Original Research

Total Joint Arthroplasty Direct-to-Consumer Advertising by Medical Device Companies Lacks Patient Diversity

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ABSTRACT

Background: Obese and African American populations suffer from higher incidence of hip and knee osteoarthritis, yet African Americans are less likely to undergo total hip and knee arthroplasty (TJA). Patient interest in TJA is a necessary first step for surgery. Medical device company direct-to-consumer advertising for TJA represents 1 potential factor driving disparities in utilization. Here we analyze demographics of models represented in medical device company direct-to-consumer TJA advertisements to understand whether advertisement content correlates with the population in need.
Methods: We analyzed medical device company pamphlets, websites, and banner and video advertisements of the top 4 medical device companies in US arthroplasty sales, collected via ad-specific search engine and direct correspondence. Variables include model race, sex, age, and weight. Pearson likelihood ratio tests were used to compare categorical variables.
Results: Of the 116 advertisements collected, the model featured in the advertisement was white in 69.8%. The proportion of white models differed across medical device companies (company C, 75%) (P < .001) and advertisement type (video, 81.8%) (P < .001). Only 2.6% of advertisements featured obese models. Neither company C nor D, nor pamphlet or website advertisements used obese models.
Conclusions: Direct-to-consumer advertising from the top 4 orthopedic US medical device companies does not represent the population in need: While TJA remains underutilized by African American/Hispanic patients, models were overwhelmingly white. While obese patients are known to need TJA, patients in the advertisements were overwhelmingly not obese. We advocate for medical device companies to refocus their advertising strategies to target diverse patients in need of TJA.
Level of evidence: III (retrospective cohort study).
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Introduction

Total hip and knee joint arthroplasty, collectively referred to as total joint arthroplasty (TJA), is a common procedure: at present, greater than 1,00,000 people/y in the United States undergo 1 of these procedures [1]. In the United States, osteoarthritis and its subsequent management are not equitably distributed. Osteoarthritis is highly represented in the geriatric population, and it disproportionately affects individuals who are obese [2—4], female [5], and African American [6—8]. The risk for those who are

overweight or obese is striking: For obese class I individuals (body mass index [BMI] of 30-34.8 kg/m^2), the risk is 8.53-fold higher to undergo total knee arthroplasty and 3.42-fold higher to undergo THA, with these risks further increasing with higher classes of obesity [9]. Despite these statistics and their evidenced high need, TJA is still underutilized by women [10,11], African Americans, and Hispanics [12—15] compared with the burden in their specific populations.

The decision to undergo TJA is a mutual decision between the patient and their surgeon, and therefore, proceeding with surgery necessitates willingness and interest from the patient. The historical and current mistreatment of both African Americans and the obese by the medical community is well documented [16] and likely contributes greatly to potential barriers to access, including mistrust, bias, fear, and lack of interest and/or

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awareness. Therefore, it is the onus of the medical community to determine the multitude of factors contributing to these instances of hesitancy that may impact disparity in medical care utilization in these communities. Ultimately, there is a need to examine potential factors which may influence a patient to seek surgical treatment.

The purpose of TJA direct-to-consumer advertising by medical device companies is 2-fold: to target those in need of surgery and maximize profits. These goals are interrelated, as accurately targeting those in need of surgery will enhance profits by expanding the patient population undergoing TJA. Therefore, the understanding of the use of body weight, race, and sex in TJA advertising is crucial. Advertisements are 1 of many factors that influence consumer decision-making. It has been demonstrated that racial groups, including African American and Hispanics, have been historically underrepresented in advertisements, and their depictions have been shown to reinforce false and negative stereotypes [17,18]. Importantly, it has been shown in consumer research that the race of models represented in advertisements strongly influence buying patterns: Individuals are more likely to make a purchasing decision if they identify with the race and/or ethnicity of the model [9,19–24].

Given the observed disparities in TJA utilization, we seek to examine the demographic representation in TJA advertisements from the top US medical device companies. To our knowledge, this has not previously been researched. Specifically, we sought to explore whether there are demographic differences within models who are represented across TJA advertisements and whether advertisement strategy differs by company or advertising medium.

Material and methods

Study design

Data were collected from the 4 largest medical device manufacturers of TJA implants in the United States: Smith and Nephew, Johnson and Johnson: DePuy Synthes, Stryker Orthopedics, and Zimmer Biomet. These 4 companies were chosen as they represent greater than 92% of the US arthroplasty market [25]. Companies were deidentified to A, B, C, and D to promote holistic and unbiased commentary.

