

Clinical and Economic Outcomes Associated with Musculoskeletal Care in an Integrated Advanced Primary Care Model: A Controlled Cohort Analysis

Courtenay J. Stewart, Dena Bravata, Michael T. Nelson, Esha Datta, Raj Behal

Submitted to: Journal of Medical Internet Research
on: April 30, 2025

Disclaimer: © The authors. All rights reserved. This is a privileged document currently under peer-review/community review. Authors have provided JMIR Publications with an exclusive license to publish this preprint on its website for review purposes only. While the final peer-reviewed paper may be licensed under a CC BY license on publication, at this stage authors and publisher expressly prohibit redistribution of this draft paper other than for review purposes.

Table of Contents

Original Manuscript.....	5
Supplementary Files.....	24
Figures	25
Figure 1.....	26
Figure 2.....	27
Figure 3.....	28
Figure 4.....	29
Figure 5.....	30
Figure 6.....	31
Multimedia Appendixes	32
Multimedia Appendix 1.....	33
Multimedia Appendix 2.....	33
CONSORT (or other) checklists.....	34
CONSORT (or other) checklist 0.....	34

Clinical and Economic Outcomes Associated with Musculoskeletal Care in an Integrated Advanced Primary Care Model: A Controlled Cohort Analysis

Courtenay J. Stewart^{1, 2} DO; Dena Bravata^{3, 1} MD, MS; Michael T. Nelson^{1, 4} DPT; Esha Datta¹ PhD; Raj Behal¹ MD

¹ One Medical San Francisco US

² Stanford University Stanford US

³ Stanford University San Mateo US

⁴ Agile Physical Therapy Palo Alto US

Corresponding Author:

Dena Bravata MD, MS

Stanford University
1840 Lexington Av
San Mateo
US

Abstract

Background: Musculoskeletal (MSK) conditions affect more than one third of US adults² and account for over \$300B in total medical spend more than any other chronic condition. Employers bear a disproportionate burden of these costs, both because they pay for the care of employees and their families with MSK conditions and because MSK pain is the second leading cause of workplace absenteeism resulting in approximately 290 million lost workdays annually.

Objective: We sought to evaluate the effects of virtual physical therapy (vPT) integrated into advanced primary care on patient access, functional status, and cost.

Methods: We performed a retrospective analysis of participants (>13 years old) receiving vPT integrated with primary care compared to a risk-adjusted, national matched cohort of patients receiving in person PT.

Results: We evaluated 1563 participants with the following demographics: average age 42.8 years, 40% female, 68% White, 22% Asian. At presentation, their primary MSK issue was pain of the shoulder (14.2%), knee (12.9%), and low back (11.8%). On average, time to vPT appointment was 7.6 days. On average, vPT patients achieved better functional status than controls. On average, vPT patients required 5.4 visits to achieve symptom resolution, compared to 6.5 visits for controls (a 17% reduction). This resulted in \$193 to \$1411 in savings per injury per patient.

Conclusions: Given that participants in virtual PT integrated in primary care were able to achieve recovery of their MSK issues in fewer visits and with greater functional improvement than controls, this model should be tested more extensively. It holds considerable promise for addressing the escalating MSK costs of the US adult population.

(JMIR Preprints 30/04/2025:76794)

DOI: <https://doi.org/10.2196/preprints.76794>

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✓ **Please make my preprint PDF available to anyone at any time (recommended).**

Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.

Only make the preprint title and abstract visible.

No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain visible to all users.

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <http://www.jmir.org/preprint/76794>

No. Please do not make my accepted manuscript PDF available to anyone. I understand that if I later pay to participate in <https://www.jmir.org/preprint/76794>



Original Manuscript

Clinical and Economic Outcomes Associated with Musculoskeletal Care in an Integrated Advanced Primary Care Model: A Controlled Cohort Analysis

Courtenay J. Stewart, DO_{1,2}, ORCID ID: 0000-0001-9254-9380

Dena M. Bravata, MD_{1,3}, ORCID ID: 0000-0002-4513-8279

Michael T. Nelson, DPT_{1,4}, ORCID ID: 0009-0006-8100-7352

Esha Datta, PhD₁, ORCID ID: 0009-0000-1607-8716

Raj Behal, MD₁, ORCID ID: 0000-0001-5418-2581

Affiliations

₁Amazon One Medical, San Francisco, CA, USA

₂Stanford Clinical Excellence Research Center, Stanford, CA, USA

₃Stanford Center for Primary Care and Outcomes Research, Stanford, CA, USA

₄Agile Physical Therapy, Palo Alto, CA, USA

Corresponding author

Courtenay Stewart; cstewart@onemedical.com; Ph 650-380-6081; One Embarcadero Center, Suite 1900 San Francisco, CA 94111.

Running

Title

Head

Integrated Musculoskeletal & Advanced Primary Care

ABSTRACT

Background: Musculoskeletal (MSK) conditions affect more than one third of US adults² and account for over \$300B in total medical spend – more than any other chronic condition. Employers bear a disproportionate burden of these costs, both because they pay for the care of employees and their families with MSK conditions and because MSK pain is the second leading cause of workplace absenteeism resulting in approximately 290 million lost workdays annually.

Objective: We sought to evaluate the effects of virtual physical therapy (vPT) integrated into advanced primary care on patient access, functional status, and cost.

