that attempts to identify all studies that meet the eligibility criteria; an assessment of the validity of the findings of the included studies (e.g., through the assessment of risk of bias); and a systematic presentation and synthesis of the attributes and findings from the studies used.
Telehealth	Telehealth is the use of telecommunication techniques for the purpose of providing telemedicine, medical education, and health education over a distance. Telehealth services use information and communication technology to transmit voice, data, images and information remotely rather than having care recipients, health professionals, and/or educators communicate in person. It encompasses diagnosis, treatment, preventive (educational) and curative aspects of healthcare services.
VSLY	The value of a statistical life year, or VSLY, is an estimate of the value society places on a year of healthy life.

Background and Context

Physical therapists play a crucial role in the U.S. health care system.

Physical therapists are licensed health care professionals who improve the quality of life of thousands of Americans each year through the prescription of therapeutic exercise, hands-on care, and patient education. There are more than an estimated 300 million physical therapy visits annually in the United States (IBIS World, 2022) in settings ranging from private clinics to local hospitals to residential care facilities (Oster, 2020). The profession is estimated to be worth $46 billion dollars and has sustained an annualized growth rate of 3.2% between 2017 and 2022 (IBIS World, 2022). The profession is subject to the fluctuations of U.S. government health policy and changes in private health coverage, which not only influence the potential for growth but deeply impact the health and well-being of America's growing and aging population.

The research reviewed in this report indicates that physical therapist services are valuable and cost-effective for a broad range of clinical indications. Physical therapist services can be valuable both as an alternative to other interventions (as in the case of surgery for osteoarthritis) and as a complementary form of therapy (as with pre-and post-surgery).

Physical therapists treat a wide range of conditions for individuals across the lifespan throughout the entire U.S. population. Many physical therapists become board certified to specialize their practice in specific areas such as geriatrics, pediatrics, women's health, sports, neurology, cardiovascular and pulmonary, clinical electrophysiology, wound care, oncology, and orthopedics. The role of physical therapists as entry-point providers is growing along with the recognition of their crucial role in improving the quality of life of their patients (Bodenheimer, 2021).

Payment for physical therapist services comes in full or in part from a variety of sources such as Medicare, Medicaid, worker's compensation, and private insurance. While insurance companies control how much is paid for health care, most plans include medically necessary health services, which may include physical therapy, depending on the plan. Plans that offer partial coverage may require individuals to pay out of pocket until they reach a deductible, and then pay 70%-90% of the remaining costs, with the individual responsible for a per-visit copayment. To limit the individual's obligation, plans often will place an annual limit on what the patient must pay, covering any amount above the limit (Bodenheimer, 2021). Limited or lack of insurance coverage may function as a high barrier (Carvalho, 2017; Curry, 2021; McCallum, 2010) to receiving physical therapist services for many Americans. These barriers may compound as rapidly changing leadership and priorities within state and federal government may further limit access to physical therapist services.

Demand for Physical Therapy Is High and Will Continue to Grow

Demand for physical therapy is expected to rise, largely due to an aging population and an increase in chronic conditions. For example, as the population ages, there is a higher incidence of musculoskeletal conditions and injuries that can be treated by physical therapists (IBIS World, 2022).

The COVID19 pandemic has highlighted the myriad benefits of physical therapy. During the pandemic when patients were unable to pursue elective surgeries, physical therapy was considered an essential service to help individuals manage condition-related symptoms and pain. Respiratory physical therapy was also used to aid in the rehabilitation of patients with COVID-19 by clearing obstructed airways and improving oxygenation (Tozato, 2021). Physical therapists also help prevent and treat patients from intensive care unit weakness after experiencing severe or long-term COVID-19 symptoms (Goulart, 2021). The pandemic also pushed physical therapists to adopt new methods of practice such as telehealth — with an increase from 2% to 48% of physical therapists in the U.S. providing video consults between 2020 and 2021 (APTA, 2021).

As a result of demand growth, the employment of physical therapists is projected to grow, with over 15,400 openings for physical therapists annually on average, between 2021 and 2031 (LaRosa, 2019).

This Report Aims to Quantify the Economic Value of Physical Therapy Across a Variety of Interventions

It is vital that changes in health policy reflect the increased need for easier access to physical therapy to support the healthcare needs of the population across the country. Physical therapist services can help contain the costs of care by preventing the need for expensive treatments, reducing the reliance on pain medications including opioids, and improving patients' overall quality of life. Thus, the quantification of the economic value of physical therapy will provide an opportunity to engage with policymakers and insurance providers, highlighting the medical, social, and economic need for physical therapists and creating a strong case for policy change and coverage enhancement.

APTA engaged Nous to analyze and estimate the average total cost of delivering the services for each condition highlighted in this report, balancing it against the average total benefits that arise from the care delivered. It is important to recognize that the analysis considers an average patient receiving typical physical therapy care; it is not intended to reflect patients at an individual level. The benefits can vary substantially due to a patient's health condition, health care coverage plan, and state of residence. The resulting calculations provide an estimated average net economic benefit that arises for every episode of care for a patient, offering a robust estimate of the value physical therapy delivers to the U.S. population.

Approach and Methodology

To quantify the economic value of physical therapist services for various conditions, we combined a detailed literature review and input from subject matter experts with trusted health economics methods and modeling.

Intervention Selection

We first identified conditions and applicable interventions that were the most quantifiable, as they would be best suited to being included in our economic model. This does not mean that excluded interventions are not effective physical therapist services, only that they may have lacked sufficient literature that could be accessed within this project's timeframe. These excluded interventions can be targeted for further research to quantify their economic value.

The eight chosen interventions reflect a variety of patient demographics, stages of life, and the breadth of physical therapist practice — criteria that were central to having a well-rounded selection of condition-based interventions for the project.

Study Selection

To build the evidence base that supports each intervention's value within our economic model, we conducted an extensive literature review, searching research repositories such as PubMed and the Physiotherapy Evidence Database, or PEDro. We reviewed a variety of study types — including randomized controlled trials, epidemiological modelling, simulations such as decision tree models, meta-analyses, and systematic reviews — to better understand each intervention's efficacy and effectiveness, and to establish a solid evidence base.

Evidence was prioritized by:

1. **Relevance:** Studies that focused on a specific PT-led intervention, with a relevant non-PT-led treatment option in comparison (typically a surgical or pharmacological intervention); studies that estimated the benefits and costs of the interventions (including quality-adjusted life years or equal value of life years gained, or QALYs and evLYGs); and studies that were based in the United States or were comparable, by approach and cost, to treatment within the U.S. health care system.
2. **Robustness:** Higher-level study designs, such as RCTs, meta-reviews, large sample sizes, and simulations (as done in the "falls prevention" study design); and those with detailed descriptions of specific elements to be used in the economic analysis, including descriptions of the specific activities involved in the intervention, estimated treatment costs, and tracking of outcomes over time.
3. **Recency:** Studies that were completed and published in more recent years.

While this report uses the best available literature for economic modelling for each condition-based intervention, some interventions have weaker evidence than others. We identify these gaps in evidence and suggest when further research would help with future modeling or when evidence from a study outside the United States has been adapted to apply to the U.S. health care system.

For example, if there was not enough evidence from U.S. studies related to an intervention area, we adapted comparable evidence from relevant health systems in other nations. In other cases, alternative studies were used or a decision was made not to pursue an economic analysis of a given condition.

To maintain consistency across different studies, we sought literature that estimates the QALYs of an intervention, among other appropriate measures. For a closer look at how and why these metrics were used in creating our economic models, read “Using QALY, evLSY, VSLY, and VSL” below.

The studies used for the intervention comparisons are listed in the appendix for the technical report.

Determining the Net Benefit of Physical Therapy.

The net benefit for each condition-based intervention area is derived from subtracting the net costs from the calculated benefits. While the net benefit calculation is based on a single episode of care, the savings and costs reflect the impact on the health care system, including all entities that paid for or received the benefits: patients, providers, insurers, policymakers, and others.

The aim is for this cost-benefit analysis to consider social and environmental effects, borne by society as a whole as a result of a care delivery option.

There are four aspects to determining the value of physical therapist services. They can be either financial, such as direct expenses for services and equipment, or nonfinancial, such as improved quality of life and the value of time saved or spent:

1. **Direct benefits.** These include improvements to the patient’s qualify of life such as reduced pain, increased mobility, reduced burden of disease, and longer life expectancy, as well as lower impact either from or on other conditions. Direct benefits were calculated by estimating the change in quality of life experienced by a patient receiving physical therapy compared with a patient receiving an alternative treatment.
2. **Indirect benefits.** These include avoided or reduced costs of receiving informal care or receiving other provider services related to the condition. The literature used in our economic analyses did not look at productivity improvements across interventions in a consistent manner, and so this report takes a conservative approach and does not include indirect benefits of productivity improvements in its calculations.
3. **Costs.** These include direct and indirect tangible expenses such as fees for physical therapy visits, medications, procedures, and equipment purchases; and intangible costs such as time spent and opportunities lost.
4. **Avoided costs.** These represent the expenses that would have been incurred had the patient used the alternative intervention. They may be direct, such as copays, or indirect, such as shorter waiting periods for a physical therapist compared with a physician. Avoided costs also include physical therapist services that reduce a patient’s reliance on other services.

For more detail on how costs were calculated, see “How Net Costs Are Derived” below.

To assess each condition-based intervention area, we included the following quantifiable benefits and costs:

1. **Quality-of-life improvements converted to dollar values (direct and, to a lesser extent, indirect benefits).**
2. **The costs of delivering the intervention.**
3. **Dollar values attributed to the time the patient spends being treated and opportunities lost by the patient while being treated.**
4. **The avoided costs of the alternative treatment.**

When the economic value attached to the quality-of-life improvements (No. 1) exceeds the net cost of care delivered (No. 2 plus No. 3, minus No. 4**),** the intervention delivers a net benefit. This represents our best estimate of the dollar value of the benefit delivered with physical therapy and is compared with the alternative treatment. (With calculations for net benefits done at the decimal level, some rounding errors should be expected in the final calculated net benefit values.) In all of our examples, the net benefit is greater than the net benefit of the alternative treatment, meaning the physical therapist intervention has a positive economic value and contributes to APTA's vision of transforming society.

Benefits and costs are measured in 2022 U.S. dollars. Inflation is accounted for using the Consumer Price Index reported by the U.S. Bureau of Labor Statistics, applied as an average since the original year of the study or studies used in each analysis.

When a study used a different currency, it was converted to U.S. dollars using the 10-year average exchange rate for that currency.

How Net Costs Are Derived

Net costs consist of the cost of physical therapist services (whether paid by the individual, employer, public health payers, or private health insurers) plus the opportunity cost of patient time, minus the avoided costs of the alternative treatment when replaced by physical therapy.

The studies used in this report present costs in two main ways:

1. A single estimate of the complete cost of care delivered for the patient based on database reviews.
2. A more detailed breakdown of direct and indirect costs of the intervention for the patient and intervention provider.

The way costs are presented in a study do not influence the positive economic value of an intervention.

For cost breakdowns, categories include:

- Direct intervention costs, such as fees for physical therapist services (including consultations), medications, procedures, and equipment purchases.
- Direct nonintervention costs, such as pain medication post-surgery.

- Indirect costs, such as patient travel.

Direct costs are further categorized by intervention provider, such as physical therapist, occupational therapist, urgent care provider, and social or community care provider.

Direct costs of consultation are taken from the applicable study where possible. Where not possible, a physical therapy consultation cost of $125 is used. This cost estimate covers the estimated average total cost of a single intervention to society as a whole, not the out-of-pocket cost to the patient.

Estimates for the opportunity cost of patient time included time spent during physical therapist visits (including consultations) plus travel time. We assumed a 30-minute commute one way to and from each session. There is not a definitive source for the commute time, but recent studies suggest 30 minutes as a reasonable time frame (Sørensen, 2014; Rocque, 2019). In most cases, the value of patient time is estimated at $25.35 per hour, which is the inflation-adjusted midpoint of the value of business and nonbusiness per-person hours (Nous Group, 2020).

Use of QALY, evLYG, VSLY, and VSL

Although methods for estimating the economic value of quality of life all have limitations, we sought research that used metrics best suited for direct comparison among studies. These included quality-adjusted life years, equal value of life years gained, and value of a statistical life year, or VSLY.

Quality-adjusted life years are designed to apply a value to changes in a person's life expectancy and the quality of life they experience during their lifetime (Prüss-Üstün, 2003). This allows the impact of interventions for different clinical indications or conditions to be measured in the same units; for instance, reduction in pain levels versus improvement in mobility. We used QALYs only for making comparisons; they were not intended, nor would we condone their use, to reduce the value of an intervention due to the severity of a person's illness, age, or disability.

In most cases, the QALYs in the studies reviewed for this report are a combined measure of mobility, pain, mental well-being, and other indicators, making it a comprehensive indicator of outcomes.

Equal Value of Life Years Gained assigns a value to life extension regardless of the impact on the quality of those extra lived years (ICER, 2022; O'Day, 2021). Where applicable, we modeled the difference between the QALY-related and evLYG-related benefits and qualified them in our findings.

To quantify the benefits of a physical therapist intervention in dollar terms, we multiplied QALYs by the VSLY. The VSLY is estimated based on the value of a statistical life, which represents the dollar amounts willing to be spent within the health care system to reduce risks of mortality in society.

There is no universally accepted VSL value that is applicable to our economic model. After reviewing several options, we chose VSL estimates in insurance and health fields in the United States and, alternatively where applicable, international values.

We were conservative in selecting a VSL value, as the higher the VSL value, the "better" interventions appear. As a basis for comparison, we used a recent study (Sweis, 2022) that estimates a U.S. median VSL value of $7.2 million, with an upper value of $12 million and lower value of $5.4 million.

As a result, per the recent study, the VSLY is estimated to be $251,634 (in 2022 U.S. dollars), determined from the median VSL of $7.2 million for 2020. VSLY was calculated using the formula:

$$VSLY = \frac{r \times VSL}{1 - (1 + r)^{-L}}$$

where, *r* is the discount rate (a percent rate used to calculate present value of a future dollar amount; usually used in financial analysis to discount future cash flows) and *L* is life expectancy.

The calculation assumes a 3% discount rate and a U.S. average life expectancy of 77.28 years, and adjusts the 2020 VSL value for inflation using the November 2022 10-year average U.S. inflation rate of 2.29% (FRED, 2023).

Upper and lower VSLY values are estimated at $419,389 and $188,725, respectively.

Our findings for VSLY and the variation in VSLY are supported by broader discussion on this topic. A 2015 study by Lakdawalla et al. found the values for a statistical life year ranged from $40,000 to $400,000 (Lakdawalla, 2015). The study, which assessed costs and benefits specific to progression-free survival in non–small cell lung cancer, adopts $100,000, $200,000, and $300,000 as the low-, medium-, and high-patient-benefit scenarios.

Given the large variation in VSLY values, we use the published Australian VSLY to inform the US VSLY value and confirm proximity to our estimate of $251,624 for the US VSLY value, described in this chapter.

The VSLY in Australia is 227,000 AUD in 2022 dollars (Department of the Prime Minister and Cabinet (Australia), 2022). To derive an estimate of the U.S. VSLY, we consider both the exchange rate and the gross domestic product based on purchasing power parity (OECD, 2012). Our calculations generate the following:

$$(GDP\ per\ capita\ PPP)_{AU:US}\ \times Exchange\ rate \times VSLY_{AU} = VSLY_{US}$$

$$1.446\ \times 0.67 \times 227{,}000 = VSLY_{US}$$

$$219{,}922.14\ \ USD = VSLY_{US}$$

The report recognizes the limitations in the use of VSLY, which is derived from an estimate of an individual's willingness to pay to reduce their own mortality. For the purposes of this report, we assume a constant and conservative VSLY value. However, we recognize that VSLY is dependent on population characteristics, such as age and changes in socioeconomic status that can create variations in the value. In addition, the willingness to pay per QALY is also dependent on other factors, such as the severity and duration of a health condition (Robinson, 2017). Relative to commonly used VSLY measures in the US, our value for VSLY remains conservative but about 14% higher than the converted Australian VSLY value.

