

Fostering Interest in STEM Careers and MSK Research: Pre- and Post-Program Survey Outcomes From Middle and High School Participants of the 2023 ORS Open Door Event

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INTRODUCTION: Diversity across all axes and intersectional identities is essential for promoting scientific and clinical excellence. The ORS began the Open Door program in 2018, with the primary goal of making musculoskeletal research more accessible to the general public. In the years since inception, the Open Door program has grown beyond focusing on the immediate connections between orthopaedic research and clinical care to broaden the program's outreach and impact. The overarching goal of the 2023 ORS Open Door Event was to inspire excitement of secondary school (i.e., grades 6-12) students and teachers for the possibility of careers in science, technology, engineering, and mathematics (STEM) fields with a particular focus on orthopaedic/musculoskeletal (MSK) sciences. We hypothesized that this all-day and immersive outreach event consisting of career speakers, hands-on activities/demonstrations, and a diversity-focused mentorship Q&A panel would increase the students' interest in pursuing STEM careers while illustrating the importance and positive impact of diversity in MSK research.

METHODS: This study was deemed exempt from review by the Human Subjects Review Committee at Union College as per 45 CFR 46.104(d)(2). **Target Audience:** In partnership with the Science Teacher Access to Resources at Southwestern (STARS) Program at UT Southwestern Medical Center, the 2023 ORS Open Door Event engaged middle and high schools in the local Dallas area where students are largely from historically underrepresented groups in STEM (>60% Hispanic/Latinx, >15% African American, first-generation college students, and/or from economically disadvantaged backgrounds). **Early Career Outreach Travel Award (ECOTA):** To recruit a diverse cohort of 8 early-career ORS members to assist with this event, the Planning Committee (with the support of the ORS Board) established the ECOTA program, providing \$375/awardee to ensure equitable access to participation. **Career Speakers and Mentorship Q&A Panel:** To expose the students to various career paths, 4 speakers spanning engineering, biology, translational research, and orthopaedic surgery presented short talks featuring their research and educational trajectories (12-minute talk and 5-minute Q&A/speaker). Additionally, a 40-minute mentorship Q&A panel comprised of researchers from different career stages and historically underrepresented groups in STEM was hosted to further address science- and career-related questions. **Interactive Workshops:** Students rotated through three 25-minute workshops on (1) sports medicine and biomechanics, (2) cartilage and bone, and (3) spine led by ORS volunteers. Workshop leaders instructed students in small groups to independently make observations, test hypotheses by collecting and analyzing data (e.g., athletic measurements such as vertical jump height), and simulate detrimental biomechanical effects of MSK disease using low-cost household items. **Event Outcomes:** Student and teacher attitudes toward STEM and MSK research regarding diversity, personal / career interests, and broader societal importance were polled electronically both pre- and post-event on a 5-point Likert scale, where 1, 3, and 5 denote strongly disagree, neutral, and strongly agree, respectively. Pre- and post-survey responses were matched according to self-reported personal identifiers. **Statistics:** To assess the impact of the 2023 Open Door Event on student and teacher attitudes, pre- and post-program survey responses were compared using Wilcoxon matched-pairs signed-rank tests. Significance was set at * $P < 0.05$ and trend at # $P < 0.10$. Data are shown as mean \pm standard error of the mean.

RESULTS: Approximately 160 students and teachers attended the 2023 Open Door Event. A total of 93 pre-program survey responses were collected, with 35 of those matched to their corresponding post-program survey responses (7 in 6th grade/4 in 8th grade/1 in 9th grade/3 in 10th grade/6 in 11th grade/10 in 12th grade/4 teachers). Student and teacher survey responses were subsequently combined for statistical analyses due to the limited teacher sample size.

Event Outcomes: Supporting our hypothesis, student and teacher attitudes toward STEM and MSK research were significantly improved for nearly all diversity-related, broader societal importance, and career-related questions. The following 3 questions reported the greatest increases: (1) *I know someone who works in MSK research* (2.00 \pm 0.24 to 3.50 \pm 0.23; 75.00% increase), (2) *I know a lot about MSK research* (2.23 \pm 0.16 to 3.75 \pm 0.18; 68.16% increase), and (3) *I am interested in becoming a MSK researcher* (2.33 \pm 0.23 to 3.07 \pm 0.25; 31.76% increase). **Student-Specific Outcomes:** When considering only the 31 matched student responses, these significant increases in attitude remained mostly consistent but became trends ($p < 0.08$) for the following 3 questions: (1) *There is diversity in STEM* ($P = 0.058$; 3.89 \pm 0.17 to 4.23 \pm 0.17), (2) *I think that MSK research is important for society* ($P = 0.074$; 4.00 \pm 0.16 to 4.47 \pm 0.12), and (3) *I am interested in learning about how to use STEM to improve at sports* ($P = 0.057$; 3.63 \pm 0.18 to 4.11 \pm 0.16).

DISCUSSION The high post-program survey responses support the positive impact of the 2023 ORS Open Door Event in fostering enthusiasm around STEM and MSK research. A limitation of this study was the relatively low survey engagement (35 matched pre- and post-survey responses out of 160 attendees; 21.88%) which precluded a more detailed breakdown of attitude changes by grade level. Future iterations of the ORS Open Door event, such as the 2024 event in Long Beach in partnership with CSU Long Beach, will actively address this shortcoming by better incentivizing attendee participation.

SIGNIFICANCE: These compelling short-term attendee outcomes illustrate the transformative impact of the ORS Open Door Event in encouraging middle and high school students to pursue STEM- and MSK-related interests and careers, thereby helping to address longstanding disparities in these disciplines.

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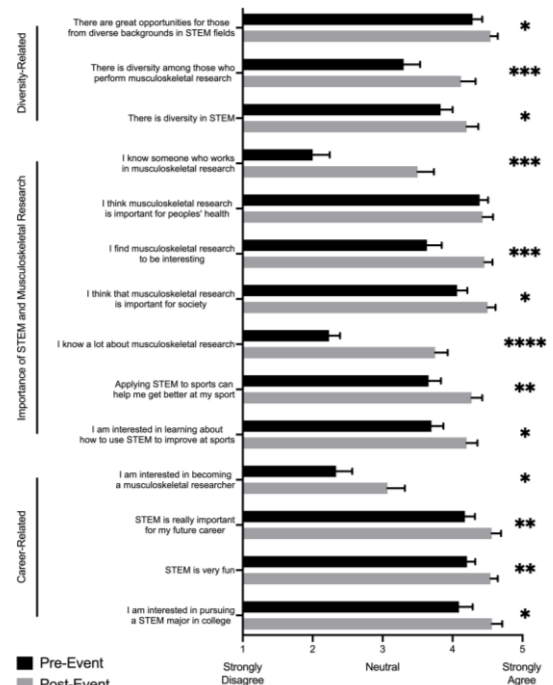


Figure 1. Comparison of 35 matched pre- (black) and post-event (gray) survey responses illustrates widespread improvements in secondary school student and teacher attitudes and enthusiasm in regards to STEM and MSK research after attending the 2023 ORS Open Door Event. * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, **** $P < 0.0001$.