Methods: We performed a retrospective analysis of participants (>13 years old) receiving vPT integrated with primary care compared to a risk-adjusted, national matched cohort of patients receiving in person PT.

Results: We evaluated 1563 participants with the following demographics: average age 42.8 years, 40% female, 68% White, 22% Asian. At presentation, their primary MSK issue was pain of the shoulder (14.2%), knee (12.9%), and low back (11.8%). On average, time to vPT appointment was 7.6 days. On average, vPT patients achieved better functional status than controls. On average, vPT patients required 5.4 visits to achieve symptom resolution, compared to 6.5 visits for controls (a 17% reduction). This resulted in \$193 to \$1411 in savings per injury per patient.

Conclusions: Given that participants in virtual PT integrated in primary care were able to achieve recovery of their MSK issues in fewer visits and with greater functional improvement than controls, this model should be tested more extensively. It holds considerable promise for addressing the escalating MSK costs of the US adult population.

KEYWORDS

Advanced primary care, musculoskeletal care, virtual physical therapy, occupational health

INTRODUCTION

Healthcare costs in the US are skyrocketing, with commercial spending increasing 7.7% between 2022 and 2023.¹ Musculoskeletal (MSK) conditions affect more than one third of US adults² and account for over \$300B in total medical spend – more than any other chronic condition.³ Employers bear a disproportionate burden of these costs,¹ both because they pay for the care of employees and their families with MSK conditions and because MSK pain is the second leading cause of workplace absenteeism resulting in approximately 290 million lost workdays annually.⁴

Employers have implemented solutions that provide their employees with rapid access to high quality MSK care.⁵ These include centers of excellence, near site and onsite clinics with MSK offerings, virtual physical therapy (PT), and digital MSK therapeutics.⁶ Especially during the pandemic, the use of digital interventions dramatically increased.⁷ Early evidence for these interventions have held promise for both increasing early access to MSK care and decreasing costs of avoidable specialist visits, imaging tests, and surgical procedures.^{8–10}

Prior research has demonstrated the value of in-person MSK care integrated with primary care and of stand-alone virtual PT;¹¹ however, there are no published studies evaluating virtual PT integrated within an advanced primary care practice. The objectives of this study are to describe and evaluate the effects of a care model that includes virtual PT integrated into a hybrid (virtual and in-office) primary care system on access to MSK care, functional status outcomes, patient experience, and cost of care compared to patients cared for in the community.

METHODS

Participants and Controls

We retrospectively analyzed data from a cohort of adolescent and adult participants (age greater than 13 years) with MSK concerns seen by a One Medical virtual PT between January 1, 2021 and Dec 7, 2023. We excluded participants who had only one virtual PT visit or did not

complete both baseline and final clinical assessments.

We compared the clinical outcomes of the patients seen in virtual PT to those in the FOTO database. FOTO has the largest available dataset on outpatient physical medicine outcomes in the US.¹² These controls were matched on age, gender, body part, predicted functional score change, predicted number of visits, acuity as assessed by the number of days from onset of the treated condition, type of insurance, BMI, and number of medical comorbidities.

Data Collection

We assessed participants' access to both primary care and PT, compared participants' functional status at baseline and at the end of their course of PT to risk-adjusted FOTO controls, providers' assessments of participants' progress with PT, participants' satisfaction with their virtual PT, and costs of care.

Timing of Data Collection. Participant data were collected at baseline, during the course of PT, and at their final appointment. Baseline assessments were sent to participants via electronic messaging within their electronic health record during the week prior to their initial evaluation. Ongoing assessments of participants' status were collected at the discretion of the provider, with a goal of collecting assessment data at either the fourth appointment or within 30 days of initial exam. Final assessments were sent following the patient's final PT appointment. Patients lost to follow-up were contacted within 2 weeks to determine reason for self-discharge and to attempt to collect a final status assessment.

Access to Care. We assessed access to both primary care and virtual PT. We measured the time to see a primary care provider using the time to the third next available appointment or the average number of business days for patients to book a providers third next available appointment, which is a commonly used measure of healthcare access.⁸ We measured the time to start PT from the date a scheduler received confirmation of insurance approval for PT to the participant's initial

appointment, which was selected based on the patient's availability. Data to measure access times were extracted from the electronic health record from August 3, 2022 to December 7, 2023.

Patient-reported Outcomes. Demographics and comorbid conditions were extracted from the electronic health record. Participants were asked to complete the well-validated Focus on Therapeutic Outcomes (FOTO) instrument.¹² FOTO uses the Functional Status Score where 0 indicates low function and 100 indicates high function.¹³ Participants completed functional status questionnaires prior to treatment, during treatment, and at discharge.

Provider-reported Outcomes. Providers categorized participants' progress with PT as meeting the goals that were jointly established at the start of therapy in three levels: mostly meeting expectations, on track, or off track. Provider-reported participant progress was extracted from the electronic health record for the 473 participants seen between February 16, 2021 and December 7, 2023. We excluded participants from this analysis who were lost to follow up or transferred out of virtual PT prior to when the provider-reported participant progress could be assessed.

Costs of Virtual Physical Therapy. Direct costs of PT care were calculated from insurance claims for direct PT billing in 2023 for patients receiving care at One Medical in California.