Additionally, we have sought to estimate the "cost per QALY gained" for each intervention, which is calculated by dividing the net cost of the physical therapist service and the comparative treatment by the net units of QALY gained between the two modes of care. This metric is compared with the VSLY value, where a "cost per QALY gained" that is lower than the VSLY indicates physical therapy is a cost-effective mode of care.

The Episode of Care

The net benefit of an intervention generally is calculated per episode of care for one person over the course of 12 months, as most studies provide QALY and cost-effectiveness data over the span of one year.

Longer time spans. Some studies, such as (Handoll, 2015), provide cost-analysis data using a time span over two or more years but provide QALY data for a single year. The difference does not affect the underlying positive economic value of the benefits of an intervention but does affect the magnitude of the benefit.

In these cases, we would need evidence of longitudinal change in the QALY to ensure accurate calculations of the intervention's economic benefit. Because this is not available for all interventions, we maintained the 12-month timeframe.

Also, for chronic conditions such as ongoing back pain, the net-benefit calculations reflect the annual value of improvement being seen for as long as treatment continues.

Shorter time spans. In some cases, such as treatment in the emergency department, an economic benefit calculation based on 12 months may not be possible given the information provided in the literature, and a shorter time frame was used. Where the literature includes information on the variation in results between different patients in the sample, a range was calculated for the net-benefit estimate.

Preventive care. In some cases, there is no injury or condition, and preventive physical therapy is compared with no treatment, such as physical therapy to prevent future falls among older adults. The benefit is not an improvement in QALYs, but instead physical therapy is a cost incurred now to prevent a loss of QALYs in the future.

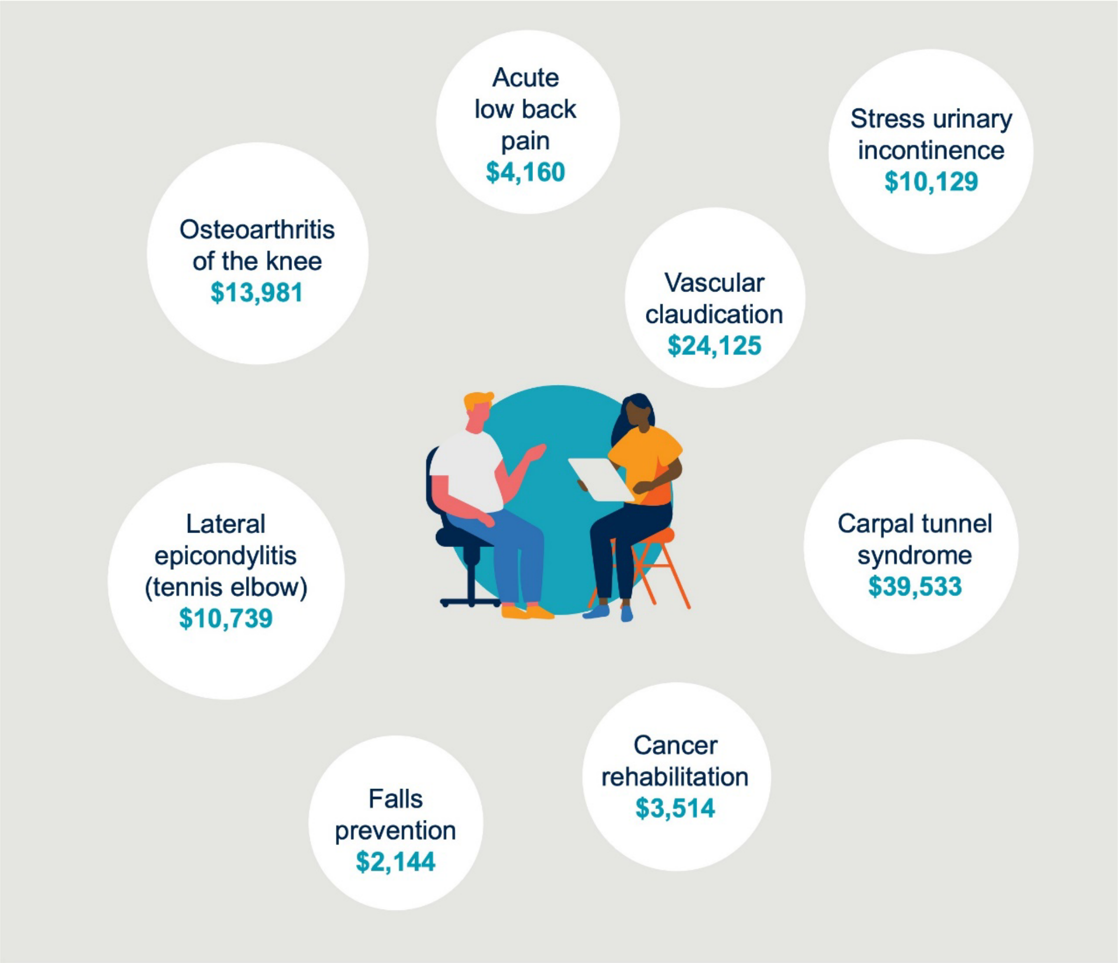
Summary of findings

Physical therapy provides value to Americans across a variety of conditions at all stages of life.

Physical therapists provide a wide range of services to help people maximize their quality of life. They work with people of all ages and abilities, and in a variety of settings. They help people rehabilitate from devastating injuries, manage chronic conditions, avoid surgery and prescription drugs, and create healthy habits. In many cases, physical therapist services are a cost-effective alternative to another course of treatment. In others, physical therapy combined with other treatments optimize patient outcomes. And sometimes, physical therapy provides a protective and preventive impact on future challenges and complications. This report investigates physical therapist services for eight different conditions, comparing physical therapy against an alternative course of treatment and quantifying the average net benefit in economic terms.

For each condition, the estimates indicate the average net economic benefit of physical therapist services. However, individual factors may produce variations in the net impact experienced case-by-case. For some, physical therapy will provide a greater net benefit than the average, while for others it will be lower. For this reason, we used conservative assumptions when estimating the net benefit and, where applicable, the benefit-to-cost ratio (for more details on this, see the **Approach and Methodology** chapter).

The Net Economic Benefit of Choosing Physical Therapy for Eight Conditions Analyzed



Physical therapy can benefit both individuals and the health care system.

For many of the conditions analyzed in this report, physical therapist services improve patient quality of life across dimensions such as mobility, self-care, usual activities, pain or discomfort, and anxiety or depression.

Physical therapy also can prevent unnecessary future health expenditures, which may be realized through avoiding a more costly alternative treatment and/or reducing the need for future medical intervention. The benefits of this can often be multi-faceted, generated through both quality-of-life improvements for the patient and cost benefits for payers. However, defining how different stakeholders realize the future benefits of physical therapy can be difficult to determine.

Cost benefits of physical therapist services may be realized as reduced out-of-pocket expenses for patients, reduced insurance payments for private health insurers, and reduced overall health expenditures for the government. In some cases, benefits are not realized in the form of current cost savings but instead as avoided future medical services. For example, physical therapist services that help prevent falls can result in reduced admission and readmission rates for emergency departments. This generates the potential for lowering future costs by limiting the demand for certain services. In addition, fewer admissions from falls can reduce wait times and open up more beds for patients who are admitted for other injuries or illnesses.

While our analyses did not attempt to allocate the impact of reduced costs to individual potential beneficiaries, this report separately identifies net cost reductions and quality-of-life improvements to help policymakers and payers understand the implications for overall health system costs.

Finally, while this report maintains an overall conservative approach to estimating the economic value of physical therapy and so does not include indirect benefits related to improvements in workforce productivity, physical therapy can and does make an overall contribution to the U.S. economy and society. For example, physical therapist services for back pain enable skilled employees to return to work more quickly.

Physical therapists can continue to innovate to further enhance the value they provide.

The importance of the physical therapy profession has been underscored by the COVID-19 pandemic. Physical therapists played an instrumental role in the rehabilitation and recovery of COVID-19 patients, particularly patients who experienced severe symptoms or required hospitalization (Thomas, 2020). They helped individuals regain strength, mobility, and function after prolonged periods of bed rest or intensive medical treatment.

Despite significant obstacles, the physical therapy profession has shown itself to be robust and adaptable, continuing to offer essential services, particularly through adoption of digital service delivery methods such as telehealth. By increasingly leveraging video conferencing and remote monitoring tools, physical therapists can provide care without the need for patients to travel to the clinic, reducing costs associated with travel. Taking advantage of these changes will further improve patient access and choice, which will be particularly true for isolated and rural areas where access to physical therapist services is frequently constrained. Despite the potential, however, the profession recognizes that telehealth is but one tool for physical therapists to choose from and will not be appropriate for every patient or every condition (particularly in cases where manual manipulation is required).

Similarly, with better insurance coverage and a focus on preventive care and patient education to minimize the likelihood of injuries or recurring issues, physical therapists will be able to continue giving patients the knowledge and skills to manage their conditions on their own, while lowering the need for prolonged treatment and thus overall costs.

Enhanced payment and coverage structures will also help drive a collaborative care and interdisciplinary approach for physical therapists with other health care professionals such as physicians, nurses, occupational therapists, speech-language pathologists, dietitians, behavioral health providers, and others.

Osteoarthritis of the Knee

Summary of Findings

Description

Osteoarthritis, or OA, is a degenerative and progressive joint disease affecting more than 32 million people in the United States (Katz, 2021; Mora, 2018). Risk factors include being older, being female, obesity, genetics, and joint injury.

Though OA can impact any joint, it most commonly affects hands, knees, hips, and feet. It is characterized by joint dysfunction, pain, stiffness, functional limitation, and inability to conduct activities such as walking and dancing (Wallace, 2017). Inactivity or insufficient mechanical stimulation can lead to more rapid degeneration (Mora, 2018).

Treatment for OA involves managing pain of the affected joints and improving overall function and quality of life.

Knee OA is the most common type of arthritis, and its prevalence has doubled in the last 70 years (Wallace, 2017). A 2022 study by Huizinga and colleagues showed that in the United States, symptomatic knee OA was one of the leading causes of chronic musculoskeletal pain for which opioids are frequently prescribed (Huizinga, 2022). The study also highlights the lasting effects of widespread opioid prescriptions for symptomatic knee OA — over a lifetime, the population receiving these prescriptions generated $14 billion in total costs in 2021, only half of which were direct medical costs. Indirect costs included diversion (defined as accessing the drug through an alternative access path, such as misuse of prescriptions of a relative or friend), and criminal justice costs.

Study Selection

This economic analysis uses the 2022 study “Cost-Effectiveness of Physical Therapy vs Intra-articular Glucocorticoid Injection for Knee Osteoarthritis,” by Rhon et al., published in JAMA Network Open (Rhon, 2022). The study examines the cost-effectiveness of physical therapy compared with intra-articular glucocorticoid injections. It was chosen for its relevance to the U.S. population, robustness of methodology, availability of details to support cost-benefit modeling, and recency of publication.

Research Findings

Measures to determine outcomes for treatment of OA typically involve:

- Improvement in patient quality of life, such as reducing pain and increasing mobility.
- Cost of treatment:
    - Direct cost of care delivered, including consultations, treatments via usual primary care management, drugs, complementary testing, and physical therapist services.
    - Patient opportunity cost, including time for treatment and travel time.

Non-Physical Therapy-Based Treatment

Treatment for OA involves pharmacological approaches, including prescribed and over-the-counter medications, integrative health treatments, and invasive interventions.

Pharmacological treatments often involve prescription of cyclooxygenase inhibitors, such as acetaminophen and NSAIDs, for pain control. As many patients with OA are elderly with multiple comorbidities, long-term use of certain medications is likely to increase risk of adverse side effects.

Interventional treatment may involve intra-articular injections, typically using corticosteroids, for pain relief (Mora, 2018). Another approach is total knee arthroplasty.

Our economic analysis for OA compares glucocorticoid injections with physical therapy-based intervention. Although we look at these treatments separately, in practice, treatments may be combined. For example, patients with OA receiving physical therapist services often also take over-the-counter or prescribed medications.

Physical Therapist Services

There has been considerable research into the care delivered for OA of the knee by physical therapists. Evaluation of the literature indicates fitness walking, aerobic exercise, and strength training for these conditions can improve patient quality of life by reducing pain and increasing mobility (Bhatia, 2013).

Physical therapy-based interventions may include (Mora, 2018):

- Land-based therapeutic exercise.
    - Aerobic and endurance training, such as walking, climbing, and cycling.
    - Anaerobic exercise and/or resistance and strength training, such as exercise targeting quadriceps, hip abductors, and hamstrings.
    - Balance and proprioceptive training.
    - Stretching.
- Water-based therapy.
- Patient education.

The Rhon study focuses specifically on exercise, manual therapy, and education, as well as aerobic warm-up exercises.

Outcomes

The study's authors measured the cost-effectiveness of physical therapy for symptomatic knee OA compared with intra-articular glucocorticoid injections over a one-year period.

The randomized clinical trial involved 156 participants who met clinical and radiographic criteria for the presence of knee OA as established by the American College of Rheumatology.

Patients were randomly assigned to receive either physical therapy or intra-articular glucocorticoid injections. Outcomes were measured using the difference in Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) total scores at the one-year mark.

Physical therapy involved eight visits over four weeks, compared with an average 2.6 injections administered to those in the injection group (an injection can be delivered in a single consultation, with guidance for 72 hours of reduced activity, but in this study, more than one injection was often needed) (Deyle, 2016; Deyle, 2020).

Of those in the injection group, 14 eventually pursued physical therapy and four underwent surgery, indicating potential higher-than-expected costs for the injection group. No one in the physical therapy group had surgery; seven within the physical therapy group also received an injection. Those seven from the physical therapy group and 14 from the injection group who received treatment from the other arm were excluded from the economic analysis to more accurately evaluate the isolated impact and cost effectiveness of each course of care.

The results of the study found that the estimated quality-of-life benefit of treating knee OA with physical therapy compared with intra-articular glucocorticoid injections was an average gain of 0.07 QALYs. Using an estimated VSLY of $251,634 (in 2022 U.S. dollars) as described in this report's **Approach and Methodology** chapter, the 0.07 gain in QALYs equates to an average total benefit of $17,614.

For 95% of patients, the total benefit ranged from $17,614 (95% CI: $5,033, $32,712) to $20,131. This indicates that most patients who receive physical therapy for knee OA are likely to benefit from the intervention.

The total medical costs were $8,866 for physical therapy and $5,699 for injection. The participants who underwent physical therapy spent $3,167 more but gained an average 0.07 QALYs more than participants in the glucocorticoid injection intervention. Patient opportunity costs were estimated to be $750 per patient for the physical therapy group, based on an average of 14.8 hours of patient time (a one-hour initial consultation; an average of 11.8 PT sessions and two follow-up appointments, with each assumed to be 30 minutes long; and a 30-minute commute time one way per appointment), at a cost of $25.35 per hour.

Patient opportunity costs for the injection group were estimated to be $284 per patient, based on 5.6 hours of patient time (a one-hour initial consultation; 2.6 injection sessions and two follow-up appointments, each assumed to be 30 minutes long; and a 30-minute commute time one way per appointment).

Subtracting the additional estimated total cost of $3,633 of physical therapy compared with the intra-articular glucocorticoid injection from the $17,614 value of quality-of-life benefit provides an average estimated net benefit of $13,981 per episode of care.

Given a quality-of-life gain of 0.07 QALYs, this suggests a cost per QALY gained of $51,906, which is substantially less than the estimated VSLY in the U.S. in 2022 of $251,634. We can conclude that physical therapy is cost-effective.

