Health literacy has been determined to be an important predictor of health status, frequent hospitalizations, poor related health outcomes, and increased health care costs [1,2]. It has been defined as “the degree to which individuals can obtain, process, understand, and communicate about health-related information needed to make informed health decisions” [3]. Adequate health literacy allows patients the ability to make appropriate health care decisions [2]. Many studies have shown that a majority of health-related materials are beyond the comprehension of most Americans [4]. In addition to this, with a growing population of non-English speaking patients, communication barrier also contributes to decreased health literacy. Despite a high prevalence, clinicians often have a difficult time identifying these patients and commonly overestimate a patient’s literacy level [5].

Many instruments have been created to assess general health literacy based on reading and numeracy skills including the Test of Functional Health Literacy in Adults, Rapid Estimate of Adult Literacy in Medicine, and the Newest Vital Sign [6–8]. These tools, while valuable, have been created to assess general health literacy and are not applicable in all clinical situations. The Literacy in Musculoskeletal Problems (LiMP) survey was created to examine health literacy in musculoskeletal diseases.
Musculoskeletal (MSK) health literacy by examining a patient’s comprehension of anatomy, terminology, diagnosis, and treatment of common MSK conditions. This survey was created based on the most commonly emphasized themes in the patient education section of the American Academy of Orthopaedic Surgeons, written at a grade level of 4.2, and validated against a general health literacy assessment tool (Newest Vital Sign) [1,9].

Although there has been some literature investigating health literacy in orthopedic trauma, hand, and foot and ankle populations [10–14], there has been very little research focusing on how MSK health literacy affects outcome scores and more specifically in an arthroplasty population. Thus, the purpose of the present study was to evaluate how MSK health literacy, as measured by the LiMP, impacts outcomes and satisfaction after primary total knee arthroplasty (TKA).

Materials and Methods

This study was approved by the institutional review board at our institution before implementation of the study methods. All patients from April 1, 2014 to December 31, 2018 who underwent primary TKA at a single institution with Current Procedural Terminology code 27447 were identified through archived records. Patients with less than 1-year postoperative period were excluded. Patients who underwent TKA for etiology other than primary osteoarthritis were excluded.

All patients who met the abovementioned criteria were sent a survey that included basic demographics, validated MSK health literacy scale (LiMP) [1,9] (Fig. 1), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and TKA satisfaction question regarding whether they would choose to undergo the same operation again. Based on these survey results, patients were categorized into ‘low’ or ‘normal’ MSK health literacy based on the number of questions answered correctly (cutoff 6 out of 9) on the LiMP [1,2,9].

Once the survey period was complete, retrospective chart review was performed on survey participants to gather patient demographics including age, race and ethnicity, body mass index (BMI), and tobacco use status. Secondary factors that were reviewed included postoperative length of stay, need for postoperative rehab, length of stay in rehab, Charlson comorbidity index, and the number of opioid tablets and prescriptions required within the first 3 months of surgery converted into morphine milligram equivalents (MME). Patients were then assigned a random ID to match survey responses to deidentified data. Data were then stored in a secure electronic database.

Fig. 1. Literacy in Musculoskeletal Problems (LiMP) questionnaire.
Indications for rehabilitation admission at our institution are based on a postoperative assessment from the physical and occupational therapists as well as a case manager and surgeon who evaluate the patient until discharge. Considerations include ability to perform activities of daily living, strength and ambulatory assessment, and caregiver/home support. If at the discretion of the surgeon, therapy, and care management team the patient is deemed not safe for discharge to home, they are then discharged to a rehabilitation facility. The exact rehabilitation facility and criteria for discharge from this facility are determined based on patient and insurance factors, and not all patients are discharged to the same facility.

Statistical analysis included a two-sample t-test for continuous variables and Fisher’s exact test for categorical variables between low and normal MSK health literacy groups. Demographics of both groups were compared to explore confounding variables that may affect the association between health literacy and primary outcomes. Confounding variables were added in the multivariate regression analysis to adjust the association. Linear and logistic regressions were used when appropriate. Statistical significance was set at $P < .05$. The analysis was conducted using IBM SPSS Statistics 27 (Armonk, NY).

**Results**

**Basic Demographics**

Four hundred fifty-three individuals fully completed the survey of eligible participants. Study follow-up time was between 1 and 6 years postoperatively with a range of 14-70 months. Mean follow-up time at the time of the survey was 36 months. Two hundred ninety-six individuals (34.7%) had normal MSK health literacy, and 157 individuals (34.5%) had low MSK health literacy (based on cutoff 6 out of 9 questions answered correctly). The average LiMP score for the entire population was 5.8 ± 1.5. Median LiMP was 6 with an interquartile range (Q1-Q3) from 5 to 7. Of the 453 survey participants, 416 identified as white/Caucasian (91.8%), 33 as black/African American (7.3%), 3 as Hispanic/Latino (0.7%), and 1 (0.2%) as other.