Patient Satisfaction. Participants were sent the following Net Promoter Score question at the end of every visit via email, "How likely is it that you would recommend the provider you saw to a friend or colleague. 0: Not at all likely, 10: Extremely likely."

Intervention

The intervention was provided by physical therapists in the One Medical integrated care system.¹⁴ Physical therapists work 1:1 with patients during 45-minute synchronous video visits. The same physical therapist conducts the initial visit and the subsequent follow up visits to ensure continuity of care. Physical therapists were educated about virtual care via a required 5-hour telehealth training course and had to pass a competency exam. Additionally, each therapist received

two 1:1 training sessions with a senior therapist, each of which included a mock patient encounter. Care quality is maintained through regular review of FOTO outcomes by a senior therapist, clinical rounds education, regular case discussion, and chart reviews to assess for evidence-based guideline adherence.

Musculoskeletal care in an Integrated Advanced Primary Care Model

Physical therapy is integrated into an advanced primary care model with five key elements: multidisciplinary team, MSK toolkit for PCPs, peer-to-peer MSK expert opinion portal, shared technology platform, and MSK Rounds. Figure 1 provides an overview of how this model of care differs from stand-alone virtual MSK care and usual MSK care.

Multidisciplinary Team. Patients have access to four specialties: primary care (delivered by physicians, physician assistants, and nurse practitioners with training in family practice, internal medicine, geriatrics and sports medicine); behavioral health (delivered by psychologists, licensed clinical social workers, licensed mental health counselors, and marriage and family therapists); health coaching (delivered by board certified health and wellness coaches, many of whom have additional certification in nutrition counseling); and MSK rehabilitation care (delivered by physical therapists).

Participants can receive specialized MSK care in a variety of ways: Participants can book a virtual or in-office visit with their primary care provider or access on-demand care through in-app messaging or video chat. Primary care providers evaluate patient concerns and develop an assessment and individualized treatment plan. This may include medications, in-office lab tests, imaging orders, and referral to specialty care, procedures, or PT (either virtual within the integrated team, or external in-person care) if indicated. Once enrolled in virtual PT, the virtual PT shares progress notes and coordinates care for emerging needs (such as in-person care for manual procedures or injections, adding on behavioral health assessment, or needed imaging) with the PCP.

Common contraindications to virtual PT include impaired balance without caregiver support, and hands-on post-operative care.

Depending on patients' needs, other clinical services are available that are integrated with the core multidisciplinary team (Figure 2). Patients with higher-acuity care needs have access to the Complex Care Team which provides care navigators and nurses for patients requiring multiple referrals, intensive medication management, or hospitalization. Patients with selected chronic conditions (e.g., obesity, diabetes) are eligible for disease management services which include a team-based approach using remote patient monitoring (e.g., activity tracking, glucose monitoring), education, laboratory testing, and behavior change interventions. Each One Medical market also includes local health system partners who provide specialty care (e.g., orthopedics, oncology, neurosurgery).

MSK Toolkit. PCPs have access to an MSK toolkit which drives five key objectives: (1) Ensure consistent, evidence-based MSK recommendations by all PCPs across the organization. This consistency includes the use of common language regarding chronic pain and recovery by all team members.⁵ (2) Enable PCPs to match the patient to the best treatment(s) for them early in their care (e.g., PT before specialist referrals for many patients, starting patients with unaddressed psychosocial factors on both PT and behavioral health treatment/stratified care,⁶ referral for imaging or procedures before PT when indicated). (3) Encourage patient buy-in ahead of PT by harnessing the trusted, longitudinal PCP relationship. PCPs are trained to use shared decision making around the initial pain education and treatment selection, which includes discussion of the patient's pain management goals and treatment expectations. (4) Educate patients on the latest guidelines for the care of their specific condition¹⁵ including whether their condition requires surgery or imaging, appropriate use of manual therapy in conjunction with other therapies, and the importance of the role of PT. And (5) provide anticipatory guidance for painful conditions, as PT and movement may increase pain and soreness in the short term. The PCP discussion focuses on helping the patient understand the expected pain

trajectory ahead of treatment to encourage PT adherence. The toolkit is available at the point of care to reduce PCP burden around decision making and challenging patient-provider discussions.

The toolkit consists of care guidelines, ready-to-prescribe at-home treatment programs, and ongoing education. MSK care guidelines are evidence-based, embedded in the EHR, and include guidance on common physical examination maneuvers, diagnostic recommendations, conservative care, when to consider imaging or specialty referrals, and best practices for communicating with patients (Appendix Figure 1). Ready-to-prescribe at-home treatment programs (Appendix Figure 2) are available for the most common MSK conditions seen in primary care. They are created by MSK experts (e.g., PTs, sports medicine physicians, physiatry) which include biopsychosocial education, and therapeutic exercises. These materials focus on functional status and include aspects of behavioral health education and fundamentals of pain science. These are typically used as a PT alternative or bridge before PT and help ensure that education and exercises are delivered as quickly as possible.