Costs and benefits are estimated over a 12-month time horizon. Physical therapy for OA requires ongoing intervention, and therefore the estimates provided here are valid only if treatment continues.

Carpal Tunnel Syndrome

Summary of Findings

Description

Carpal tunnel syndrome, or CTS, is considered the most common entrapment neuropathy, affecting one out of 20 individuals in the United States. It occurs when compression of the median nerve at the wrist increases carpal tunnel pressure, resulting in numbness or burning sensations in the hand and reduced grip strength and movement (Joshi, 2022).

Common risk factors for CTS include, but are not limited to, gender, inflammatory conditions, pregnancy, diabetes, and hypertension. CTS is commonly identified as an occupational hazard, as people at highest risk have occupations that require forceful and often repetitive hand movements, such as office administrative staff and production workers.

Management of CTS involves both surgical and nonsurgical methods to reduce compression of the median nerve, minimize pain, and improve function. Diagnostic ultrasonography and electrophysiologic examinations may help to rule out conditions that can mimic CTS, to determine the severity of the condition, and to identify whether physical therapy is the appropriate course of care (Joshi, 2022). These testing procedures may be performed by physical therapists, and diagnostic testing is vital for patients, as delayed treatment can lead to hand muscle atrophy and irreversible nerve damage.

Without conservative or surgical management, CTS-associated costs were estimated to be between $21.8 and $39 billion from 2005 to 2012, or $2.7 to $4.8 billion per year (Hubbard, 2018). In addition to direct financial costs, untreated, the condition can progress to loss of hand function, lingering pain, and disrupted household routines (Dembe, 2001). On average, work-related CTS leads to 28 days of absence from work, and almost 23% of workers are unable to resume their previous jobs, even after undergoing surgery (Bureau of Labor Statistics, 2007). Between 2005 and 2012, approximately 1.5 million people were identified in the Medicare patient population as being diagnosed with CTS.

Study Selection and Additional Methodology

This economic analysis primarily uses the 2019 study “Cost-Effectiveness Evaluation of Manual Physical Therapy Versus Surgery for Carpal Tunnel Syndrome: Evidence From a Randomized Clinical Trial,” by

Fernández-de-las-Peñas, et al., published in the Journal of Orthopaedic & Sports Physical Therapy (Fernández-de-las-Peñas, 2019). This study was chosen due to its methodology, the availability of details to support cost-benefit modeling, and recency of publication.

The study examines the cost-effectiveness of physical therapy versus surgery for patients with CTS through a randomized controlled trial in Spain in 2019.

In addition, a study by Pomerance et al., “The Cost-Effectiveness of Nonsurgical Versus Surgical Treatment for Carpal Tunnel Syndrome,” published in the Journal of Hand Surgery, was used to determine baseline physical therapy cost values in a U.S. health care context (Pomerance, 2009). Costs were adjusted for inflation for the year 2022 following the same methodology addressed in the **Approach and Methodology** chapter.

Research Findings

Measures to determine outcomes for treatment of carpal tunnel syndrome typically involve:

- Improvement in patient quality of life, such as reducing pain and increasing mobility, using QALYs/evLYGs.
- Hand and wrist functional outcomes using the Boston Carpal Tunnel Syndrome Questionnaire.
- Cost of treatment:
    - Direct cost of care delivered, including consultations, surgery, and physical therapist services.
    - Patient opportunity cost, including time for treatment and travel time to and from appointments.

Non-Physical Therapy-Based Treatment

What is determined as optimal treatment greatly depends on the severity of the patient’s CTS. However, typical treatment may include immobilization with wrist splinting or pharmacological treatment through NSAIDS or corticosteroid injection (Joshi, 2022). Even with these treatments, symptoms can reappear.

If symptoms are severe, surgery may be needed to mitigate the risks of long-term complications. During the procedure, the flexor retinaculum is released to relieve pressure on the median nerve (Joshi, 2022). Recovery can take weeks or months and likely involve physical therapy to strengthen the wrist and hand (John Hopkins Medicine, n.d.).

Physical Therapist Services

Options for physical therapy-based interventions in place of pharmacological or surgical treatments may include (Joshi, 2022; Presazzi, 2011; Zaralieva, 2020; Erickson, 2019 Fernández-de-las-Peñas, 2020).

- Supervised exercise such as resistance/strength training (e.g., wrist flexor and extensor, finger flexor and extensor, etc.), nerve and tendon glides, and manual stretching/mobilization.
- Patient education.
- Superficial heat for short-term symptom relief.
- Trial of interferential current for short-term pain symptom relief in patients with idiopathic, mild to moderate CTS.
- Wrist brace orthosis.

Outcomes

The study's authors assessed the cost effectiveness and effect of physical therapy on CTS compared with typical treatment involving open or endoscopic release surgery over a one-year period (Fernández-de-las-Peñas, 2019). They found that physical therapist services for CTS can improve patient quality of life by reducing pain and improving function and nerve conduction.

The randomized clinical trial involved 120 women diagnosed with CTS according to clinical and electrophysical findings from a regional hospital in Madrid, Spain. Participants were randomly divided into two groups: surgical intervention or nonsurgical intervention using physical therapy. Three of the individuals originally placed in the latter group eventually pursued surgery and were excluded from the economic analysis.

Patients in the physical therapy group received three 30-minute sessions of manual therapy a week and one educational teaching session on performing tendon and nerve gliding exercises at home. Patients in the surgery group underwent either open- or endoscopic-release surgery, based on patient and surgeon preference. They also received the same educational teaching session. Health outcomes were measured at baseline and at each follow-up period (one month, three months, six months, and 1 year post-treatment) using the five-level version of the European Quality of Life-5 Dimensions scale and converted into QALY.

The results of the study found that the estimated quality-of-life benefit of physical therapy for CTS compared with surgery was an average gain of 0.135 QALYs. Using an estimated VSLY of $251,634 (in 2022 dollars) as described in this report's **Approach and Methodology** chapter, the gain in QALYs equates to an average total benefit of $33,971. For 95% of patients, the total benefit ranged from $33,719 to $34,222 (i.e., 95% CI: $33,719, $34,222).

Total medical costs were $7,468 (DartmouthHealth, n.d.) for the surgery group and $1,829 (Pomerance, 2009) for the physical therapy group. In this analysis, medical costs for the surgical intervention did not include the cost of post-surgical physical therapy or rehabilitation that is commonly prescribed for individuals who have undergone CTS surgery (Johns Hopkins Medicine, n.d.). Thus, true medical-related costs for those undergoing surgery may be higher than the estimated value.

Patient opportunity costs were estimated to be $317 per patient for the physical therapy group, based on eight hours of patient time (a one-hour initial consultation; three physical therapy sessions and four follow-up appointments, with each assumed to be 30 minutes long; and a 30-minute commute time each way per appointment), at a cost of $25.35 per hour.

Opportunity costs for the surgery group were estimated to be $241 based on six hours of patient time (a one-hour initial consultation; one-hour surgical treatment; four follow-up appointments, with each assumed to be 30 minutes; and a 30-minute commute time each way per appointment). In this analysis, patient opportunity cost estimation for the surgical intervention does not include participants' opportunity cost during post-surgery recovery time. It is estimated that recovery from CTS surgery can range from several weeks to months (Johns Hopkins Medicine, n.d.). As such, it is likely that true total patient opportunity costs are higher than the values estimated for the surgery group.

Adding the estimated total cost saved from physical therapist services compared with surgery (total medical cost plus patient opportunity costs) to the $33,971 value of quality-of-life benefit provides an average estimated net benefit of $39,533 per episode of care.

Given a quality-of-life gain of 0.135 QALYs, this suggests a cost per QALY gained of $41,206, which is substantially less than the estimated VSLY of $251,634. We can conclude that physical therapy for CTS is cost-effective.

Low Back Pain

Summary of Findings

Description

Back pain is a leading musculoskeletal disorder with a high occurrence, costly treatment, and significant effect on a person's quality of life.

A National Health Interview Survey found that in 2019, 39% of U.S. adults suffered from back pain, with older adults, women, and those with lower incomes more likely to experience it (Lucas, 2021). Although many cases of acute low back pain (lasting less than four weeks) resolve without intervention, one in three patients still have symptoms a year after an episode of low back pain (Ibrahim, 2022). Postponing physical therapy may result in higher overall medical costs and a higher risk of needing invasive procedures, such as surgery or injections (Arnold, 2019).

Back pain is the leading cause of missed-work days and work limitations (Georgetown Health Policy Institute, 2019) and can result in patients seeking emergency care. Low back pain-related costs have risen faster than overall health care costs (Dieleman, 2016). One study that looked at health expenditures associated with 154 conditions in the United States found that low back and neck pain generated the highest spending in 2016, at $134.5 billion (Dieleman, 2020).

Study Selection

This economic analysis uses the 2017 study "Cost-Effectiveness of Primary Care Management With or Without Early Physical Therapy for Acute Low Back Pain: Economic Evaluation of a Randomized Clinical Trial," by Fritz et al., published in Spine (Fritz, 2017). It was chosen because of its relevance to the U.S. population, robustness of methodology, and availability of details to support cost-benefit modeling. Cost data from the study has been inflation-adjusted to reflect 2023 U.S. dollars.

The study is a randomized clinical trial examining the cost-effectiveness of physical therapy for acute low back pain compared with usual primary care management, which involves a waiting period of a few weeks to allow for spontaneous recovery before considering referral to a physical therapist or another provider.

Research Findings

Measures to determine outcomes for treatment of low back pain typically involve:

- Improvement in patient quality of life, such as controlling pain and restoring function (Pergolizzi, 2020).
- Improvement in psychosocial factors, such as reduction in pain-related fear-avoidance behaviors typically associated with disability and depression (Fujii, 2019).
- Cost of treatment:
    - Direct cost of care delivered, including consultations, treatments via usual primary care management, drugs, complementary testing, and physical therapist services.
    - Patient opportunity cost, including time for treatment and travel time.
    - Indirect costs, including home care, and childcare expenses.
    - Intangible costs, such as pain, emotional impairment, and loss of function (Lubeck, 2003).

The economic analysis in this report focuses primarily on direct costs and patient opportunity costs. Inconsistencies in measuring indirect and intangible costs limit the reliability of these measures; therefore, these have not been considered in the economic analysis for acute low back pain.

Non-Physical Therapy-Based Treatment

Treatment for back pain varies depending on the severity and length of the pain.

Acute low back pain treatments other than physical therapy typically involve primary care management, education and self-care, advice to stay active, modified work, deferred referral, and potential use of NSAIDS, such as ibuprofen (Hong, 2017; Traeger, 2021).

Patients whose pain does not respond to nonsteroidal anti-inflammatory drugs and other non-physical therapy first-line treatments may receive pharmacological therapy involving opioids, benzodiazepines, skeletal muscle relaxants, and tricyclic antidepressants (Traeger, 2021).

Those whose low back pain becomes chronic and is not responsive to non-invasive treatments may receive more invasive treatments such as intradiscal injections, radiofrequency denervation, or elective surgery.

Physical Therapist Services

For acute low back pain, physical therapy can involve patient education, manual therapies, and strengthening exercises that focus on trunk muscle activation and building endurance to reduce pain (George, 2021).

Physical therapy also can be used to treat chronic low back pain, such as directional preference exercises, which focus on rapid pain relief through exercises that include lumbar flexions and rotations performed in the patient's preferred or opposite direction (George, 2021), as well as manual therapies and patient education.

Outcomes

The study's authors measured the cost effectiveness of early physical therapy on acute low back pain compared with usual primary care management over a one-year period.

The clinical trial involved 220 participants with low back pain that lasted fewer than 16 days. Patients were randomly assigned to receive either physical therapy, which involved four physical therapy sessions consisting of spinal manipulation and exercise, or the usual care of advice to wait a minimum of four weeks. Clinical effectiveness outcomes were followed up through patient self-reporting at four-week, three-month, and one-year intervals.

The results of the study found that the estimated quality-of-life benefit of early physical therapy for acute low back pain compared with usual care was an average gain of 0.02 QALYs. Using an estimated VSLY of $251,634 (in 2022 U.S. dollars) as described in this report's **Approach and Methodology** chapter, the 0.02 gain in QALYs equates to an average total benefit of $5,033. For 95% of patients, the total benefit ranged from $1,258 to $8,807 (95% CI: $1,258, $8,807). This indicates that most patients who receive early physical therapy for low back pain are likely to benefit from the intervention.

Medical costs associated with physical therapy versus usual care, adjusted to 2023 U.S. dollars, were $1,205 (95% CI: $704, $1,706) and $536 (95% CI: $319, $751), respectively. This indicates that direct medical costs of physical therapy were $670 higher than usual care. The total cost, which takes into consideration both medical and patient opportunity costs, was $1,459 (95% CI: $957, $1960) for physical therapy and $586 (95% CI: $369, $802) for usual care. This implies that the physical therapy group had a mean QALY of 0.02 more than patients receiving usual care, at a higher mean total cost of $872.

All patients received an initial education session that provided information about and advice on managing acute low back pain. Patient opportunity costs were estimated at $254 for the physical therapy group, based on 10 hours of patient time (one education session and four physical therapy sessions, with each appointment assumed to be one hour long; and a 30-minute commute time one way per appointment) at a cost of $25.35 per hour. Opportunity costs for usual care were estimated at $51, based on two hours of patient time (one education session assumed to be one hour long, and a 30-minute commute time one way per appointment).

Subtracting the additional estimated total cost of $872 for physical therapy compared with usual care from the $5,033 value of the quality-of-life benefit provides an average estimated net-benefit of $4,160 (rounded) per episode of care for acute low back pain (and a benefit-to-cost ratio of 3.45).

Given a quality-of-life gain of 0.02 QALYs, this suggests a cost per QALY gained of $43,624, which is substantially less than the estimated VSLY of $251,634. We can conclude that physical therapy is cost-effective.

Stress Urinary Incontinence

Summary of Findings

Description

Stress urinary incontinence, or SUI, is the involuntary leakage of urine during actions that include exercise, coughing, laughing, or sneezing. It is the most common form of urinary incontinence in women and has also been reported in men. SUI can result from loss of support from pelvic floor connective tissues and muscles. Reasons for the loss include pregnancy, connective tissue disorders, and heavy lifting (Lugo, 2023). Additional risk factors include aging, obesity, smoking (Luber, 2004), urethral sphincter damage, and neurologic conditions. Treatment options for SUI can involve behavioral, physical, pharmacological, and surgical interventions, with all patients ideally receiving education about common bladder irritants, such as coffee or alcohol, that are likely to exacerbate the condition (Lugo, 2023). A 2011 study reports the direct expenditure associated with SUI in the United States as $13.12 billion per year (Chong, 2011).

Study Selection

This economic analysis uses the 2021 study “Impact of the Availability of Midurethral Slings on Treatment Strategies for Stress Urinary Incontinence: A Cost-effectiveness Analysis,” by Chang et al., published in BJOG, An International Journal of Obstetrics & Gynaecology (Chang, 2021). The study modelled different treatment options over a two-year period, based on success and complication probabilities extracted from a Cochrane Review. It was chosen for its relevance to the U.S. population, availability of details to support economic modeling, and recency of publication. Cost data from the study, stated in 2019 U.S. dollars in the study, has been inflation adjusted to reflect 2023 U.S. dollars.

For our economic analysis, we focused on treatment options that are not combined with midurethral sling in order to compare the isolated impact of physical therapy against an alternative and common treatment form called urethral bulking.

Research Findings

Measures to determine outcomes for treatment of SUI typically involve:

- Improvement to patient quality of life, as in minimizing urine leakage.
- Cost of treatment:
  - Direct cost of care delivered, including consultations, treatments via non-physical therapy-based and physical therapist services.
  - Patient opportunity cost, including time for treatment and travel time to and from appointments.