Mean age of those who underwent surgery and participated in the survey was 65.7 ± 8.6 years with a range of 38-87 years. Average age of those with low MSK health literacy was 66.0 ± 9.4 and those with normal MSK health literacy was 65.6 ± 8.2 (Table 1). One hundred ninety-two men (42.4%) and 261 women (57.6%) in total completed the survey. There were 67 men (34.9%) and 90 women (34.5%) who had low health literacy (Table 1). BMI was evaluated as recorded at the time closest to surgery. Average BMI of all participants was 31.7 ± 6.3 with a range of 17.2-52.5. Average BMI of those with low MSK health literacy was 31.4 ± 6.1, and average BMI of those with normal MSK health literacy was 32.2 ± 6.7 (Table 1). Smoking and tobacco use status was assessed and divided into 3 categories: those who have never smoked, current/former smokers, and those not assessed or unavailable in the record. Two hundred thirty-two participants (51.2%) were identified as never smoking (51.2%), 193 as current or former smokers (42.6%), and 28 not assessed/available (6.2%). Of those who had low MSK health literacy, 60 of 146 were current or former smokers (41.1%). Of those who had normal MSK health literacy, 133 of 279 (47.7%) were current or former smokers (Table 1).

Number of opioid tablets and prescriptions provided up to 3 months postoperatively were evaluated in all participants. Controlled substances included oxycodone, oxycodone + acetaminophen, hydrocodone + acetaminophen, hydromorphone, morphine, and tramadol. This was converted into MME to standardize the evaluation of opioid use. Range of prescriptions was 1 to 9 and 1 to 7 in normal and low MSK health literacy groups, respectively, with median of 2 opioid prescriptions in each group (Table 1). The Charlson comorbidity index (CCI) was evaluated retrospectively at the time of surgery. It is a weighted scale containing 17 comorbidities expressed as a sum and has been shown to be a validated predictor of postoperative function after primary TKA [15]. Range of the CCI for patients who participated in this study was 0-7, with a median score of 2 (Table 1).

All demographic data described previously were evaluated in a comparison between MSK health literacy groups. None were found to be significant (Table 1).

**Table 2**

<table>
<thead>
<tr>
<th>Primary Outcome Measures: WOMAC and Satisfaction.</th>
<th>Low MHL</th>
<th>Normal MHL</th>
</tr>
</thead>
<tbody>
<tr>
<td>WOMAC 18.0 ± 19.7</td>
<td>12.1 ± 15.4</td>
<td>$P = .001^a$</td>
</tr>
<tr>
<td>Surgery again?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>129 (82.2%)</td>
<td>269 (90.9%)</td>
</tr>
<tr>
<td>No</td>
<td>28 (17.8%)</td>
<td>27 (9.1%)</td>
</tr>
</tbody>
</table>

OR > 1 indicates normal MHL higher likelihood surgery again. $^a P < .05$. 

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BMI, body mass index; MME, morphine milligram equivalents; MHL, musculoskeletal health literacy.
**Primary Outcome Measures**

Average WOMAC (196) was 18.0 ± 19.7 in the low and 12.1 ± 15.4 in the normal health literacy groups. Patients with low health literacy had significantly higher WOMAC (worse function) than those with normal health literacy (P = .001). Twenty-seven out of 296 patients (9.1%) in the normal health literacy group and 28 out of 157 patients (17.8%) in the low health literacy group would not undergo the same operation again. Patients with normal MSK health literacy were significantly more likely to undergo the same operation again (P = .001, odds ratio 2.163) (Table 2).

One hundred three of 453 participants (22.7%) required a rehabilitation stay after being discharged from the hospital. Of participants with low MSK health literacy, 47 of 157 (29.9%) required a rehabilitation stay as compared with 56 of 296 (18.9%) with normal MSK health literacy. Those with low health literacy were significantly more likely to require a rehabilitation stay than those with normal health literacy (P = .009, odds ratio 1.831). Of those that required rehabilitation, 57 of 103 (55.3%) required a stay of greater than 7 days. Of participants with low MSK health literacy, 34 of 47 (72.3%) required a stay of greater than 7 days than 23 of 56 (41.1%) with normal MSK health literacy. Of participants who required a rehabilitation stay, those with low health literacy were significantly more likely to stay greater than 7 days than those with normal health literacy (P = .002, odds ratio 3.753) (Table 3).