Peer-to-peer MSK expert opinion portal. PCPs have access to a messaging portal with One Medical MSK specialists (e.g., physical medicine and rehabilitation physicians, sports medicine physicians, physical therapists) for quick curbside consults. This service uses Slack technology to enable PCPs to ask questions and learn from the responses being provided to their own questions (typically same day) and those of their colleagues. PCPs post questions before, during or after a clinical encounter with a patient. The nature of these questions includes: When to refer to PT vs specialist referral? What is your interpretation of this imaging study? This patient is not getting better as expected – what is the best next step?

Shared Technology Platform. The integrated electronic health record (EHR) facilitates team-based care. Specifically, internal providers can and do easily refer to each other and provide real time questions, patient updates, and handoff details. Commonly, PTs will identify new issues that require PCP attention (such as a new medication prescription) and patients can easily receive this care in-

house. The PCP delivers and coordinates care for patients simultaneously enrolled in behavioral health and PT for chronic MSK pain. Providers can coordinate their care plans using a real-time provider messaging forum. Moreover, patients are spared having to repeatedly provide historical information that is key to the care of their MSK issues including history of trauma, chronic pain diagnoses, recurrent injuries in the same body part as all of this information is available for all members of the care team.

Patients have an app which they use to schedule appointments, manage prescriptions, message their care team, speak with a provider via video visits 24/7, and access their care plan and health records. All patient-provider messages are visible to all members of the care team. The platform is available as a native app on iOS and Android devices and as a web app on personal computers.

MSK Rounds. All members of the care team participate in MSK Rounds which cover a range of primary care topics, including pain, injury, and common MSK care. Some MSK Rounds are developed by the internal One Medical clinical learning team (e.g., updates on the evidence of mental health interventions for chronic pain), others are presented by visiting lecturers (e.g., specialists from affiliated academic referral centers), and internal MSK experts.

Analysis

We used univariate analyses to describe the demographics of patients, measures of their access to care, patient reported outcomes, and provider reported outcomes. We considered analyses with $P < 0.05$ to be statistically significant. For the clinical outcomes, we conducted a retrospective matched cohort analysis comparing patients receiving virtual PT integrated with primary care to controls in the FOTO data set. Specifically, we compared the number of visits and functional status for the vPT patients with those predicted from FOTO and with FOTO controls. We computed a two-sided t-test on patients' functional status and number of visits residuals (residuals are the FOTO-

predicted value minus what was actually observed for a patient).

As all data used in this analysis are routinely collected on all patients cared for by clinicians in One Medical clinics, this protocol was considered exempt by the WCG IRB (Protocol OM.001, October 2023).

RESULTS

Participant Characteristics

The average age of the 1563 participants was 42.8 years (SD 10.4 years), 40% identified as female, 68% as White, 22% as Asian, and 3% as Black/African American (Table 1). On average, participants were overweight (mean BMI 26.3kg/m², SD 5.4kg/m², Table 1). Their most common MSK conditions at baseline were shoulder pain (14.2%), knee pain (12.9%), and low back pain (11.8%) (Figure 3).

Table 1. Participant Characteristics

Characteristics	N (Percentage)
Number	1563 (100%)
Age (years)	Mean 42.8 (SD 10.4)
16-30	139 (8.9%)
31-45	786 (50.3%)
46-60	538 (34.4%)
60+	100 (6.4%)
Gender	
Male	731 (46.7%)
Female	586 (37.5%)
Not reported	242 (15.5%)
Non-binary	4 (.3%)
BMI (kg/m ²)	Mean 26.3 (SD 5.4)
None reported	683 (43.7%)
<18.5 (underweight)	21 (1.3%)
18.5 to 25 (normal weight)	414 (26.5%)
25 to 30 (overweight)	300 (19.2%)

>30 (obese)	145 (9.3%)
Race/Ethnicity	
Not Reported	712 (45.6%)
Caucasian/White	574 (36.7%)
Asian	182 (11.6%)
Multiple Races	42 (2.7%)
Other	24 (1.5%)
African American/Black	19 (1.2%)
Middle Eastern or North African	8 (0.5%)
Native American/Alaska Native	2 (0.1%)

Access to Care

We measured time to access both primary care and PT. The mean third next available appointment for PCPs was 6.6 days (SD 8.2 days). On average, time to see a PT (after referral and insurance check are complete), was 7.6 days (SD 5 days). “Early PT” is typically defined as care initiation within 30 days of index healthcare visit.¹⁰

Health Services Utilization

Of the 1563 patients in virtual PT, the comorbidities for which they received primary care included anxiety (27.8%), depression (17.9%), overweight/obesity (16.6%), hypertension (11.3%), and chronic kidney disease (2.6%). On average PCPs sought 2.7 peer-to-peer MSK expert opinion consults per week.

After referral and initiating vPT, most patients (91.4%) were able to be cared for in PT alone (excluding lost to follow up patients). Small proportions of patients required additional care: 57 (3.7%) patients were referred back to their PCP for further evaluations or medication management (e.g., imaging, specialty consults) and 77 (4.9%) patients were transferred to in-person PT. Notably, 188 (12%) patients were lost to follow up (stopped responding to physical therapist or scheduler messages or failed to present for scheduled appointments).