Non-Physical Therapy-Based Treatment

Several different treatment options exist for SUI ranging from behavioral options, such as bladder retraining, to pharmacological, surgical, and electrostimulation options. Pharmacological treatment options for SUI can involve estrogen replenishment (suitable for postmenopausal women) or tricyclic antidepressants that assist with urethral contractions (Lugo, 2023; Juneau, 2019).

A common intervention is injection of a bulking agent, which is less invasive and carries a lower risk of adverse effects than most surgical interventions (Mamut, 2017).

The practice of urethral bulking dates to the early 1900s and involves injecting materials such as collagen into the urethral mucosal layer (Mamut, 2017) using local anaesthesia to tighten the bladder neck's opening (Lugo, 2023). Multiple injections may be required for optimal management, as effectiveness can drop considerably over time (Lugo, 2023).

Physical Therapist Services

Pelvic floor physical therapy for SUI is typically recommended as a first line of care delivery and includes exercises to improve continence through conscious pelvic floor muscle contraction and relaxation. This helps build endurance and muscle coordination, providing support to pelvic organs and strengthening closure of urethral sphincter muscles (Alouini, 2022). Physical therapists also use biofeedback and/or electrical stimulation in conjunction with pelvic floor muscle exercise, bladder training, and manual and visceral therapy (Wójcik, 2023), as well as fitting and management of pessaries.

Outcomes

The study's authors used a probability-based model of seven different treatment options for stress urinary incontinence (Wójcik, 2023).

Given that the study is based on a model and not actual participants, the QALY benefit stated in this study was generated based on an assumption of 12 sessions. This is supported by the methods from a 2022 study by Cacciari et al. (Cacciari, 2022) and aligns with the primary study, which lists a physical therapy cost per session of $104 and total physical therapist service cost over two years of $1,241. For urethral bulking, the economic analysis assumes two sessions over the two-year period to generate the stated QALY benefit. This assumption is based on the decline in efficacy of urethral bulking agents over time, with one study reporting efficacy of collagen bulking agents at 48% at the 12-month mark and 77% of patients requiring additional treatment (Mamut, 2017).

The results of the Chang study found that the estimated quality of life benefit of physical therapy for stress urinary incontinence compared with urethral bulking was 0.009 QALYs. Using an estimated VSLY of $251,634 (in 2022 U.S. dollars) as described in this report's **Approach and Methodology** chapter, the 0.009 gain in QALYs equates to an average total benefit of $2,265. As this analysis used a model as opposed to actual participants, 95% confidence intervals are not calculated.

Direct intervention costs for physical therapist services versus urethral bulking were $1,359 and $9,729, respectively. This indicates that direct intervention costs of physical therapy were $8,371 lower than for urethral bulking. The total cost, which takes into consideration both direct and patient opportunity costs, were $1,967 for physical therapy and $9,831 for urethral bulking, for a difference of $7,864. Patient opportunity costs were estimated at $608 for physical therapy, based on twelve sessions, (each assumed to be one hour long; and a 30-minute commute time one way per session, at a cost of $25.35 per hour). Opportunity costs for urethral bulking were estimated at $101, based on least two sessions of urethral bulking and a 30-minute commute time one way per session.

Adding the estimated total cost saved from physical therapist services compared with urethral bulking (total intervention cost plus patient opportunity costs) of $7,864 to the $2,265 quality-of-life benefit provides an average estimated net benefit of $10,129 per episode of care for SUI (and a benefit-to-cost ratio of 33.9:1).

Given a quality-of-life gain of 0.009 QALYs higher and a mean medical cost of $7,864 lower than patients who received urethral bulking, we can conclude that physical therapy for SUI is cost-effective.

Lateral Epicondylitis (Tennis Elbow)

Summary of Findings

Description

Lateral epicondylitis, also known as tennis elbow, is an overuse injury caused by eccentric overload of the extensor carpi radialis brevis tendon. It is commonly caused by activities that include loaded or repeated gripping, such as tennis, squash, or badminton (Buchanan, 2022) and is most common in individuals older than 40 years of age (Johnson, 2007).

Despite its name, only 10% of the patient population is comprised of tennis players (Degen, 2018); as many as 15% of workers in highly repetitive jobs report having tennis elbow (Johnson, 2007). Annual incident of tennis elbow is between 1% and 3% in the U.S. Despite its prevalence, there is no single first-line procedure that is consistently prescribed for symptom management (Vaquero-Picado, 2017).

Study Selection

This economic analysis primarily uses the 2015 study “Economic Evaluation Favours Physiotherapy But Not Corticosteroid Injection as a First-line Intervention for Chronic Lateral Epicondylalgia: Evidence From a Randomized Clinical Trial,” by Coombes et al., published in the British Journal of Sports Medicine (Coombes, 2015). It was chosen due its robustness of methodology, its ability to be used for a U.S. population, and the availability of details to support cost-benefit modeling.

The study is a randomized clinical trial examining the cost-effectiveness of physical therapy and/or corticosteroid injection for tennis elbow in comparison to a placebo injection.

The analysis also used a 2016 study by Sanders et al., “Health Care Utilization and Direct Medical Cost of Tennis Elbow: A Population-Based Study,” published by Sports Health: A Multidisciplinary Approach, to determine the average costs of physical therapy and corticosteroid treatments for tennis elbow in the United States (Sanders, 2016).

Research Findings

Measures to determine outcomes for treatment of tennis elbow typically involve (Ma, 2020):

- Improvement in patient quality of life, such as controlling pain and restoring function.
- Reduction of pain.
- Cost of treatment:
  - Direct cost of care delivered, including consultations, medications, injections, surgery, and physical therapist services.
  - Patient opportunity cost, such as participants' lost leisure time and time loss due to work absence.

Non-Physical Therapy-Based Treatment

Treatment for tennis elbow depends on a variety of factors, such as severity.

Typical treatments often include short-term options such as topical or oral NSAIDs and corticosteroid injections. Less commonly prescribed treatments include a proximal forearm strap, topical nitrates, acupuncture, and Botox injections (Johnson, 2007). In severe cases of tennis elbow, surgery can remove damaged sections of the tendon and repair the remaining sections; it is effective in roughly 85%-90% of cases.

Physical Therapist Services

Physical therapy involves various interventions including manual therapy, orthotic devices, and therapeutic exercise programs, as well as dry needling and ice to manage pain on a short-term basis (Jones, 2009).

Orthotic devices, including tennis elbow braces, are prescribed in up to 21% of tennis elbow cases and have been shown to lead to significant pain reduction and increased grip strength (Lucado, 2022).

Exercise programs are often a combination of physical therapist-led exercises and patient education sessions. These programs improve the strength and flexibility of the forearm muscles to minimize future cases of tennis elbow, help support tendon healing, and reduce pain. They also may improve blood flow to the tendons to improve healing time (Cleveland Clinic, n.d.).

Outcomes

The Coombes et al. study (Coombes, 2015) examined the cost-effectiveness of physical therapy compared with corticosteroid injection as a first-line intervention for tennis elbow over a one-year period.

The randomized controlled trial involved 165 participants from Brisbane, Australia, with unilateral tennis elbow that lasted for longer than six weeks. Participants were randomized into four intervention groups: saline injection (placebo); corticosteroid injection; saline injection and physical therapy (eight sessions of elbow manipulation and exercise); or corticosteroid injection and physical therapy.

All participants also were advised to rest for 10 days with gradual return to activity and were asked to complete a daily home exercise program. Health-related quality of life was measured at baseline and at four, eight, 12, and 26 weeks, and 1 year using the EQ-5D questionnaire. Responses were then converted to utility scores and QALYs.

The authors found that, while physical therapy requires a higher mean intervention cost than a corticosteroid injection, it is ultimately the most cost-effective course of care for tennis elbow. They additionally found that a corticosteroid injection alone and even a corticosteroid injection combined with physical therapy were both less effective from QALY and cost perspectives than physical therapy alone.

The results of the study found that the estimated quality-of-life benefit of physical therapy for tennis elbow compared with injection was an average gain of 0.047 QALYs. Using an estimated VSLY of $251,634 (in 2022 U.S. dollars) as described in this report's **Approach and Methodology** chapter, the 0.047 gain in QALYs equates to an average total benefit of $11,827. For 95% of patients, the total benefit ranged from $8,870 to $19,711. This indicates that most patients who receive early physical therapy for tennis elbow are likely to benefit from the intervention.

Medical costs associated with physical therapy versus injection, adjusted to 2023 U.S. dollars, were $937 and $96, respectively. This indicates that direct medical costs of physical therapy are $841 higher than a corticosteroid injection.

Patient opportunity costs were defined as time loss due to work absence, per protocol leisure time loss, and nonprotocol leisure time loss. The values, which were converted from Australian to U.S. dollars are estimated to be $437 for physical therapy and $190 for corticosteroid injection, respectively.

The total cost, which takes into consideration both medical and patient opportunity costs, were $1,374 for physical therapy and $287 for corticosteroid injection. This implies that the physical therapy group had a mean QALY of 0.047 more than patients receiving injection, at a higher mean total cost of $1,087.

Because the study included a placebo group, we also analyzed physical therapy versus no treatment and injection versus no treatment, based on QALYs observed one year after treatment. The cost-benefit-to-cost ratio of physical therapy versus placebo was found to be +7.9, while the benefit-to-cost ratio of injection versus placebo was -9.44. This indicates that injection had a lower benefit-to-cost ratio than no treatment at all, suggesting there is no benefit of corticosteroid injection in the treatment of tennis elbow after one year when compared to a placebo.

Subtracting the additional estimated total cost of $1,087 for physical therapy over injection from the $11,827 value of the quality-of-life benefit provides an average estimated net benefit of $10,739 per episode of care.

Given a quality-of-life gain of 0.047 QALYs, this suggests a cost per QALY gained of $23,141, which is substantially less than the estimated VSLY of $251,634. We can conclude that physical therapy is cost-effective.

Vascular Claudication

Summary of Findings

Description

Claudication is a pain in the calves, thighs, or buttocks brought on by walking or other exercise, and relieved by rest. Claudication is a symptom of a more serious underlying condition and is classified as one of two main types: vascular claudication, resulting from restricted arterial blood flow, and neurogenic claudication, resulting from an impacted spine and/or nervous system, which causes compression of blood vessels near the spine (Nadeau, 2013).

Our comparison of interventions focuses on vascular claudication, which is typically the result of peripheral arterial disease, or PAD. PAD is caused primarily by plaque buildup in the arteries, known as atherosclerosis, that restricts proper blood flow to the lower limbs.

PAD is reflective of one's overall health, as atherosclerosis is the key factor for most cardiovascular conditions. Common risk factors for PAD and associated claudication are cigarette smoking, older age, and diabetes (Cassar, 2006). Approximately 5% of men and 2.5% of women 60 years old or older experience claudication (Patel, 2023). Younger people also may experience claudication, although PAD is less likely the cause (Cassar, 2006).

When claudication results from PAD, it is important to recognize that patients face a significantly higher mortality than age-matched controls, with the majority of deaths occurring from a heart attack. In a 10-year follow-up for claudication, literature shows that while 18% of patients will require surgical intervention and 10% will require amputation, mortality from infarcts and strokes is much higher at 50% (Hirsch, 2001). Therefore, treatment for claudication, when it results from PAD, is addressed from two fronts: risk factor modification and reducing risk of cardiovascular events and improvements to the claudication symptoms, such as through exercise, medication, revascularization, or surgery.

Study Selection

This economic analysis uses the 2014 study "Cost-Effectiveness of Supervised Exercise, Stenting, and Optimal Medical Care for Claudication: Results From the Claudication: Exercise Versus Endoluminal Revascularization (CLEVER) Trial" by Reynolds et al., published in the Journal of the American Heart Association (Reynolds, 2014). It was chosen for its relevance to the U.S. population, the robustness of methodology, and the availability of details to support cost-benefit modeling.

The researchers compared three treatment options: optimal medical care alone; monitored exercise plus optimal medical care; and revascularization — stenting — plus optimal medical care (Reynolds, 2014). For the purposes of our economic analysis, we compared the first two options only.

Monitored exercise is defined as walking therapy and treadmill training administered by physical therapists (Spannbauer, 2019). Optimal medical care is defined as risk factor management, as suggested by guidelines from the American College of Cardiology and American Heart Association, and involves antiplatelet therapy and claudication pharmacotherapy (Murphy, 2012). It includes a prescription of cilostazol and advice on home exercise and diet in the form of standardized verbal instructions and printed material (Murphy, 2012).

Research Findings

Measures to determine outcomes for treatment of claudication typically involve:

- Improvement to patient quality of life and reduction in pain, as in increasing walking distance or length of time walking before onset of pain.
- Prevention of critical limb ischemia and reduced risk of future amputation.
- Cost of treatment.
    - Direct cost of care delivered, including consultations, treatment via non-physical therapy and physical therapist services.
    - Patient opportunity cost, including time for treatment and travel time to and from appointments.

Non-Physical Therapy-Based Treatment

As addressed earlier, treatment for claudication resulting from PAD is addressed through both risk factor modification and targeting relief of or improvement to the claudication symptoms.

Non-physical therapy-based treatments may include the following:

- Medication. Cilostazol and pentoxifylline, which are approved for the treatment of claudication, target improvements in pain-free walking time and total distance walked (Tjon, 2001).
- Endovascular revascularization. A balloon angioplasty, also known as percutaneous transluminal angioplasty, is a minimally invasive procedure involving insertion of a medical balloon to the site of the blockage to widen the opening and promote blood flow (Topfer, 2018). Patients may also undergo stent implantation, which involves using mesh to keep the artery open. Stenting may also be used in cases where balloon angioplasty is not successful (Fakhry, 2015).
- Surgical revascularization. Patients with extensive arterial disease or for whom endovascular revascularization failed may undergo bypass surgery inserting a graft (Cassar, 2006).

Physical Therapist Services

For patients with lower extremity PAD, physical therapy is prescribed with the intention of improving a patient's quality of life by reducing the pain induced by walking, increasing walking distance before onset of pain, and reducing risk of cardiovascular complications.

Monitored exercise involving walking therapy, along with risk factor management, is the conservative care delivery option for claudication. Patients typically attend 30-minute to 60-minute sessions three times a week for monitored walking training on a treadmill (Spannbauer, 2019). There are varying opinions on the acceptable degree of pain as part of the monitored exercise. Based on guidelines from the American Heart Association, the TransAtlantic Inter-Society Consensus on the Management of Peripheral Arterial Disease, and the European Society of Cardiology, the recommendation is that walking sessions be conducted to a degree of moderate pain intensity (Treat-Jacobson, 2019).

Outcomes

The study's authors compared three care delivery options — monitored exercise plus optimal care, stenting plus optimal medical care, and optimal care alone — for patients with moderate to severe claudication due to aortoiliac PAD, which is characterized by narrowing or blockage of the iliac artery that brings blood to the legs.

The trial involved 98 patients divided among the three care delivery options. All patients received cilostazol as part of optimal medical care. Monitored exercise involved one-hour exercise sessions conducted three times a week for 26 weeks, followed by a 12-month telephone-based program to encourage adherence to the exercise regimen. Quality-of-life years were determined based on EQ-5D questionnaires at baseline and at six months and 18 months.

Results from the study showed that both monitored exercise and stenting improved quality adjusted life expectancy compared with optimal medical care alone. However, relative to optimal medical care alone, stenting cost $12,350 more while monitored exercise only cost $6,072 more. In comparison, the incremental QALY gain for stenting over monitored exercise was small and uncertain in the 18-month period. For this reason, the economic model for this analysis does not include the stenting option and compares only monitored exercise plus optimal medical care with optimal medical care alone.