To ensure no confounding results, a multivariate linear regression analysis was completed to evaluate WOMAC against various independent variables including age, gender, race, smoking status, BMI, opioid use (in MME), and CCI. We found that MSK health literacy is still associated with postoperative function, even after adjusting for confounding variables. Patients with normal MSK health literacy were found to have a lower WOMAC score (P = .002). African American race and opioid use were also associated with a higher postoperative WOMAC score (P = .002, P = .003) (Table 4). A multivariate logistic regression analysis was completed to evaluate surgery again and rehabilitation stay against the same independent variables. MSK health literacy was associated with the desire to have surgery again (P = .019), and patients with low MSK health literacy were more likely to be discharged to a rehab facility after surgery (P = .034). African American race and those with a higher CCI were less likely to undergo the same operation again (P = .046, P = .049). Higher BMI was also associated with a rehabilitation stay (P = .006). All other variables were not found to be significant (Table 5).

### Table 3

<table>
<thead>
<tr>
<th>Outcome</th>
<th>All</th>
<th>Low MHL</th>
<th>Normal MHL</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehab</td>
<td>103 (22.7%)</td>
<td>47 (29.9%)</td>
<td>56 (18.9%)</td>
<td>.002</td>
</tr>
<tr>
<td>No</td>
<td>350 (77.3%)</td>
<td>110 (70.1%)</td>
<td>240 (81.1%)</td>
<td></td>
</tr>
<tr>
<td>Rehab &gt; 7 d</td>
<td>Yes 57 (55.3%)</td>
<td>34 (72.3%)</td>
<td>23 (41.1%)</td>
<td>.002</td>
</tr>
<tr>
<td>No</td>
<td>46 (44.7%)</td>
<td>13 (27.7%)</td>
<td>33 (58.9%)</td>
<td>.002</td>
</tr>
</tbody>
</table>

OR > 1 indicates low MHL higher likelihood rehab and rehab > 7 d.

*P < .05.*

### Table 4

<table>
<thead>
<tr>
<th>Multivariate Linear Regression Analysis With Beta Coefficient (Beta Coeff), 95% Confidence Interval (CI), and P-Value.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcomes</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>MSK health literacy</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Gender (female)</td>
</tr>
<tr>
<td>Race (African American)</td>
</tr>
<tr>
<td>Smoking</td>
</tr>
<tr>
<td>BMI</td>
</tr>
<tr>
<td>Opioid use (in MME)</td>
</tr>
<tr>
<td>CCI</td>
</tr>
</tbody>
</table>

Statistically significant results determined if the 95% CI does not cover zero and P-value is less than 0.05 (bolded).

MSK, musculoskeletal; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; BMI, body mass index; MME, morphine milligram equivalents; CCI, Charlson comorbidity index.

### Discussion

Health literacy is an important determinant of health-related outcomes. Multiple studies have been performed investigating the role of health literacy in various medical subspecialties with specialty-specific surveys to better correlate outcome measures [2,16,17]. There is still little research investigating health literacy in orthopedic surgery, but studies have shown that in an orthopedic trauma population, there is limited comprehension of injuries as well as postoperative instructions. They also showed that patients with lower educational levels tended to have lower health literacy than those with higher educational levels [11]. Cosic et al showed that by providing a predischarge discussion with the patient to include a handout with an x-ray of the initial injury, x-rays of the operative fixation, and a small amount of written material describing the injury and ongoing management, it improved patient health literacy significantly [10]. Institutions have different protocols in place for both preoperative reading materials combined with postoperative instructions. At our institution, we provide reading materials to patients before surgery as well as comprehensive discharge instructions to include the procedure performed and rehabilitation and therapy protocol. Interestingly, it was recently shown by Hadden et al in an arthroplasty population that caregivers may not be better equipped to use or comprehend patient education materials than the patients they assist [18]. This emphasizes the need for a team-based approach to patient care to provide appropriate expectations for surgery as well as easily comprehensible reading materials.