Clinical Outcomes

Participants in vPT within an advanced primary care model achieved significantly greater improvements in functional status compared to FOTO controls and required fewer clinic visits than control patients (Figures 4 and 5). On average, FOTO functional status residual (which is the actual functional status change minus the predicted functional status change) was 5.82 for knee patients ($P<.001$), 5.70 for lumbar spine patients ($P<.001$) and 5.07 for neck patients ($P=0.007$). Other body parts: thoracic spine, shoulder, elbow, foot, pelvis, ankle, wrist, leg and arm also showed more improvement in functional score over the course of treatment compared to FOTO controls, albeit not statistically significantly (Figure 4). The functional status residual (difference between what was observed for vPT patients compared to FOTO predicted) was -4.14 for knee, -4.80 for lumbar spine, and -3.06 for neck. In the FOTO control population, participants generally had less functional clinical improvement than predicted. This demonstrates that patients in vPT integrated in advanced primary care had statistically and clinically significant improvements in their functional status compared with FOTO controls.

On average, virtual PT patients required 5.41 visits (SD 2.66 visits) to resolution of symptoms. This compares favorably to the FOTO risk-adjusted predicted number of visits which was 10.3 (SD 1.55 visits), and to the national benchmark from the FOTO matched controls of 6.49 visits (SD 5.47 visits) (Figure 5).

Provider reported Patient Progress

Providers reported patient progress for 473 patients (Figure 6). Recovery, defined as patients either meeting, mostly meeting, or on track to meet expectations, was achieved for 97.5% of participants.

Patient satisfaction

Overall participant satisfaction was high with a net promoter score for PTs of 98.

Costs of Virtual Physical Therapy

Direct cost of PT care in 2023 for patients receiving care in California ranged from \$176 to \$288 per visit. Since the results of this study found that the intervention reduced the total number of PT visits by 4.9 when using the FOTO database prediction and by 1.1 when using the FOTO control, we estimate that the total cost savings for this intervention ranges from \$193 to \$1411 per injury. Related cost savings such as procedure, imaging and surgery reduction were not included.

DISCUSSION

Principal Results

This study of a virtual PT intervention integrated with primary care for a demographically diverse population demonstrated four key findings. First, 91.4% of patients who were prescribed and completed virtual PT had successful treatment of their MSK issue. This highlights that a virtual PT approach, when integrated into primary care and triaged by a PCP, is appropriate for many patients.

Second, patients achieved excellent clinical outcomes: patients required 5.4 visits to symptom resolution, compared to 6.5 visits for controls, and 10.3 predicted visits from risk-adjusted benchmarks. Several components of the studied model likely contribute to efficient care, including easy access to physical therapy, guideline-driven care by both primary care providers and physical therapists, and care collaboration among providers. Additionally, when physical therapy is delivered virtually, self-management techniques (ex. self massage) may take the place of passive, time-consuming treatments, such as modalities or manual therapy. Beyond the PT-specific care, primary care integration enables treatment of both the MSK condition and the co-morbid conditions in

tandem (for example obesity, anxiety and depression), which may contribute to highly efficient recovery.

Third, knee pain, lumbar spine pain and neck pain had the most statistically significant clinical improvement compared to FOTO controls. There were other body parts that showed similarly large average improvements such as foot, elbow, thoracic spine, pelvis, hip, and upper leg. However, we did not have enough samples in these categories to show statistical significance. The knee and back respond well to education and exercises that do not require equipment, both of which can be delivered virtually. Early and ongoing studies of the knee, specifically virtual PT post knee arthroplasty, have consistently shown value.¹¹ For the shoulder, the prevalence of adhesive capsulitis, which has a long natural history and can take up to two years to resolve,¹⁶ in the group could create lower-than-expected functional change during short-term treatment.

Fourth, given the reduction in required PT visits to achieve a patient's clinical goals, the virtual PT intervention saved an estimated \$193 to \$1411 per injury. This promising result warrants a more comprehensive economic evaluation that includes costs beyond reduced physical therapy visits, such as costs for prevented imaging, specialist visits, and MSK interventions which were not included in this analysis. The most recent analysis accounting for both the direct and indirect cost of PT treatment was published by the American Physical Therapy Association¹⁷ with net benefit calculations for MSK conditions ranging from \$4,160 for low back pain to \$39,533 for carpal tunnel syndrome.

Limitations

This study had three key limitations. First, this study focused on commercially-insured populations. Given the promising results, it warrants future evaluations in older (Medicare) populations. Second, the patients were largely concentrated in California. Although the One Medical integrated care model operates nationwide and we do not anticipate significant differences in other

geographies, this warrants validation in other locations with different labor costs and reimbursement rates. Finally, the cost outcomes were estimated from One Medical claims for in-person PT. An analysis of all costs for patients receiving virtual PT in advanced primary care systems should be a priority.

Conclusions

Given that participants in virtual PT integrated in primary care were able to achieve recovery of their MSK issues in fewer visits and with greater functional improvement than controls, this model should be tested more extensively. It holds considerable promise for addressing the escalating MSK costs of the US adult population.

ACKNOWLEDGEMENTS

We thank Jeffrey P. Burr, Sergio Martinez-Ortuno, Hila Shprecher, and Scott Buttlere for their help with this study.

This project was funded by One Medical.

AI was not used in any part of the design, implementation, evaluation, analysis, or reporting of this study.

Author Contributions

CS provided supervision to all aspects of the work including intervention design, data collection and analysis, and manuscript preparation. DB provided project supervision and manuscript preparation support. MN provided data collection and manuscript preparation support. ED provided data science support. RB provided intervention design and manuscript preparation support. All authors approved the final manuscript.