The estimated quality-of-life benefit of treating claudication with monitored exercise plus optimal medical care compared with optimal medical care alone was an average gain of 0.12 QALYs. Using an estimated VSLY of $251,634 (in 2022 U.S. dollars) as described in this report's **Approach and Methodology** chapter, the gain in QALYs equates to an average total benefit of $30,196. For 95% of patients, the total benefit ranged from $15,890 to $44,502. This indicates that most patients who receive monitored exercise plus optimal medical care for claudication are likely to benefit from the intervention.

Total care delivery costs over the 18-month period were $6,795 for optimal medical care alone and $12,866 for monitored exercise plus optimal medical care. Although participants in the monitored exercise group spent $6,072 more, they gained an average of 0.12 QALYs more than participants receiving only optimal medical care.

The study provides the patient opportunity costs as a combined measure in the total cost. Therefore, individual patient opportunity costs were not calculated for this intervention. Based on the details provided by the study authors, patient opportunity costs for those in the monitored exercise group were based on the actual number of sessions attended, the total time spent in the program, and the estimated travel time to and from each session. They were calculated using the nominal U.S. wage rate.

Subtracting the additional estimated total cost of $6,072 for monitored exercise plus optimal medical care over optimal medical care alone from the $30,196 value of the quality-of-life benefit provides an average estimated net benefit of $24,125 (rounded) per episode of care (and a benefit-to-cost ratio of 2.3:1).

Given a quality-of-life gain of 0.12 QALYs, this suggests a cost per QALY gained of $50,596, which is substantially less than the estimated VSLY of $251,634. We can conclude that physical therapist-monitored exercise plus optimal medical care is cost-effective.

Falls Prevention

Summary of Findings

Description

Falls are a major injury risk for older adults and often result from reduced muscle strength, decline in balance, decreased gait assurance, and decreased cognitive function. Falls are closely associated with an increased incidence of fractures, such as hip and wrist fractures. Data from 2018 shows that falls led to nearly 3 million emergency department visits and resulted in approximately 32,000 deaths in the United States (Burns, 2018). Falls-related deaths are a growing risk, particularly for those 85 or older (Burns, 2018).

Data from 2015 estimates that approximately $50 billion was spent on medical costs associated with falls-related injuries annually in the United States (Florence, 2018). Nonfatal falls accounted for the majority of these medical costs, with Medicare covering approximately $28.9 billion, Medicaid covering $8.7 billion, and other payers covering $12 billion; fatal falls accounted for $754 million in medical costs (Florence, 2018). Given these numbers, falls pose major considerations for health care expenditures and patient morbidity.

Managing falls risk first involves conducting a multifactorial risk assessment. This includes considering modifiable risk factors, such as safety of the home environment, and also fall history, functional status (e.g., gait, strength and/or balance deficits, ability to perform activities of daily living), medical conditions, cognitive deficits, and medication review, as certain medications, particularly psychoactive medications, can impact falls risk (Phelan, 2015). Based on this assessment, management can involve exercise and training, medication changes, use of assistive devices, removal of hazards within the home, patient education, and behavioral therapy.

Study Selection

This economic analysis uses the 2016 study “Cost-Effectiveness of Combined Oral Bisphosphonate Therapy and Falls Prevention Exercise for Fracture Prevention in the USA,” by Mori et al., published in Osteoporosis International (Mori, 2017). The researchers modeled the cost effectiveness of falls-prevention exercise and oral bisphosphonate therapy to prevent fractures using a Markov microsimulation model that incorporated fracture incidence data from U.S. hospital discharges to determine the impacts over a one-year period. It was chosen for its relevance to the U.S. context and its availability of details to support cost-benefit modeling.

For our economic analysis, we focused on physical therapy-based falls-prevention exercise compared with no intervention to evaluate the isolated impact of physical therapy-based exercise on preventing falls and reducing future costs associated with common fractures. Cost data from the study, stated in 2014 U.S. dollars, has been inflation-adjusted to reflect 2023 U.S. dollars.

Research Findings

Measures to determine outcomes of falls-prevention strategies typically involve (Campbell, 1997):

- Fall monitoring, as in tracking actual falls.
- Improvements on standardized measures of balance, strength, gait, and activities of daily living.
- Tracking of falls-related injuries, such as type and severity of injury.
- Cost of treatment.
    - Direct cost of care delivered, including physician consultations and physical therapist services.
    - Patient opportunity cost, including time for treatment and travel time to and from appointments.

Non-Physical Therapy-Based Treatment

Falls prevention, as described above, requires a multifactorial assessment. Strategies to prevent falls focus on managing the factors that contribute to fall risk.

Examples of falls-prevention strategies include the following:

- Reviewing and modifying medications: Certain medications, particularly psychoactive medications, play a considerable role in increasing falls risk. Potentially replacing or discontinuing use of a medication can produce a significant impact on reducing falls risk (Cooper, 2003).
- Addressing nutritional deficiencies: Malnutrition can impact falls and fracture risk. Health care providers may recommend nutritional supplements to address potential micronutrient or protein deficiencies that impact strength, mobility, and visual acuity, all of which contribute to falls risk (Esquivel, 2017).
- Managing osteoporosis: Osteoporosis leads to lower bone strength, resulting in an increased risk of fracture. Medications for osteoporosis, such as oral bisphosphonates or infusions with zoledronic acid, help maintain bone strength and reduce fracture risk. Supplements that target bone density, such as with Vitamin D and calcium, also may be recommended (Harvard Health, 2021; Rula, 2021)https://www.webmd.com/osteoporosis/guide/understanding-osteoporosis-treatment.

Physical Therapist Services

Physical therapists take a multimodal approach to reducing risk of falls, which can include:

- Creating safe, hazard-free spaces: Most falls occur at home, and managing potential hazards is an important way to reduce risk of falls. Physical therapists work with multidisciplinary colleagues to help patients address potential hazards. Specific interventions can include education on proper footwear, clearing walkways and stairs, ensuring adequate lighting, placing handrails on stairs and in bathrooms, and keeping areas uncluttered (Campani, 2021).

- Adaptive and assistive technology: Physical therapists prescribe and provide training on the use of durable medical equipment and assistive devices such as canes, walkers, prostheses, and braces to help patients improve mobility and safely complete activities of daily living (American Physical Therapy Association, 2023).

Physical therapists also select appropriate exercises for managing falls risk. These include (Shubert, 2011):

- Static balance exercises: These exercises focus on stabilizing the patient in certain positions or postures to keep the body stationary by maintaining the center of mass within the body's base of support.
- Dynamic balance exercises: These exercises focus on movement such as walking. They involve progressing functional capabilities such as standing and turning. Dynamic exercises improve the body's ability to react to sudden changes that may cause a loss of balance.
- Strength training: These exercises target lower extremity and postural muscles and are often combined with balance exercises to support prevention of falls.
- Walking: For older adults with adequate balance, physical therapists may prescribe an independent walking program to support prevention of future falls. For older adults with balance or mobility deficits for whom independent walking is unsafe or may contribute to falls, the physical therapist often supervises walking training, which may include progressive challenges in different environments to safely improve walking function.

The Mori study specifically looks at the Otago Exercise Program, a home-based exercise program delivered by a physical therapist that involves strength training, balance retraining, and walking exercises (UNC School of Medicine, n.d.). The program has a demonstrated 40% reduction in falls over a one-year period and includes warm-up exercises followed by strength, balance, and walking exercises (Shubert, 2011). Within the study by Mori et al., Otago is administered through four at-home visits by a physical therapist followed by a self-managed exercise and walking program.

Outcomes

The study's authors leveraged fracture incidence rates, reported from U.S. hospital discharge data, to predict falls-related fractures in the different age-based cohorts starting at age 65. The simulation considered a one-year period for modeling, specifically for white women in the U.S. For our analysis, we considered only women 80 or older, as this age group faces the highest risk of falls-related injury and would likely benefit the most from falls-prevention exercise.

The results of the study found that the estimated quality-of-life benefit from falls-prevention exercise compared with no intervention was an average gain of 0.009 QALYs. Using an estimated VSLY of $251,634 (in 2022 dollars) as described in this report's Approach and Methodology chapter, the gain in QALYs equates to an average total benefit of $2,265. Because this analysis used a model as opposed to actual participants, 95% confidence intervals are not calculated.

Direct medical costs for the group receiving physical therapist services were $649, which included $436 for the falls-prevention exercise program and $212 for the initial assessment, which involved a physician exam and a bone density scan. For the no treatment group, the only direct medical cost was $212 for the assessment. Predicted injury-related costs for the falls-prevention exercise group were $756 and for the no-treatment group were $1,135. These predicted costs factor in the one-year costs associated with hip, vertebral, wrist, and other osteoporotic fractures.

Total medical costs, factoring in direct medical costs, predicted injury costs, and patient opportunity costs, amounted to $1,468 for the falls-prevention exercise group and $1,347 for the no-treatment group. Patient opportunity costs were estimated at $63 for the falls-prevention exercise group, based on 2.5 hours of patient time (one initial at-home visit of one hour and three subsequent at-home visits of 30 minutes each) at a cost of $25.35 per hour. The no-treatment group incurred no patient opportunity costs. Opportunity costs do not consider the prescribed exercise program that individuals conduct independently at home.

Subtracting the additional estimated cost of $121 for physical therapy-based falls-prevention exercise compared with no treatment from the $2,265 value of the quality-of-life benefit provides an average estimated net benefit of $2,144 per episode of care (and a benefit-to-cost ratio of 1.54:1).

Given a quality-of-life gain of 0.009 QALYs, this suggests a cost per QALY gained of $13,425, which is substantially less than the estimated VSLY of $251,634. We can conclude that physical therapy is cost-effective.

Of particular interest is the difference in predicted injury costs, which shows an approximate 33% lower injury-related cost for the falls-prevention exercise group compared with the no-intervention group.

Cancer Rehabilitation

Summary of Findings

Description

With a rapidly growing and aging population, as much as 39.5% of the U.S. population will have cancer at some point in their lives, according to the National Cancer Institute (National Cancer Institute, 2020). Couple this with advancements in cancer treatment and diagnosis, and an increasing number of people are living with, recovering from, and surviving cancer — as well as the long-lasting side effects of cancer and its treatments. Examples of side effects include pain, fatigue, lymphedema, and changes in memory, mobility, and balance. Survivors under 65 years are three times less likely to return to work than those without a history of cancer (Rizzo, 2016).

Cancer rehabilitation can occur at any point across the cancer continuum, and includes prehabilitation, post-treatment rehabilitation, and palliative rehabilitation (Mayer, 2022). These programs often tailor interventions based on the patient's individual needs, situation, and wants. The goal of rehabilitation is to improve function, participation in work and life, and quality of life, as well as reduce the risk of late effects (Alfano, 2018).

Many physical consequences of cancer and its treatment can be effectively treated with physical therapist interventions and physical rehabilitation programs, but there are few opportunities and referrals to physical therapy programs for this condition in the United States (Brennan, 2022). Exercise has been shown to be beneficial before, during, and after cancer treatment across all cancer types and for a variety of cancer-related impairments, including fatigue, aerobic fitness, anxiety, self-esteem, cognitive function, and general quality of life (Stout, 2017; Speck, 2010; Campbell, 2020).

Study Selection and Additional Methodology

This economic analysis primarily uses the 2019 study "Cost-Effectiveness of the Collaborative Care to Preserve Performance in Cancer (COPE) Trial Tele-rehabilitation Interventions for Patients With Advanced Cancers," by Longacre et al., published in Cancer Medicine (Longacre, 2020).

The randomized controlled trial compared the cost-effectiveness of three approaches: a physical therapy-based telerehabilitation program, physical therapy plus pain management, and monthly home monitoring for late-stage cancer patients in the United States. For our economic analysis, we focused only on the physical therapy-based telerehabilitation program compared with home monitoring in order to compare the isolated impact of telehealth physical therapist service over home monitoring.

The study was chosen due to its robustness of methodology, the availability of details to support cost-benefit modeling, recency of publication, and applicability to the U.S. health care and physical therapy context.

Research Findings

Measures to determine outcomes of treatment for patients with cancer typically involve:

- Improvement to the patient's overall quality of life, such as reducing pain, increasing mobility, and improving mental health, using QALYs or QoL (Wang, 2022).
- Improvement in physical mobility, such as improving strength and reducing fatigue (Speck, 2010).
- Improvement in tolerance to cancer treatment and/or reduction in treatment-related side effects, such as body weight and body mass index (Olsson Möller, 2019; Ligibel, 2012).
- Reduction in cancer-related cognitive impairment (Campbell, 2020) and/or improvement in mental health, such as decreased levels of depression and anxiety (Ligibel, 2012).
- Change in biomarkers associated with cancer progression (Meneses-Echávez, 2023).

Non-Physical Therapy-Based Treatment

Cancer rehabilitation programs are determined by the needs of the patient, the type of cancer, and the type of treatment. The program is often designed by a team of medical professionals that may include an oncologist, physiatrist, occupational therapist, nutritionist, social worker, psychologist, and physical therapist. Each member of the team may support distinct aspects of the patient's rehabilitation program, such as (Mayer, 2022):

- Assessing the patient's cancer progression and establishing a definitive treatment plan.
- Providing medicine or drugs to support recovery and cancer treatment.
- Assessing the patient's cognition, behavior, and coping skills and helping the patient and caregiver with coping methods.
- Evaluating the patient's metabolic demands and recommending an optimal diet for recovery and support.

Physical Therapist Services

Treatment of cancer symptoms and cancer treatment side effects have been widely studied and support the use of physical therapy and exercise as an effective intervention to improve patient quality of life through a variety of pathways, including delivery via telehealth, and in a variety of cancer types and stages (Stout, 2017). However, physical therapy is often underused in the oncology setting due to a lack of consensus around when to initiate an exercise program during cancer treatment (Rizzo, 2016). Some physical therapist-led exercise programs may include:

- Aerobic, anaerobic and/or resistance exercise.

- Superficial and deep heat, cold, and transcutaneous electrostimulation, and massage therapy to target pain reduction.
- Stretching-based exercises to improve joint mobility.
- Task-oriented exercises.

Outcomes

The study's authors measured the cost effectiveness of a physical therapy-based telehealth program compared with home-based monitoring for rehabilitation in late-stage cancer patients experiencing functional limitations. While the study took place over six months, the costs and benefits in the analysis were estimated over a 12-month period.

The study involved 516 participants in a randomized controlled trial conducted in three U.S. academic medical centers in the Midwestern, Southern, and Western regions. Participants with advanced-stage cancers were randomly assigned to one of three groups: control, telerehabilitation physical therapy, or telerehabilitation physical therapy and pain management. The economic model for this analysis compared outcomes of the first two groups only.

All participants underwent automated monthly home-based monitoring of physical functioning and pain through telephone or web-based surveys (Cheville, 2019). For participants in the telerehab group, services were based on the collaborative care model provided by a physical therapist-physician team. This intervention included a pedometer-based walking program to increase physical activity and a validated resistance-based exercise program called REST.

For the first four weeks, participants were instructed to perform a personalized REST exercise routine twice weekly under the supervision of a local physical therapist to treat any disabling physical impairments. Some participants achieved this in under eight sessions, while some required continued treatment past the eight-week mark. After this time, participants performed the exercises by watching instructional videos and using resistance bands for a recommended four times per week. The exercise program consisted of an upper and lower body routine and could be performed by patients with mild disabilities in less than 10 minutes. They also participated in check-in calls with a physical therapist "fitness care manager" in the physical therapist-physician team on weeks 1, 2, and 4 and then monthly between weeks 5 and 24 to establish pedometer step count goals, evaluate physical impairments, and monitor the progression of their REST exercises. Throughout the study duration, participants recorded their step counts and REST sessions through an automated system on a weekly basis; some patients reported fortnightly or monthly if the reporting burden was too high.