Data were collected for any advertisements available for the period between July and August 2020 from the following sources: patient-oriented website banner advertisements, patient pamphlets and handouts, medical device company patient-oriented websites, and patient-oriented videos regarding patient testimonials and education. All advertisements pertaining to hip, knee, or both were included.

Data for racial breakdown of TJA utilization were abstracted from the 2012-2018 American College of Surgeons National Surgical Quality Improvement Program database. Data were selected using relevant Current Procedural Terminology codes for total knee and total hip arthroplasty.

Data collection

Data from candidate medical device companies were collected via the banner advertisement search engine Moat by Oracle Data Cloud (https://www.moat.com/). Moat is a publicly available, advertisement-specific software search engine, powered by Oracle, that allows one to search the Web for banner advertisements by company. This service allows you to see all banner advertisements a company promotes online, with their dates of availability. All advertisements pertaining to hip, knee, or both

were examined for all 4 companies. We confirmed the accuracy of the banner search results with only 1 of the marketing departments and extrapolated that the results were true for the other 3 companies. Patient pamphlets, company websites, and videos were acquired via direct correspondence with the 4 companies. For videos and websites, this consisted of direct contact with customer service marketing representatives for each medical device company, to direct researchers to the specific patient-related portion of their websites to ensure comprehensive review of all advertisements. For pamphlets, this consisted of direct contact with company representatives, where pamphlets were mailed or emailed to the research team.

From the various mediums of advertisements, the following variables were collected: company name, focus of advertisement (hip, knee, both), white-focused (Y, N), use of male or female models, estimated age of model (child, youth, adult, and elderly), race of model (white vs non-white), physical activity of model, famous spokesperson (Y, N), BMI (normal vs overweight/obese). Age of model (specifically adult vs elderly) was determined based on demonstrated level of activity as well as evident facial and physical characteristics. Featured models were defined as those who occupied a predominant focus of the advertisement, compared to other models present. Due to our inability to confidently characterize ethnicity for models of color, we categorized models based on race alone as white and non-white. White-focused vs non−white-focused advertisements were determined by the racial composition of the advertisement. Non−white-focused advertisements required the presence of at least 2 races in the advertisement with equal focus on both the white and non-white models. If a non-white model was in the advertisement but a white model was the focus of the advertisement, the advertisement was categorized as white-focused (Fig. 1). We chose this method as we intend to use the term non−white-focused as a proxy for parity between races, and if 1 model of a specific race is the overwhelming focus, this does not represent parity. This is to help eliminate bias that could be created by the "featured" model taking the dominant portion of the audience's attention. Obesity was determined based on surveillance of model body habitus and estimated to be a BMI greater than 30. While subjective, this was reviewed by 2 reviewers (A.B. and R.O.) to ensure inter-rater reliability and was verified by a physician (D.W.). All data collection processes were conducted by 2 individuals (A.B. and R.O.), and when there was a disagreement, this was adjudicated by a third (D.W.). Of the 116 advertisements analyzed, there was reviewer disagreement for 3 advertisements, with a kappa of 0.97.

Data analysis

Likelihood ratio chi-squared tests were used to compare categorical variables, including advertisement attributes and ad type. These included advertisement medium by company, model demographics by company, and model demographics by advertisement medium. For analyses having >20% of data points with expected values <5, Fisher's exact tests were used. Only results from analyses with n > 10 were considered. Significance was set at $P < .05$ for all analyses. Statistical analysis was performed using JMP Pro Version 15 (Cary, NC).