Conflict of Interest

All authors were employees of, consultants to, or advisory board members of One Medical during the preparation of this evaluation.

Data Availability

Summary data will be made available upon reasonable request from the corresponding author.

REFERENCES

1. Workforce Health Index: 2023. apree health Available from: <https://apreehealthcom/resources/report/2023-workforce-health-index/>. May 2023.
2. Lawrence RC, Felson DT, Helmick CG, et al. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States: Part II. *Arthritis Rheum*. 2008;58:26–35.
3. Dieleman JL, Cao J, Chapin A, et al. US Health Care Spending by Payer and Health Condition, 1996-2016. *JAMA*. 2020;323:863.
4. Bryla J. Low back pain takes toll on worker health and productivity. Integrated Benefits Institution; October 23, 2013.
5. Large Employers' Health Care Strategy and Plan Design Survey. 2020. Business Group on Health Available from: <https://www.businessgrouphealth.org/en/resources/2020-large-employers-health-care-strategy-and-plan-design-survey>.
6. Business Group on Health Available from: <https://www.businessgrouphealth.org/en/search?query=musculoskeletal&facets=&relevancysorting=true>. Accessed September 20, 2023.
7. Cantor JH, McBain RK, Pera MF, Bravata DM, Whaley CM. Who Is (and Is Not) Receiving Telemedicine Care During the COVID-19 Pandemic. *American Journal of Preventive Medicine*. 2021;61:434–438.

8. Ojha HA, Wyrsta NJ, Davenport TE, Egan WE, Gellhorn AC. Timing of Physical Therapy Initiation for Nonsurgical Management of Musculoskeletal Disorders and Effects on Patient Outcomes: A Systematic Review. *J Orthop Sports Phys Ther*. 2016;46:56–70.
9. Horn ME, Fritz JM. Timing of physical therapy consultation on 1-year healthcare utilization and costs in patients seeking care for neck pain: a retrospective cohort. *BMC Health Serv Res*;18 . Epub ahead of print November 26, 2018. DOI: 10.1186/s12913-018-3699-0.
10. Arnold E, La Barrie J, DaSilva L, Patti M, Goode A, Clewley D. The Effect of Timing of Physical Therapy for Acute Low Back Pain on Health Services Utilization: A Systematic Review. *Arch Phys Med Rehabil*. 2019;100:1324–1338.
11. Gozalo PL, Resnik LJ, Silver B. Benchmarking Outpatient Rehabilitation Clinics Using Functional Status Outcomes. *Health Serv Res*. 2016;51:768–789.
12. FOTO Patient Outcomes. Frequently Asked Questions. What definitions are used by FOTO to define FOTO Outcome Measurement Scores? Available from: <https://fotoinc.com/frequently-asked-questions/>. 2023.
13. Waddell G, Newton M, Henderson I, Somerville D, Main CJ. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. *Pain*. 1993;52:157–168.
14. One Medical Available from: www.onemedical.com. Accessed September 20, 2023.
15. Stewart M, Loftus S. Sticks and Stones: The Impact of Language in Musculoskeletal Rehabilitation. *Journal of Orthopaedic & Sports Physical Therapy*. 2018;48:519–522.
16. Le HV, Lee SJ, Nazarian A, Rodriguez EK. Adhesive capsulitis of the shoulder: review of pathophysiology and current clinical treatments. *Shoulder Elbow*. 2017;9:75–84.
17. The Economic Value of Physical Therapy in the United States. American Physical Therapy Association; September 2023.

Preprint
JMIR Publications

Supplementary Files

Figures

Musculoskeletal care components by care model..

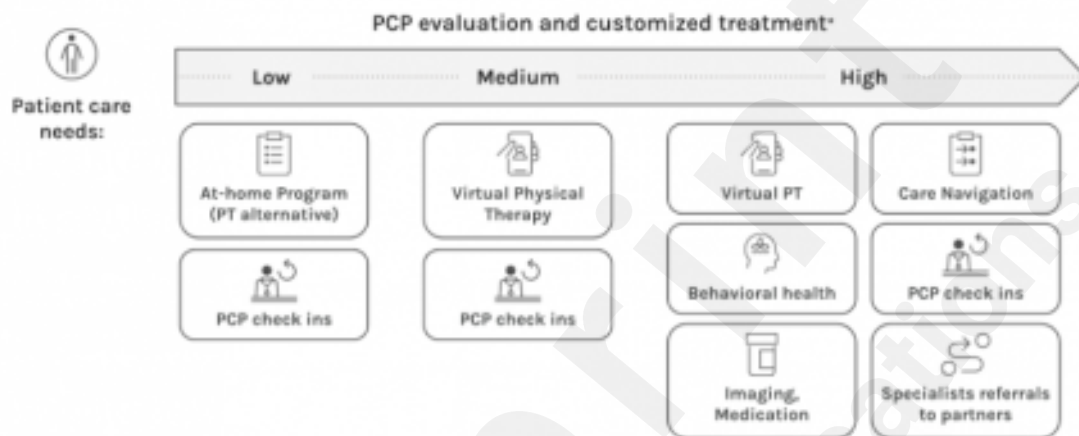
Figure 1. Musculoskeletal care components by care model.