Health outcomes were measured using EQ-5D-3L at baseline, and at three and six months, converted into QALY values. Participants' hospitalization data was obtained through medical records, and associated costs were estimated from unit cost data and hospital-associated utilization data found in the literature.

The results from the study found that the estimated quality-of-life benefit of physical therapy-based rehab compared with home-based monitoring was an average gain of 0.01 QALYs. Using an estimate of VSLY of $251,634 (in 2022 dollars), as described in this report's **Approach and Methodology** chapter, the 0.01 gain in QALYs equates to an average total benefit of $2,516.

The analysis also included the benefit of avoided costs associated with future hospitalizations. Those in the telerehab group spent significantly less time in the hospital (less than two-thirds of the time experienced by the home-monitoring group) and were more likely to be discharged home than those in the home-monitoring group. The cost savings benefit of reduced hospitalization for the telerehab group was estimated to be $1,707 based on expenses accrued over time spent in the hospital, excluding the cost of specific services such as cancer treatment.

Direct medical costs for the telerehab group were $431, comprising the cost of instructional DVDs, elastic resistance bands, pedometers, and the visits with the physical therapist (assuming an average of eight sessions). No direct medical costs were associated with the home-based monitoring group.

Patient opportunity costs were estimated to be $279 per patient for the telerehab group. This is based on a check-in phone call accruing to three hours total (six phone calls, each assumed to be 30 minutes long) and the average patient travel time to the physical therapist, accruing to 8 hours total (assumed travel time of 30 minutes, one-way for eight sessions) at a cost of $25.35 per hour. Because patients spent less than 15 minutes per week performing the program's virtual self-paced exercises, they were not included in the opportunity cost.

Subtracting the estimated total cost of physical therapy telerehab (total medical cost plus patient opportunity cost) from the total benefit (quality-of-life benefit plus avoided hospital costs) provides us with an average estimated net benefit of $3,514 per episode of care.

Given a quality-of-life gain of 0.01 QALYs, this suggests a cost per QALY gained of $70,951, which is substantially less than the estimated VSLY of $251,634. We can conclude that physical therapy for cancer rehabilitation is cost-effective.

Future Additions to the Report

This report considers eight interventions that most closely reflect the core of APTA's service offerings and that demonstrate robustness in their evidence base to support economic evaluation. A comprehensive range of interventions were considered at the start of this report and were narrowed down based on the criteria described in the **Approach and Methodology** chapter.

Given the limitations to the scope of this work, there remain several interventions that reflect APTA's service offerings but were not considered within this report. Below is the list of interventions considered based on APTA's service offerings, the role that physical therapy plays for each, and the current available evidence base, including limitations restricting their evaluation. Many of these interventions may be considered for evaluation in the future, provided the limitations in their evidence base can be adequately addressed.

Intervention	Relevance of physical therapy to intervention, available evidence base and limitations
Schizophrenia *Schizophrenia is a mental disorder characterized by hallucinations, delusions, and mood disorder.*	Schizophrenia patients present higher levels of physical inactivity compared to the general population and, as such, show increased morbidity and mortality. Physical therapy for schizophrenia focuses on the management of comorbidities, such as cardiovascular disease and diabetes, as well as on management of mental state, anxiety, and psychological distress (Vancampfort, 2012). Several limitations exist in the current evidence base evaluating physical therapy for schizophrenia, including absence of recent U.S.-based publications, measurement of benefits in a form other than QALYs or another usable measure for modeling, and lack of cost effectiveness data (Vancampfort, 2012). Economic evaluation of schizophrenia requires robust studies that provide consistent quantification of benefits and supply sufficient cost-effectiveness data.
Chronic obstructive pulmonary disorder *COPD is an inflammatory lung disease characterized by obstructive airflow and breathing problems.*	Physical therapy is used for COPD to support pulmonary rehabilitation and employs a variety of exercise and breathing techniques geared towards generating a coordinated pattern of breathing, promoting relaxation, increasing exercise tolerance, and reducing breathlessness. Existing evidence base includes several economic evaluations and clinical trials from Europe that look specifically at respiratory physiotherapy interventions for COPD (Leemans, 2021). Adaptation of international studies to the US context proves challenging, specifically finding the relevant US costs, including adequately accounting for cost differences across states within the U.S. Economic evaluation of physical therapy for COPD in the U.S. requires robust U.S.-based studies that provide the necessary US cost data.

Intervention	Relevance of physical therapy to intervention, available evidence base and limitations
Pregnancy *Pregnancy is frequently characterized by lumbopelvic pain.*	Physical therapy for pregnancy focuses on pregnancy-related low back and/or pelvic pain or dysfunction. The studies identified in our assessment measure outcomes using various pain measures (Visual Analogue Scale, Disability Rating Index, sick leave due to pain, fear avoidance beliefs, etc.) (van Benten, 2014). Although these measures are useful for measuring the benefits of physical therapy, the data is not available in a form required to support economic evaluation. The evidence base further presents limitations in the availability of cost-effectiveness data applicable to the US context. For APTA to consider economic evaluation for pregnancy, we require US-based data that supplies benefit data in the form of QALYs or another relevant measure as well as adequate US-based cost data.
Asthma *Asthma is a chronic inflammatory disease associated with airway hyperresponsiveness to various triggers, such as allergens and exercise, and causes episodes of wheezing, breathlessness, and chest tightness (Quirt, 2018).*	Physical therapy for asthma focuses on breathing retraining, including hyperventilation reduction, yoga breathing techniques, inspiratory muscle training, and non-hyperventilation reduction breathing techniques (O'Connor, 2012). Research on breathing retraining for asthma is emerging and while evidence exists to support benefits of physical therapy for asthma (O'Connor, 2012), robust studies that quantify benefits consistently and are applicable within the US context are lacking. The current evidence base looking at physical therapy breathing retraining and cost effectiveness is predominantly UK-based (Bruton, 2018). Adapting this to the US context would require specific consideration for current breathing retraining practices and recommendations in the US as well as US-specific cost considerations.
Multiple Sclerosis *Multiple sclerosis is a disease where the immune system attacks the central nervous system (brain and spinal cord).*	Some of the common symptoms of multiple sclerosis involve fatigue, cognitive changes, visual impairment, pain, coordination and balance problems and inability to walk (Mayo Clinic, 2022). Physical therapy for multiple sclerosis aims to maintain strength, support movement (e.g., maintain posture, improve walking cadence), and improve exercise tolerance (Döring, 2011). There is currently limited research available in the field that consistently quantifies the benefits of physical therapy for multiple sclerosis and that considers cost effectiveness. Existing evidence based is limited, older and based outside of the US context (Winser, 2020; Tosh, 2014). Economic evaluation of physical therapy for multiple sclerosis in the US would require robust US-based studies or recent international studies with the potential for adaptation to the US context.

Intervention	Relevance of physical therapy to intervention, available evidence base and limitations
Fibromyalgia *Fibromyalgia is a chronic disorder that causes pain and tenderness throughout the body, as well as fatigue and trouble sleeping.*	Physical therapy for fibromyalgia focuses on the use of education, aerobic exercise (mainly aquatic exercise programs as studies indicate) (Gusi, 2008), and strengthening exercise to help improve fibromyalgia. Limited reliable research is available to support the cost-effectiveness of physical therapy for Fibromyalgia.
Amyotrophic Lateral Sclerosis *ALS, also known as Lou Gehrig's Disease, is a rare neurological disease that affects motor neurons (nerve cells in the brain and spinal cord that control voluntary muscle movement).*	Physical therapy for amyotrophic lateral sclerosis focuses on treating symptoms and maximizing function and involvement to help people with ALS live their lives to the fullest and with quality (Bello-Haas, 2018). Several limitations exist in the current evidence base evaluating physical therapy for ALS. Existing evidence is limited with respect to the US-based context and outlining quality-of-life improvements (QALYs or similar) and cost data for economic analysis (Silva, 2022). Strong US-based studies or recent international studies with the potential to be adapted to the US environment, including the necessary cost and quality-of-life improvement data, are required for the economic evaluation of physical therapy for ALS in the US.
Neck Pain *Neck pain is a common musculoskeletal pain problem, often resulting in muscle tightness and limitations in the range of motion of the neck.*	Physical therapy for neck pain focuses on managing pain, strengthening musculature, expanding range of motion, and improving neck posture and function for day-to-day activities (Verhagen, 2021). There is limited evidence that specifically focuses on the impact of physical therapy for neck pain. Although existing literature exists on manual therapy, a subset of physical therapy, much of the literature is several years old, based in an international context, and/or lacks sufficient QALY and US-based cost data to support modelling (Aboagye, 2022; Korthals-de Bos, 2003). Robust studies that clearly assess the impact of physical therapy on neck pain in a US context and sufficiently quantify quality of life improvements are required for economic evaluation of physical therapy for neck pain in the US.
Heart failure *Heart failure is a complex condition whereby the heart cannot sufficiently pump blood to the body, often a result of impaired ventricular filling or a weakened heart that cannot effectively pump blood (Malik, 2022).*	Physical therapy for heart failure focuses on the continuum of care due to the variety of symptoms that heart failure can generate, and is typically targeted towards managing mobility and fatigue, strengthening arms and legs, and improving breathing. Physical therapy for heart failure involves a range of exercises that can include aerobic training, resistance training, and inspiratory muscle training (Shoemaker, 2020). The current evidence base demonstrating the impact of physical therapy on heart failure is growing yet limited in the type of data

Intervention	Relevance of physical therapy to intervention, available evidence base and limitations
	required to support economic evaluation. An evaluation of studies focusing on the impact of inspiratory muscle training on heart failure shows that many of these studies focus on measuring functional outcome measures or other alternative measures to QALYs, which although useful, cannot be directly used to support economic evaluation (Azambuja, 2020). Economic evaluation of heart failure requires robust studies that clearly quantify benefits in a form appropriate for economic modeling and that supply sufficient cost data for physical therapist services for heart failure in the US context.
Stroke *A stroke occurs when the brain is damaged either from a blockage in or rupturing of a blood vessel.*	Stroke rehabilitation using physical therapy targets the balance and mobility disorders resulting from a stroke, and focuses on strengthening muscles, improving mobility, and lowering the risk of falls (Hugues, 2019). The evidence base for stroke rehabilitation using physical therapy is both growing and positive. There are several studies that examine the impact of various forms of physical therapy, such as constraint-induced therapy, functional task training and musculoskeletal intervention, on stroke patients. Several studies also exist that focus on aquatic based physical therapy for stroke rehabilitation. Limitations in the current evidence base exist with regard to the measurement of benefits in the form of QALYs or another usable form for economic evaluation as well as US based cost data for physical therapist services for strokes. Economic evaluation of physical therapy for strokes in the future is promising, as demonstrated by emerging studies including one which uses Markov modeling to develop the necessary benefit data, albeit in an international context (Darvishi, 2023) and another which considers aquatic therapy impacts using EQ-5D measures, which could potentially be converted to QALYs (Lee, 2018). Further identification of quality studies providing necessary cost and benefit data in the US context is required to support economic evaluation for strokes.
Direct Access *Direct access to a physical therapist is a model of care whereby no physician or third-party referral is required to access physical therapist services.*	The provider (e.g., physician, physical therapist) that conducts the primary assessment of a patient has a considerable impact on the end-to-end pathway of care for the patient, the overall cost of care, and the health outcomes generated. Direct access to a physical therapist has the potential to provide targeted care early on, improve the time to access care and reduce health service costs. The current evidence base for direct access to physical therapist services in the US is limited. There is a small body of evidence from other jurisdictions comparing the impact of primary assessment of a patient conducted by a physician to that by a physical therapist (Ho-Henriksson, 2022). However, direct access has a very specific country-specific context that makes it difficult to

Intervention	Relevance of physical therapy to intervention, available evidence base and limitations
	adapt international models to the US context. Key factors that make it difficult to adapt the current evidence base for direct access to the US context include variations in reimbursement context and the differences on healthcare utilization in public versus privatized healthcare settings. Economic evaluation for direct access in the US will require US-based studies that provide the necessary cost information, and that account for healthcare utilization and healthcare pathways in the US.
Long Covid *Covid-19 infection can present longer-term side effects in some individuals that can range from general symptoms such as fatigue and fever to various respiratory, neurological, digestive, and other symptoms.*	Physical therapy can be tailored to address the specific symptoms of Long Covid, such as breathing exercises for respiratory issues (Toulgui, 2022) or patient education and activity guidance for post-exertional symptom exacerbation knee-pain (Smith, 2023). COVID-19 is a novel coronavirus of which the longer-term side-effects are only beginning to be realized. The current evidence base examining the application of physical therapy for Long Covid is limited due to the recency of the infection. However, given the broad range of long-term symptoms of COVID-19, it is likely that the different ways in which physical therapists can assist with managing Long Covid will be a growing area of interest. To perform economic evaluation, we will need studies relevant to the US context that can clearly define the physical therapist services for Long Covid, the benefits they generate in the relevant form for modeling, and the cost of the physical therapist services.

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Work Group Co-Chairs From the Public Policy and Advocacy Committee and the Scientific and Practice Affairs Committee

Greg Bennett, PT, DSc, MS

Jason Falvey, PT DPT, PhD, Board-Certified Geriatric Clinical Specialist

Kate Minick, PT, DPT, PhD, Board-Certified Orthopaedic Clinical Specialist

Janet Shelley, PT, DPT

Work Group Members

Ryan Boggs, PT, DPT, DSc (APTA Academy of Clinical Electrophysiology & Wound Management)

Christine Cabelka, PT, MA, PhD (APTA Pelvic Health)

Julie Fritz, PT, PhD, FAPTA (APTA Academy of Research)

Joseph Hannon, PT, DPT, PhD (American Academy of Sports Physical Therapy)

Ellen Hillegass, PT, EdD, FAPTA, Board-Certified Cardiovascular & Pulmonary Clinical Specialist (APTA Academy of Cardiovascular & Pulmonary Physical Therapy)

Tiffany Kendig, PT, DPT, MPH (APTA Oncology)

Trevor Lentz, PT, PhD, MPH (APTA Academy of Orthopaedic Physical Therapy)

Rachel Prusynski, DPT, PhD, Board-Certified Neurologic Clinical Specialist (APTA Geriatrics)

Erin Simunds, MS, PT (APTA Academy of Pediatric Physical Therapy)

James Tompkins, PT, DPT (APTA Acute Care)

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Impact of parents' physical activity on preschool children's physical activity: a cross-sectional study

Chang Xu[1], Minghui Quan[1], Hanbin Zhang[1,2], Chenglin Zhou[1] and PeiJie Chen[1]

[1] School of Kinesiology, Shanghai University of Sport, Shanghai, China
[2] Health Promotion Center, Zhejiang Provincial People's Hospital, Hangzhou, China

ABSTRACT

Purpose. This study examined the associations of physical activity levels between parents and their pre-school children based on gender and weekday/weekend.
Method. A total of 247 parent-preschool child triads from Shanghai, China were analyzed. The children had a mean age of 57.5 ± 5.2 months. Both sedentary behavior and physical activity were measured in all participants using an ActiGraph GT3X^{+} accelerometer over seven consecutive days from Monday through the following Sunday. A multivariate regression model was derived to identify significant relationships between parental and child physical activity according to gender and weekday/weekend.
Results. There was a significant correlation between mothers' and girls' moderate-to-vigorous physical activity (MVPA) and total physical activity (TPA) on weekdays. Fathers' MPVA levels correlated significantly with those of boys and girls, with paternal influence appearing to be stronger than maternal influence. However, there was not a significant correlation between fathers' and children's TPA. TPA levels of both mothers and fathers correlated with those of girls, but not with those of boys. Parental sedentary levels on the weekend correlated significantly with girls' levels, but not with boys' levels. Children's physical activity levels on weekends were influenced more by fathers' activity levels than by mothers', while the opposite was observed on weekdays.
Conclusion. Sedentary behavior and physical activity levels of parents can strongly influence those of their preschool children, with maternal influence stronger during the weekdays and paternal influence stronger on the weekends. Parents' activity levels influence girls' levels more strongly than they influence boys' levels.