When looking at arthroplasty, most of the literature has focused on the need for improvement of patient education to enhance patient expectations, some in the context of the importance of health literacy to this effect [18–20]. There is also recent study showing that there is a paucity of data regarding health literacy in orthopedic rehabilitation after TKA and total hip arthroplasty [21]. There has been less focus on specifically how health literacy affects outcomes after TKA, although our hypothesis is they are directly proportional. To our knowledge, this is the first study to investigate the association between health literacy and outcome scores after TKA.
Given literature necessitating the importance of subspecialty-specific surveys to test health literacy, we elected to focus on MSK health literacy using the validated survey LIMP [1,9]. There is a significant association between the MSK health literacy score and validated knee outcome measure (WOMAC). Not only did those patients with lower MSK health literacy have worse outcomes scores, they were also significantly less likely to undergo the same operation again. These findings are important yet problematic in that they expose a potential discordance between physician and caregiver goals to enhance satisfaction and outcomes with a dissatisfied patient. We sought to determine if there were any confounding variables that may have distorted this conclusion, and based on our analysis, there were no obvious confounders (age, race, gender, BMI, smoking status, opioid use, and CCI). Through this analysis, we did find that African American race was a predictor of a worse WOMAC score and being less likely to undergo the same operation again. Race and ethnicity has previously been shown to be associated with postoperative outcomes after TKA [22]. It is important to recognize that these disparities exist and like in the case of health literacy underscores the need for increased perioperative education and focus to improve outcomes.

With recent changes in the health care system, more effort is being placed to allow patients to be discharged early but safely in their postoperative course [23]. We evaluated what effect health literacy had on discharge to rehab and length of stay in rehab. Lower MSK health literacy was significantly associated with a rehabilitation admission. In addition, these patients with low MSK health literacy were significantly more likely to require a stay in rehab greater than 7 days than corresponding patients in rehab with normal MSK health literacy. This finding also underscores the importance of identifying patients’ health literacy preoperatively to be able to plan for or identify reasons as to why these patients will need such an extended stay. Especially with the push for earlier discharge after arthroplasty in the age of expanding inpatient and outpatient arthroplasty surgery, avoiding rehabilitation will become increasingly important, as these patients tend to have longer inpatient stays before their discharge to a rehab facility.

In the era of bundled payments for total joint arthroplasty, there is a goal for efficiency and cost reduction as well as the avoidance of dissatisfaction and readmission [24]. These study results show that if patients with low MSK health literacy were not willing to undergo the same operation again, it is reasonable to suppose they were not satisfied with their initial operation. Health literacy can be another tool used to help predict which patients are more likely to be satisfied with their surgery, which has the potential to affect reimbursement and predict patients likely to follow up for future joint replacement surgeries.

Preoperative WOMAC scores have been shown to be positively associated with postoperative WOMAC scores [25]. A major limitation in this study is that we do not have preoperative WOMAC scores, so we cannot adjust for the full effect of health literacy on postoperative outcomes. It is also important to note that this is not a single-surgeon study, and most TKAs were performed by 2 surgeons at our institution. Their preoperative and postoperative protocols are similar, but slight differences may exist in their perioperative care, although patients receive the option to attend a one-hour presurgical session provided by the nursing, therapy, and care management team to help with postoperative expectations. About 55%-65% of patients who undergo arthroplasty attend these sessions, and if a patient does not attend the session, they are sent the information electronically to review before surgery. We feel that this has improved understanding of the postoperative recovery period eliminating some of the stress patients feel before surgery. With the knowledge that MSK health literacy has a significant effect on outcomes, satisfaction, and postoperative course, the obvious question becomes how do we address it? It is possible that some patients had lower health literacy before surgery and their MSK knowledge improved leading to an improved score postoperatively, potentially underestimating the results. It is also possible that MSK health literacy does not change from preoperative status to postoperative status. Rather than focusing specifically on improving health literacy by itself, it may be more important to just identify these patients preoperatively, so more time can be spent to clarify expectations and provide more explanation. Although the presurgical sessions have helped provide patients more information, health literacy could be another avenue to offering this more personalized approach for those who are in need of it. More research is needed to evaluate this with a randomized control trial surveying MSK health literacy preoperatively and postoperatively after an intervention to see what effect this has on health literacy scores, outcomes, and satisfaction. We hypothesis that by streamlining the educational materials at an easily comprehensible level, having frank discussions about expectations that are tailored specifically to the patient’s medical history, and having team-based care that spends more time at discharge reinforcing this knowledge are key to improving outcomes and satisfaction after TKA.

Conclusions

Health literacy is an important topic that will continue to be evaluated in all facets of medicine and orthopedics. This study helps to quantify an underappreciated variable in the perioperative period that can have a significant impact on a patient’s...
postoperative course and feeling about the entire operation after TKA. All arthroplasty surgeons have the goal of improving their patient’s quality of life after a total joint arthroplasty, and MSK health literacy is an area that can be improved and focused on to achieve this goal. We recommend that orthopedic surgeons use this information to help guide preoperative protocols to enhance patient expectations and understanding to allow for an excellent result for both the surgeon and the patient.

Acknowledgments

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References