Results

Overall advertisement demographics

Overall, 116 advertisements that pertained to hip, knee, or both were collected across all companies that were available
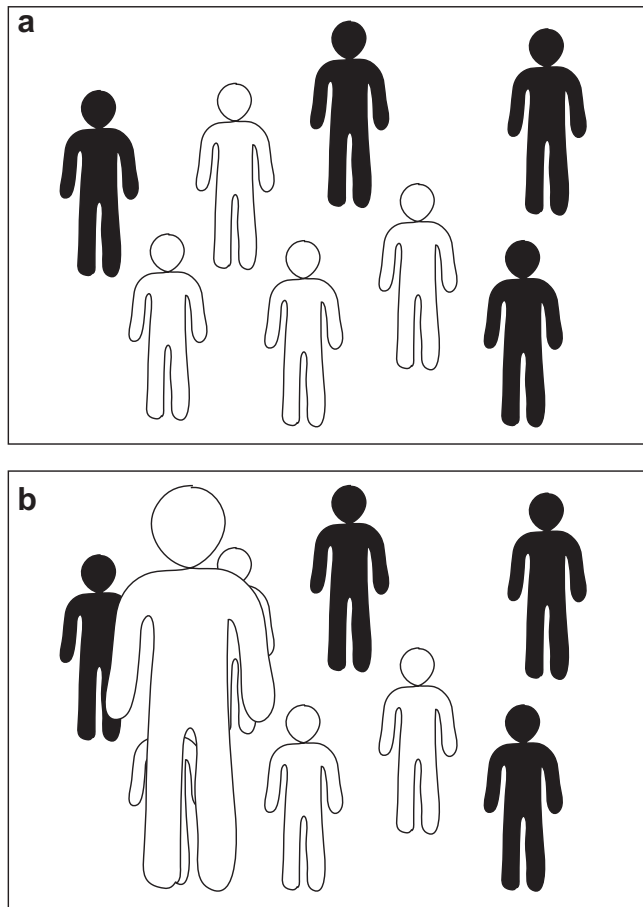
Figure 1. Non−white-focused ad assessment. (a) Representation of an advertisement that was deemed to meet criteria for non−white-focused designation, given its parity of representation without an explicitly featured model. (b) Representation of an advertisement with diversity that did not meet criteria for non−white-focused designation, due to its large emphasis on a featured model.

between July and August 2020. All advertisements that met criteria released by these companies were included. Twenty-four (20.7%) were website banner advertisements, 32 (27.6%) were pamphlets, 11 (9.5%) were videos, and 49 (42.2%) were websites. Fifty-six advertisements (48.3%) were made by company A, 17 (14.7%) by company B, 28 (24.1%) by company C, and 15 (12.9%) by company D (Table 1). When examining the advertising medium used by each company, we found there were significant differences across the medium used, based on company (P < .001). Company A mostly advertised via website (51.8%), company B via banner advertisements (47.1%), company C via banner advertisements or website (39.3% each), and company D via pamphlet (73.3%) (Table 2).

Demographic differences of models across TJA advertisements

Models featured in the advertisements included 2.6% (3) of overweight/obese models, 65.5% (76) elderly models, and 56.0% (65) men (Table 3). Of all, 69.8% (81) of advertisements featured a model of white race, and 30.2% (35), a model of non-white race. Examination of the demographics of the entire composition of the advertisement (not only featured models) showed 80.2% (93) contained a model of white race, while only 13.8% (16) contained a non-white model (Table 3). Overall, models were more likely to be white (all P < .001).

Table 1
Advertisement mechanisms and medical device companies.

Advertisement medium or company	N (%) (n = 116)
Ad medium	
Website banner advertisement	24 (20.69)
Pamphlet	32 (27.59)
Video	11 (9.48)
Website	49 (42.24)
Company	
A	56 (48.28)
B	17 (14.66)
C	28 (24.14)
D	15 (12.93)

Advertisement strategies by company and advertising medium

The rate at which white models were featured differed across both companies (P < .001) and types of advertisements (P < .001). Company C had the largest representation of white models (75.0%), whereas company B had the lowest (64.7%). Video advertising had the highest proportion of white models (81.8%), and website banner advertisements had the lowest (62.5%) (Tables 4 and 5). When examining the rates at which white models were present (80.2%), we found no differences by company (P = .770) or advertisement type (P = .116).

Overall, only 3 advertisements used obese models. Company A had 2 of these (3.6%), and company B had 1 (5.9%). These advertisements were represented across banner (2) and video (1). Company C or D used no obese models in their advertising. There were no pamphlet or website advertisements that featured any obese models (Tables 4 and 5).

The rate at which the elderly were featured in advertisements also varied based on advertisement type (P = .005). Pamphlets had the largest representation of elderly models (87.5%), and banner advertisements had the lowest (41.7%) (Tables 4 and 5).

We found no differences in the rates of non−white-focused advertisements, female and male models, or male vs female models based on either company or ad medium (Tables 4 and 5).