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Corresponding authors
Chang Xu, xuchang@sus.edu.cn
PeiJie Chen, chenpeijie@sus.edu.cn

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INTRODUCTION

Prevalence of obesity and overweight continue to increase among preschool age children in China (*Xiao et al., 2015*; *Zhou et al., 2014*). Data from the International Obesity Task Force, World Health Organization, and US Centers for Disease Control and Prevention show that among preschool children with a mean age of 5.02 years in northeast China, the prevalence of overweight is 11–12% and the prevalence of obesity is 6–14% (*Ma et al., 2011*). Data from these three organizations indicate that among preschool children aged 3–6 years in Shanghai, the prevalence of overweight is 13–17% and the prevalence of obesity is 6–11% (Quan et al., 2014).

Inadequate physical activity and excessive sedentary time are the primary causes of overweight and obesity in preschool children (Dennison, Erb & Jenkins, 2002; Epstein et al., 2000; Gortmaker et al., 1999). Increasing preschool children's physical activity, especially the level of moderate-to-vigorous physical activity (MVPA), can improve issues with overweight, obesity, cardiopulmonary function and bone density (Physical Activity Guidelines Advisory Committee, 2008; Strong et al., 2005). In addition, increasing MVPA can promote cognitive development in preschool children and youth and improve their academic performance (Fedewa & Ahn, 2011; Sibley & Etnier, 2010). In this way, promoting physical activity may benefit preschool children and youth both physically and mentally.

Environmental factors likely affect the behaviors and habits of preschool children, including their tendency to engage in MVPA (Stokols, 1992). These factors can originate at home (Spurrier et al., 2008), in the preschool (Kreichauf et al., 2012) and within the broader community (Roemmich et al., 2006)—with the home environment appearing to exert the strongest influence (Sterdt et al., 2014). As the earlist, most direct and lasting campanion, parents will affect preshool children's behavior acquisition for a very long time, even for the whole life. As a result, so as to promote preschool children and adolescents' physical activity, their parents' physical activity styles and levels turn into hot issues to be researched by relevant scholars.

For example, preschool children's physical activity correlates with that of their parents (Cools et al., 2011; Dowda et al., 2011; Oliver, Schofield & Schluter, 2010). Parental MVPA levels show a significant association with total physical activity (TPA) levels in preschool children, although this association weakens as the child gets older. Children with two active parents are 5.8 times more likely to be active than are children with two inactive parents (Oliver, Schofield & Schluter, 2010). Parental physical activity influences children's activity directly or indirectly by affecting children's self-efficacy (Trost et al., 2003). Parents have been shown to influence their preschool children's physical activity by acting as role models or playmates, emphasizing the importance of physical activity, and setting goals for sports skills (Cools et al., 2011).

The relationship between parents' and children's physical activity appears to be complex. The child's gender may play a role, with some work suggesting that parents affect the physical activity of their sons more than the activity of their daughters (Sterdt et al., 2014). As found by another research, parental sedentary levels correlated significantly with girls' levels, but not with boys' levels (Jago et al., 2010). Under some conditions, there may be no relationship at all between parental and child activity, suggesting that the relationship may vary with environmental conditions and raising the possibility that some preschool children are naturally physically active without parental intervention (Hesketh, Hinkley & Campbell, 2012; Taylor et al., 2009). On account of the discrepancies of the different research above, further study is still needed about how much parental factors affect preschool children's physical activity action and characteristics.

While adults typically engage in various types of physical activity (work, housework, physical exercise, entertainment), preschool children engage predominantly in entertainment, which involves brief but frequent bursts of activity. Measuring such activity can be challenging. Although direct observation is considered the gold standard for measuring physical activity, it may not be feasible in many situations because of expectancy bias, observation effects, and even issues of privacy for study participants. Self-report instruments such as questionnaires can be used to measure physical activity, but children younger than 10-11 years may not have the necessary cognitive skills to accurately report physical activity levels. For children, then, objective tools such as motion sensors can be the most appropriate method for assessing physical activity levels. Pedometers and actigraphs have been used to measure numbers of steps in youth studies (*Kelder et al., 1994*; *Matusik & Malecka-Tendera, 2011*; *Taylor et al., 2013*), but merely measuring the number of steps can lead to a distorted, inaccurate understanding of physical activity.

A superior alternative to assessing children's physical activity levels may be to use pedometers and accelerometers. With the rapid development of computer science and technology, the application of accelerometer not only reduce the errors of retrospecting physical activity by ones' memories, still this can measure the time needed to achieve a given intensity of activity as well as estimate energy consumption. As a result, accelerometer has been widely used in the measuring of children and adolescents' physical activity (*Hnatiuk, 2014*). The newest-generation accelerometers, such as the ActiGraph GT3X (*Yam et al., 2011*), which can measure accelerations of three directions as frontal axis (X axis, fore-and-aft direction), sagittal axis (Y axis, left and right direction) and vertical axis (Z axis, upward and downward direction), then turn it to electrical signal through inner chip sensing sensor, and then turn electrical signal to counts number and to be outputted, lastly classify the counts number according to intensity division points and obtain the accumulative time of SB, LPA, MPA and VPA. This can provide a more comprehensive understanding of children's physical activity,and then gradually replace the methods of previous,such as International Physical Activity Questionaire (IPAQ), Children's Leisure Activities Study Survey (CLASS), motion sensors and pedometers.

Based on the existing relevant researches and circumstances of Chinese preschool children physical activity, this research will adopt a cross-sectional study design, to probe into the relevance between parental physical activity level between preschool children activity level. Supposing that parents' physical activity levels have great effect on preschool children physical activity level, and the effect may exist differences for the gender and time range (weekday, weekends) factors.The ActiGraph GT3X^{+} (Actigraph LLC, Pensacola, FL, USA) accelerometer was used to measure both sedentary behavior and physical activity of preschool children and their parents living in Shanghai, China. A multivariate regression model was derived to identify associations in physical activity levels between parents and children according to gender and weekday/weekends.

METHODS

Ethical approval

The study was carried out ethically and approved by the Ethical Committee of Shanghai University of Sport (No. 2014028).

Participants

A sample of 346 parent–child triads were recruited from a larger measurement validation study of families with children attending four public and three private kindergartens in the Yangpu and Baoshan districts of Shanghai, China. Before subject recruitment, the principals and teachers of the kindergartens and parents were informed of the purpose and procedures of the study, which was approved by the Ethical Review Committee of the Shanghai University of Sport. The purpose of the study was explained to the father or mother of the participating families, who then gave written informed consent.

Measures and procedures

Measurements of physical activity and sedentary behavior

Study participants wore an ActiGraph GT3X+ accelerometer (Actigraph, Pensacola, FL, USA) from 6 am to 11 pm every day for seven consecutive days from a Saturday through the following Sunday (five weekdays and one weekend) (*Fuemmeler, Anderson & Masse, 2011*; *Ridgers et al., 2014*). Participants were instructed to wear the accelerometer constantly except when bathing, swimming and sleeping. The accelerometer measures 4.6 cm × 3.3 cm × 1.5 cm, and it weighs 19 g. Its sampling frequency was set to 30 Hz, and the sampling interval (epoch) in the present study was set to be 1 s for children and 60 s for adults (*Ostbye et al., 2013*; *Pate et al., 2006*). Subjects wore their accelerometer on the waist, above the right hip, using an elastic belt (*Hesketh et al., 2014*). Accelerometer data were analyzed to measure the following parameters: daily duration of sedentary behavior (SB), light physical activity (LPA), moderate physical activity (MPA), and vigorous physical activity (VPA). The MVPA was the sum of MPA and VPA, while TPA was the sum of MVPA and LPA.

Demographics

Participants were asked to fill out three questionnaires. The children's questionnaire, which was filled out by the children's parents or guardians, asked about birth date, gender, daily care and early childhood education. Age in months was calculated as months from the birthdate until the measurement date. The parent's questionnaire asked about education level, monthly income, family structure, parent's working style and duration of daily contact with children (on weekdays and weekends). Finally, the Child Behavior Checklist (CBCL), which was filled out by the child's main preschool teacher, asked four items: "whether the child shows lack of concentration or non-persistent attention", "whether the child is introverted and unwilling to talk", "whether the child is over-fatigued" and "whether the child has slow actions or anenergia." Respondents could select a response of "not at all" (1 point), "occasionally" (2 points) or "frequently" (3 points). This test was used to assess the movement ability of preschool children, identify behavioral problems in participating children and ensure the validity of the collected data.

Weight and height were measured using standard physical fitness monitoring equipment. Body mass index (BMI) was calculated using the formula: BMI = (body weight in kg)/(height in m)^2. According to the International Obesity Task Force (IOTF), the children with BMI >25 were classified as overweight and >30 as obese (*Cole et al., 2000*).

Fitness testing

Cardiorespiratory and motor fitness (*Esteban-Cornejo et al., 2014*) were assessed using a 20-m shuttle-run test, along with a 2 × 10-m shuttle-run test (*Leger et al., 1988*). Performance on each test was included in the regression analysis as a confounding factor. For the 2 × 10-m shuttle-run test, the preschool children were grouped into pairs, each of which was instructed to stand behind the starting line with legs apart, then to run immediately to the turn line after hearing the start signal, touch a car tire, then turn and run to the target line. Performance times were recorded to the nearest 0.1 sec, with another 0.1 sec added if the hundredths place was >0 (e.g., 0.13 was reported as 0.2).

For the 20-m shuttle-run test, the preschool children had to run back and forth for 20 m at an initial speed of 8.5 km/h, which increased by 0.5 km/h every minute in response to a whistle sound played on a CD (*Leger et al., 1988*). Maximal performance was determined when the child no longer kept pace or the child stopped because of exhaustion. Results were expressed in terms of stages, with one stage corresponding to approximately 20 m. A member of the study staff ran together with the children in order to avoid confusion.

Data reduction

Duration of physical activity was estimated using a floating window algorithm (*Choi et al., 2011*). For accelerometer data to be considered valid, the accelerometer had to be worn for at least 8 h per day, and data had to be available for at least two weekdays and one weekend of the study period (*Ostbye et al., 2013*; *Ruiz et al., 2011*). SB, LPA, MPA and VPA measurements of children were categorized into the following groups (counts/min): <100, 100–1,680, 1,680–3,368, and ≥3,368 (*Pate et al., 2006*). The corresponding categories for parents were <100, 100–2,020, 2,020–5,999, and ≥5,999 (*Troiano et al., 2008*). Recordings of more than 20,000 counts/min were considered impossible and deleted (*Maher et al., 2014*; *Wang, Chen & Zhuang, 2013*). Data sampling and analysis parameters of this research, are all the often used and reasonable parameter assignment of existing index for measuring preschool children physical activity, so as to ensure the accuracy of the research results and comparability with other similar studies.

Data analysis

All analyses were conducted using SPSS 22.0 (IBM, Chicago, IL, USA). A two-sided $p < 0.05$ was considered statistically significant. Results for normally distributed data were reported as mean ± standard deviation (SD), while results for skewed data were reported as median (interquartile range). Inter-gender differences were assessed for significance using the independent t test for normally distributed data, the Mann–Whitney U test for skewed data, or the chi-squared test for categorical data. Multiple linear regression was used to examine possible effects of parent's physical activity on preschool children's physical activity, after some factors such as age, BMI, family structure, family income, parents' daily

Table 1 Characteristics of study subjects.

Characteristic		Total ($n = 247$)	Boys ($n = 140$)	Girls ($n = 107$)	p
Age (month)		57.4 ± 5.2	57.9 ± 5.2	56.9 ± 5.3	0.927
BMI (kg/m^2)		16.3 ± 1.9	16.6 ± 1.9	15.8 ± 1.7	0.083
	Normal	195	102	93	
	Overweight/Obese	52	38	14	0.011
Child behavior score	Low (4–6 points)	155	74	81	–
	Median (7–9)	82	56	26	–
	High (10–12)	10	10	0	–
Cardiorespiratory fitness (laps)		11 (10–14)	11 (9–14)	12 (10–15)	0.151
Motor fitness (S)		7.0 (6.6–7.6)	7.0 (6.5–7.6)	7.1 (6.7–7.6)	0.219
Family structure	Living with both parents	238	136	102	–
	Other	9	4	5	–
Household income (RMB/month)	<4,000	6	4	2	–
	4,000–8,000	41	21	20	–
	8,001–15,000	108	63	46	–
	15,001–30,000	73	44	29	–
	>30,000	18	8	10	–

Notes.
Values are reported as mean ± SD for normally distributed data, as median (interquartile range) for skewed data, or count for categorical data.
BMI, body mass index.

interaction and parent's working style were controlled. Then the effect of father's physical activity on preschool children's physical activity and the effect of mother's physical activity on preschool children's physical activity were examined respectively using linear regression model as above.

RESULTS

Of the 346 parent–child triads initially recruited into the study, 99 were excluded due to inadequate data. As a result, 247 parent–child triads were included in the analysis, which comprised 86 fathers, 161 mothers, 140 boys and 107 girls (Table 1). The preschool children had a mean age of 57.5 ± 5.2 months. Male and female children did not differ significantly in age, cardiorespiratory fitness or motor fitness. However, BMI showed a tendency to vary with gender (boys, 16.6 ± 1.9; girls, 15.8 ± 1.7; $p = 0.083$). A total of 38 boys and 14 girls were overweight or obese. The prevalence of these conditions differed significantly between genders ($p = 0.011$; Table 1).

Physical activity in preschool children and parents

Boys spent significantly longer amounts of time in sedentary behavior on weekdays (596.9 ± 68.8 min/day) than on weekends (537.5 ± 89.6 min/day; $p < 0.001$) and significantly less time in MVPA on weekdays (73.3 ± 18.4 min/day) than on weekends (77.8 ± 26.2 min/day; $p = 0.013$). Similarly, boys' TPA was significantly lower on weekdays (174.1 ± 33.0) than on weekends (182.3 ± 47.7 min/day; $p = 0.02$). Girls spent significantly longer amounts of time in sedentary behavior on weekdays (604.8 ± 71.2 min/day) than on weekends (531.7 ±83.9 min/day; $p < 0.001$). Fathers and mothers alike spent significantly longer

Table 2 **Accelerometer-based physical activity (min/day) in preschool children and parents.**

Parameter		Total	Weekday	Weekend	*p*	*Cohen's d*
Boys' physical activity ($n = 140$)	Sedentary	580.8 ± 61.4	596.9 ± 68.8	537.5 ± 89.6	<0.001	0.74
	MVPA	74.6 ± 18.7	73.3 ± 18.4	77.8 ± 26.2	0.013	−0.20
	TPA	176.6 ± 32.9	174.1 ± 33.0	182.3 ± 47.7	0.020	−0.20
Girls' physical activity ($n = 107$)	Sedentary	585.7 ± 59.8	604.8 ± 71.2	531.7 ± 83.9	<0.001	0.94
	MVPA	69.9 ± 15.0	69.8 ± 16.1	69.2 ± 18.8	0.729	0.03
	TPA	166.4 ± 27.0	165.8 ± 29.3	166.3 ± 35.9	0.878	−0.02
Fathers' physical activity ($n = 86$)	Sedentary	422.8 ± 78.1	437.0 ± 94.4	394.1 ± 101.8	0.001	0.44
	MVPA	37.7 ± 22.7	39.5 ± 26.4	33.6 ± 23.1	0.026	0.24
	TPA	316.1 ± 68.2	318.2 ± 76.8	311.9 ± 78.7	0.477	0.08
Mothers' physical activity ($n = 161$)	Sedentary	399.5 ± 81.8	409.7 ± 93.2	369.7 ± 95.1	<0.001	0.42
	MVPA	33.3 ± 21.3	36.1 ± 22.2	26.6 ± 27.5	<0.001	0.24
	TPA	334.0 ± 81.6	335.3 ± 87.5	331.5 ± 94.6	0.552	0.04
Parents' interaction time with children (h)	≤1	–	61	32	–	
	2–4	–	137	19	–	
	>5	–	49	196	–	

Notes.