MSK Care Component	Primary Care with Integrated VPT	Stand-alone virtual MSK Care	Usual MSK Care
Synchronous virtual PT	●	●	●
Rapid/direct access to MSK care	●	●	○
MSK care integrated with behavioral health care	●	●	○
Medication management	●	○	●
Direct messaging between patients and care team	●	●	●
PCP-prescribed at-home exercise program (alternative to PT)	●	●	○
Peer-to-peer MSK expert consultation for PCPs	●	○	○
Evidence-based MSK guidance for PCPs in EHR	●	○	○
Care coordination and navigation	●	○	○
Specialist referrals (e.g., neurosurgery, orthopedics)	●	○	●

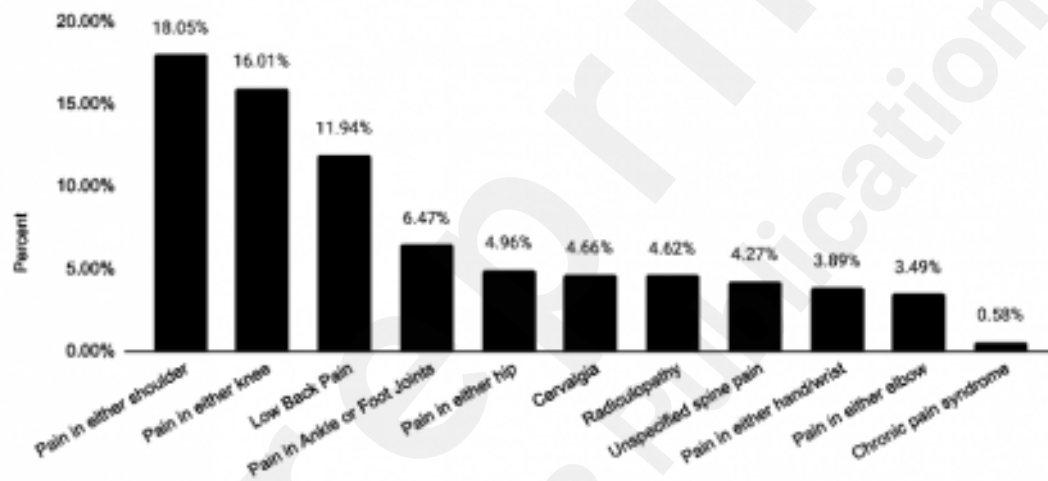
- Indicates core component of this care model, typically always available.
- Indicates that this is component that is sometimes available as part of this care model.
- Indicate this is not available in this care model.

MSK care matched to patient needs.

Figure 2. MSK care matched to patient needs

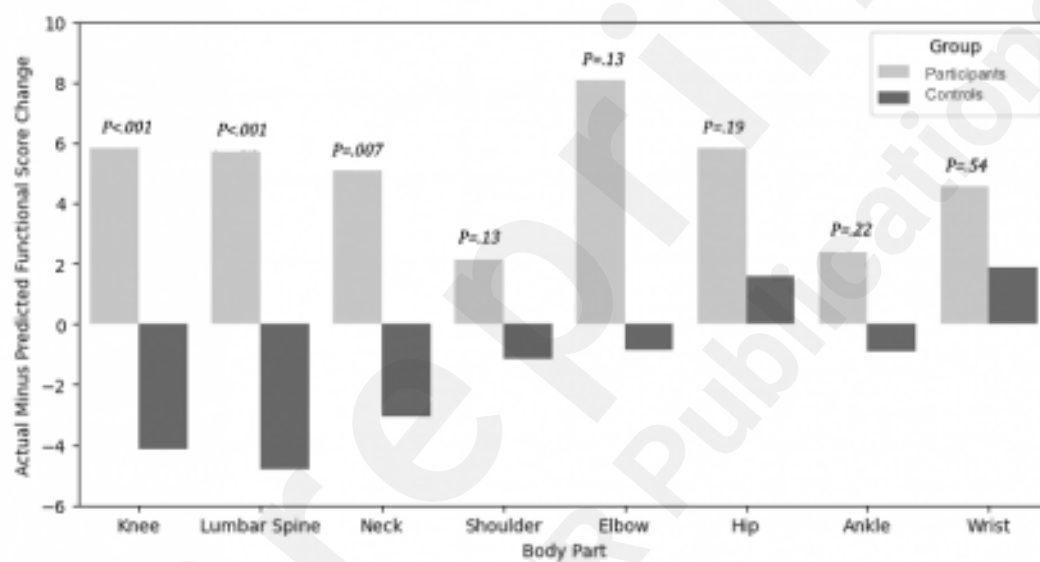


Primary MSK Complaint.

Figure 3. Primary MSK Complaint

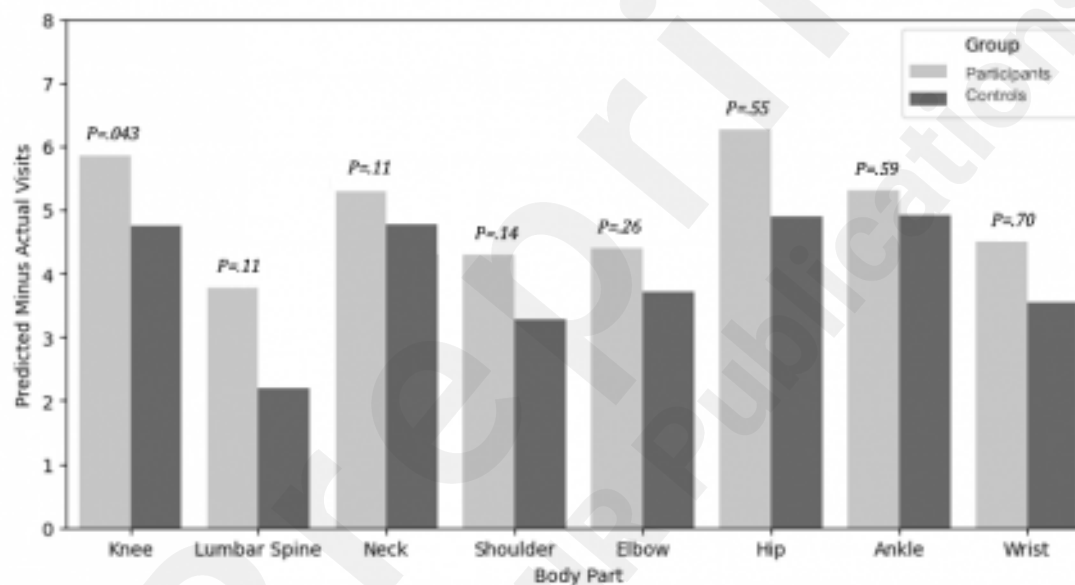
Difference in change in functional status between participants and controls.

Figure 4 Difference in Change in Functional Status Between Participants and Controls



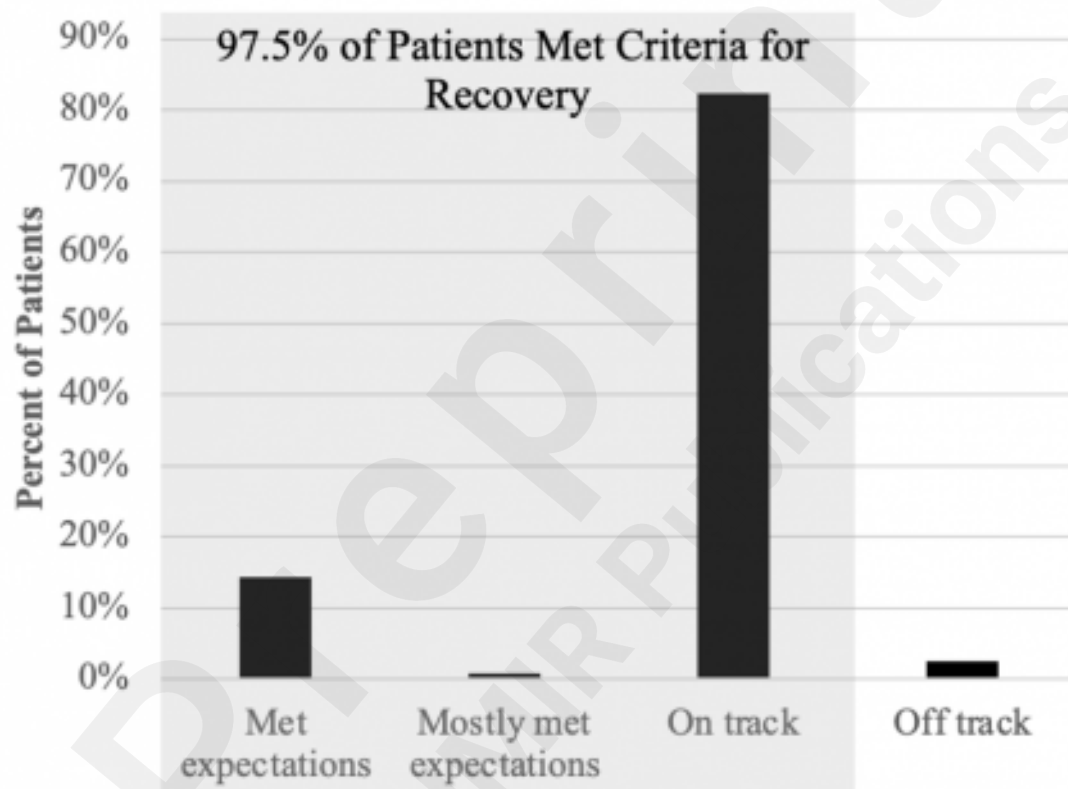
Difference in time to improvement between participants and controls.

Figure 5. Difference in time to improvement between participants and controls.



Provider reported outcomes.

Figure 6. Provider reported outcomes.



Multimedia Appendixes

Primary care provider educational content embedded in the electronic health record: Example for low back pain.

URL: <http://asset.jmir.pub/assets/5f838642a4ff3b172cbf814a5c610ecc.docx>

Ready-to-prescribe at-home treatment program content for patients: Example for shoulder pain.

URL: <http://asset.jmir.pub/assets/a1379e5ab931952b3a5cb897ae4f0816.docx>



CONSORT (or other) checklists

STROBE Checklist.

URL: <http://asset.jmir.pub/assets/537ff92cf3d384a4c8ac3ecca025c5b8.pdf>