Values are reported as mean ± SD for normally distributed data, as median (interquartile range) for skewed data, or count for categorical data.

MVPA, moderate-to-vigorous physical activity; TPA, total physical activity.

time in sedentary behavior on weekdays than on weekends (fathers, $p = 0.001$; mothers, $p < 0.001$); the same was observed with MVPA (fathers, $p = 0.026$; mothers, $p < 0.001$). Fathers and mothers showed similar TPA on weekends as on weekdays (Table 2).

Just over half (55.5%) of the fathers or mothers wearing an accelerometer spent 2–4 h with their children on weekdays (Table 2). One quarter (24.7%) of fathers or mothers spent less than 1 h with their children, while 19.8% spent more than 5 h. On weekends, 79.4% of fathers or mothers spent more than 5 h with the children, 13% spent less than 1 h, and 0.08% spent 2–4 h (Table 2).

Correlation in sedentary behavior and activity level between parents and preschool children

There was a significant correlation on weekdays between parental sedentary activity and the sedentary activity of boys, girls and all children combined (all $p < 0.01$; Table 3). Fathers' sedentary levels correlated significantly with those of girls, but not those of boys; mothers' sedentary levels correlated significantly with those of boys, but not those of girls. Parents' and girls' MVPA significantly correlated with the MVPA of all children combined ($p < 0.01$ and 0.05, respectively), but not with boys' MVPA. Mothers' and girls' MVPA significantly correlated with each other ($p < 0.01$). Parental TPA significantly correlated with the TPA of boys ($p < 0.05$), girls ($p < 0.05$) and all children combined ($p < 0.01$). Mothers' TPA correlated with the TPA of girls or all children combined. However, no association was observed between fathers' and children's TPA levels.

On weekends, sedentary levels of parents correlated with those of girls and all children combined (all $p < 0.01$). Fathers' sedentary levels had more of an impact on girls' sedentary levels than mothers' levels did, while mothers' sedentary levels had more of an impact than

Table 3 **Associations of parents' and preschool children's sedentary behavior with physical activity levels.**

		Sedentary behavior			MVPA			TPA		
Time	Subject	Boy	Girl	All	Boy	Girl	All	Boy	Girl	All
Weekday	Father	0.244	0.318*	0.279**	0.032	0.332*	0.153	0.181	0.134	0.153
	Mother	0.260*	0.201	0.238**	0.039	0.373**	0.163*	0.154	0.249*	0.202*
	All	0.278**	0.255**	0.270**	0.038	0.331**	0.155*	0.168*	0.205*	0.191**
Weekend	Father	0.050	0.453**	0.235*	0.339*	0.444*	0.329*	0.279	0.337*	0.272*
	Mother	0.145	0.319**	0.213**	0.051	0.105	0.086	0.127	0.309*	0.204*
	All	0.109	0.357**	0.212**	0.123	0.201*	0.145*	0.177*	0.314**	0.231**

Notes.
MVPA, Moderate-to-vigorous physical activity; TPA, total physical activity.
*$P < 0.05$.
**$P < 0.01$.

fathers' levels on the sedentary levels of all children together. However, no association was observed between parental and boys' sedentary levels.

Parents' MVPA levels correlated significantly with those of girls and all children combined (both $p < 0.05$). Fathers' MVPA levels correlated significantly with those of boys, girls and all children combined (all $p < 0.05$), and fathers' levels affected girls' levels more than boys' levels. However, no association was observed between mothers' MVPA and that of all children combined. Parental TPA levels correlated significantly with boys' ($p < 0.05$), girls' ($p < 0.01$) and all children's levels ($p < 0.01$). Both fathers' and mothers' TPA levels correlated with girls' and all children's levels (all $p < 0.05$), but boys' TPA levels showed no association with either fathers' or mothers' levels.

Linear regression to identify correlations between parental and children's sedentary and activity levels

Linear regression models were developed to describe the effects of parental physical activity on children' physical activity on both weekdays and weekends (Table 4). Model 2 indicated that, after adjusting for age, BMI, family structure, household income and parent's daily interaction time with children and parent's working style, parental levels of sedentary behavior significantly correlated with preschool children's levels on weekdays ($p < 0.001$) and weekends ($p = 0.001$). The association was stronger on weekdays. On weekdays and weekends, mothers' sedentary behavior levels influenced preschool children's levels more so than fathers' sedentary behavior did. Parental MVPA levels showed significant associations with preschool children's levels on weekdays ($p = 0.018$) and weekends ($p = 0.029$), with a stronger association observed on weekdays. Mothers' MVPA levels correlated with preschool children's levels on weekdays, but not weekends. Conversely, fathers' MVPA levels were associated with preschool children's levels on weekends, but not weekdays. Parental TPA levels correlated significantly with preschool children's levels on weekdays ($p = 0.003$) and weekends ($p < 0.001$), with a stronger association observed on weekends. Mothers' TPA levels, but not fathers', correlated with preschool children's levels on weekdays. Fathers' and mothers' TPA levels were associated with preschool children's levels on weekends; fathers' levels exerted a stronger effect on children's levels than mothers' levels did.

Table 4 **Linear regression analysis to identify associations between parents' and preschool children's accelerometer-based physical activity.**

	Sedentary behavior		MVPA		TPA	
	β	p	β	p	β	p
Model 1[a]						
Weekday						
Father ($n=86$)	0.279	**0.009**	0.153	0.159	0.153	0.160
R^2	0.067		0.012		0.012	
Mother ($n=161$)	0.243	**0.002**	0.162	**0.041**	0.207	**0.009**
R^2	0.053		0.020		0.037	
Total ($n=247$)	0.274	**<0.001**	0.154	**0.016**	0.194	**0.002**
R^2	0.072		0.020		0.034	
Weekend						
Father ($n=86$)	0.235	**0.029**	0.329	**0.002**	0.272	**0.011**
R^2	0.044		0.098		0.063	
Mother ($n=161$)	0.214	**0.006**	0.086	0.287	0.206	**0.009**
R^2	0.040		0.001		0.036	
Total ($n=247$)	0.214	**0.001**	0.144	**0.025**	0.232	**0.001**
R^2	0.042		0.017		0.050	
Model 2[b]						
Weekday						
Father ($n=86$)	0.281	**0.013**	0.138	0.222	0.197	0.074
R^2	0.045		−0.002		0.055	
Mother ($n=161$)	0.243	**0.003**	0.140	**0.030**	0.186	**0.020**
R^2	0.058		0.057		0.088	
Total ($n=247$)	0.276	**<0.001**	0.146	**0.021**	0.191	**0.003**
R^2	0.072		0.040		0.067	
Weekend						
Father ($n=86$)	0.240	**0.032**	0.381	**0.001**	0.318	**0.005**
R^2	0.014		0.055		0.058	
Mother ($n=161$)	0.227	**0.003**	0.046	0.574	0.203	**0.012**
R^2	0.129		0.037		0.039	
Total ($n=247$)	0.211	**<0.001**	0.137	**0.035**	0.234	**<0.001**
R^2	0.082		0.019		0.041	

Notes.
MVPA, moderate to vigorous physical activity; TPA, total physical activity.
The p values less than 0.05 are bolded.
[a] Model 1: Unadjusted.
[b] Model 2: Adjusted for age, BMI, family structure, household income, child behavior score, parent–child interaction time per day and parent's working style.

DISCUSSION

The present study showed a significant association between levels of sedentary behavior and physical activity of preschool children in Shanghai with the corresponding levels in their parents. Multivariate linear regression revealed significant differences in physical activity levels between weekdays and weekends, between fathers and mothers, and between boys and girls. This regression was adjusted for age, BMI, family structure, household income, parent–child interaction time per day and parent's working style.

Parental and preschool children's sedentary behavior levels on weekdays and weekends

Levels of SB, MVPA, and TPA differed significantly between weekdays and weekends for parents and children. Sedentary behavior levels in boys, girls and parents were higher on weekdays than on weekends. This is consistent with the idea that on weekdays, most parents are at work and have little time to participate in planned physical activity. In contrast, preschool children stay in kindergarten between 7 am and 5 pm, with high sedentary behavior levels.

On weekdays and weekends, parents and preschool children spent more time in sedentary behavior than in physical activity. The factors behind this are likely similar to those reported in the study "Physical Activity and Health in Children and Adolescents" released by the Spanish government (*Merino & Briones, 2007*). These factors include: (1) overuse of electronic products such as television, computers, cell phones and tablets, which gradually replace time spent in outdoor activities; (2) car-based modern transportation, which reduces daily time spent walking; and (3) continuously accelerating urbanization. Parental sedentary behavior levels significantly affected preschool children's behavior, on weekdays and weekends (Table 3). Previous work has shown that children whose parents frequently engage in sedentary behavior (watching TV) also spend a substantial amount of time watching TV (*Jago et al., 2010*).

Parental and preschool children's physical activity levels on weekdays and weekends

We found that parental physical activity had a significant influence on preschool children's physical activity ($p = 0.001$). These results are consistent with the finding that children of two active parents are 5.8 times more likely to be active than children of two inactive parents (*Oliver, Schofield & Schluter, 2010*). Meanwhile, we also found that the influence of parental physical activity differs between weekdays and weekends. Parents and preschool children showed lower MVPA and TPA levels on weekdays than on weekends. This suggests that on weekends, both parents and children have more opportunities to participate in physical activity and spend more time in leisure and entertainment activities instead of sedentary behavior. Consistent with this idea, most parents spent more than 5 h per day with their children on weekends, compared to 2–4 h per day on weekdays. In addition, parents' and children's MVPA correlated with each other, as did their TPA levels. It is likely that parents spend time with their preschool children in order to protect them (especially when activities take place outdoors), and they likely spend more time with them in the evenings. Through these interactions, parents can directly influence their children's physical activity (*Cools et al., 2011*).

Analysis of discrepant influence of physical activity levels of parents on boys and girls

We examined to what extent the observed parental effects on children were dependent on gender. Our data indicated that parents' sedentary behavior and TPA were associated with the corresponding behaviors in their sons and daughters. The data also showed an association between parents' and daughters' MVPA levels. On weekends, parents' MVPA as well as their sedentary behavior correlated with girls' levels, and parents' TPA levels correlated with those of boys. Previous work has reported higher physical activity levels in boys than in girls, especially in families where parents strongly support children's participation in physical activity (*Sterdt et al., 2014*). Data from 986 preschool children and 539 parents based on accelerometers, questionnaires and interviews indicated an association between parents' and daughters' sedentary time, but not between parents' and sons' sedentary time (*Jago et al., 2010*). Similarly, we found in the present study that physical activity levels were higher in boys than in girls, and parents' physical activity had a stronger influence on girls than boys. It may be that boys exhibit (or are encouraged to exhibit) greater autonomy, whereas girls tend to depend more strongly on the parents.

Variation analysis of the influences of fathers and mothers on the physical activity level of preschool children

Our study also examined the relative influence of fathers' or mothers' physical activity on their children's activity. Most of the previous studies have focused on the mother-child link. For example, one study involving 554 preschool children aged 4 years old and their mothers showed associations between the two groups in accelerometer-measured sedentary behavior, LPA and MVPA (*Hesketh et al., 2014*). A cross-sectional study of 150 fathers of preschool children aged 3–5 years in which physical activity was assessed using the Pre-Physical Activity Questionnaire showed significant positive relationships between the two groups' physical activity on weekdays and weekends (*Vollmer et al., 2015*). Our study indicated that on weekdays, sedentary behavior of fathers was associated with that of their children, but the same was not observed for MVPA or TPA levels. In contrast, mothers' sedentary behavior, MVPA and TPA levels were associated with those of their children. On weekends, not only sedentary behavior but also MVPA and TPA levels of fathers were associated with those of their children, while sedentary behavior and TPA levels of mothers were associated with those of their children. These differences in maternal-paternal influence on children's physical activity likely reflect gender-based parenting roles within the traditional Chinese household. Our results suggest that on weekdays, the mother's physical activity influences that of the children to a greater extent than the father's does, while the converse is true on weekends. On weekdays, the father is more likely to focus on work and generating income, while the mother is more likely to look after the children and interact with them. Indeed, men in Chinese families typically spend less time in household activities than women (*Ng et al., 2014*). On weekends, in contrast, the father typically determines preschool children's physical activity. Future work may therefore need to focus on each parent separately and take into account whether physical activity occurs on a weekday or weekend; such work is needed to examine what characteristics of the father and mother influence their own levels of physical activity and their influence on their children's activity. For example, a mother's level of education and job type have been shown to affect preschool children's physical activity levels (*Ostbye et al., 2013*): women with more education and office work tend to elicit greater physical activity in their preschool children.

In summary, these findings suggest that preschool children's home environment must be taken into account when developing physical activity guidelines for Chinese preschool children. These guidelines should inform and influence parent–child interactions. However, this research still belongs to a cross-sectional study, the results of the present study should be interpreted with caution because of several limitations. Since the accelerometer cannot measure all types of physical activity in preschool children, it is possible that TPA was underestimated. It is also possible that the physical activity in our study was affected by factors that we did not control, such as the weather and parents' and children's emotional states. We did not assess parental lifestyle, hobbies, interests or exercise skills, all of which can affect preschool children's physical and mental development, emotional state (*Lenze, Pautsch & Luby, 2011*), behavior acquisition (*Eisenstadt et al., 1993*), personality development and attitudes toward eating (*Brown & Ogden, 2004*)—all of which, in turn, can affect children's physical activity. We also did not take into account differences in the duration of daytime *vs.* nighttime interaction between parents and children on weekdays. Such work has been reported (*Fuemmeler, Anderson & Masse, 2011*; *Johansson et al., 2016*), but comparing that work to ours is difficult and potentially misleading because of substantial differences in the subjects and in mediating factors present.

Further studies are needed to systematically analyze associations between parents' and preschool children's physical activity over a given time period. Lastly, we did not take into account the possible influence of household composition such as the presence of grandparents and hired nannies. These factors are likely to influence preschool children's physical activity, particularly in the multigenerational, single-child households that still predominate in urban centers like Shanghai.

CONCLUSION

The results of this study demonstrate that parental levels of physical activity and sedentary behavior affect the corresponding levels in their preschool children. These associations are significant and can be affected by many factors, include the parent's gender, the child's gender and whether it is a weekday or weekend. For example, maternal influence appears to be stronger during the weekdays, and paternal influence stronger on the weekends. Parents' activity levels influence girls' levels more strongly than they influence boys' levels.

ADDITIONAL INFORMATION AND DECLARATIONS

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Competing Interests

The authors declare there are no competing interests.

Author Contributions

- Chang Xu conceived and designed the experiments, prepared figures and/or tables, authored or reviewed drafts of the paper.
- Minghui Quan analyzed the data, performed the experiments, prepared figures and/or tables.
- Hanbin Zhang performed the experiments.
- Chenglin Zhou contributed reagents/materials/analysis tools, authored or reviewed drafts of the paper.
- PeiJie Chen conceived and designed the experiments, contributed reagents/materials/analysis tools, authored or reviewed drafts of the paper.

Human Ethics

The following information was supplied relating to ethical approvals (i.e., approving body and any reference numbers):

This study was approved by the Ethical Committee of Shanghai University of Sport (No. 2014028).

Data Availability

The following information was supplied regarding data availability:

The raw data has been provided as a Supplemental File.

Supplemental Information

Supplemental information for this article can be found online at http://dx.doi.org/10.7717/peerj.4405#supplemental-information.

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