Discussion

While TJA is a commonly performed procedure, with currently greater than 1,000,000 people/y undergoing 1 of these procedures, disparities in utilization exist for women, African Americans, and Hispanics. These populations also have higher rates of obesity than their white counterparts, and obesity is a known risk factor for osteoarthritis. Given that the demographics of a model and the demographics of the target audience may influence behavior following consumption of a direct-to-consumer advertisement [9,19−24], we sought to assess the demographics of models utilized in TJA advertisements, to see if there are any observable disparities in model sex, race, and weight representation. In reviewing data from advertisements from the top 4 medical device companies, we found that advertisement models were overwhelmingly of normal

Table 2
Mechanism of advertisement display by medical device company.

Advertisement medium	Company (n = 116); N (%)				P value
	A	B	C	D	
Website banner advertisement	5 (8.93)	8 (47.06)	11 (39.29)	0 (0.00)	<.001
Pamphlet	18 (32.14)	2 (11.76)	1 (3.57)	11 (73.30)	
Video	4 (7.14)	2 (11.76)	5 (17.86)	0 (0.00)	
Website	29 (51.79)	5 (29.41)	11 (39.29)	4 (26.67)	

Significance was set at P < .05.

Table 3
Demographics of advertisement models.

Model demographics	N (%) (n = 116)
Highlighted model	
White race	81 (69.83)
Minority race	35 (30.17)
Obese	3 (2.59)
Elderly	76 (65.52)
Male	65 (56.03)
Entire composition	
Any white model	93 (80.2)
Non−white-focused	16 (13.79)

body weight and more likely to be white, in contrast to the population most in need of this surgery. Strikingly, only 3 of 116 (2.6%) advertisements included a model who was obese, only 30.2% of advertisements used models of a non-white race, and only 13.8% of advertisements were non−white-focused. While not at exact parity, sex was the most equitably represented demographic (56% male). We also found that advertisement strategies differ by company and advertising medium, based on the demographics of the featured model. For example, a majority of pamphlet advertisements used elderly models, and less than half of banner advertisements used elderly models. This can speak to assumption of technology literacy in the elderly population. Perhaps most importantly, very few companies used obese models overall, and 2 of the 4 companies did not use any obese models.

Study limitations include a small number of overall advertisements per company, the wide variation in number of advertisements among companies, the subjective nature of identifying race and obesity, and the lack of data on ad viewership. Additionally, the direct relationship between direct-to-consumer advertisements and patient interest in undergoing TJA was not explored here but represents an area worthy of future pursuit. However, some samples were significantly powered to show statistical significance. To mitigate potential discrepancy in codifying model race and obesity, we had 2 independent reviewers evaluate each advertisement.

In the United States, more than 42% of the population meets the criteria for obesity [4]. Given the large proportion of the US population that qualifies as obese, and the fact that obese patients are more likely to have osteoarthritis, this lack of representation is troubling. As advertisement demographics have been shown to influence consumers, this lack of representation may negatively impact obese individuals from seeking surgical treatment for their osteoarthritis, which may reduce profits for these medical device companies.

In the United States, 60.1% of the population is white, 13.4% are African American, 18.5% are Hispanic, 5.9% are Asian, and 2.8% are of multiple races, [26] with 39.9% of the US population being of minority race. Therefore, even when controlling for the racial breakdown of the American population, white models are still overrepresented at 69.8%, and non-white models are underrepresented at 30.2% of advertisements. This parallels national disparities observed in TJA utilization, with more than 75% of these procedures being performed on white patients.

The observed racial disparity in models was particularly evident in the advertisements of company C, in which 75% of advertisements featured white models. The rates at which white models were featured differed significantly by company. As it pertains to advertising medium, video advertising had the most striking racial inequities, with more than 80% of models being white. Overall, the rates at which white models were present did not differ significantly by company or advertising medium. This may be due to the saturation of white models, as white models were present in more than 80% of all advertisements. This suggests that companies, especially company C, are narrowly focused on a white target audience and are overlooking large potential patient populations in communities of color, who are in need of this procedure [6−8,12−15].

There is no "perfect" schema of representation, especially given that for-profit companies have a duty to their shareholders. However, the noted lack of obese individuals, as well as the lack of racial minority representation, suggests that these 4 companies could expand their marketing to target a set of more diverse individuals who need TJA. While not the only mechanism to increase patient awareness—and ultimately patient TJA utilization—direct-to-consumer advertising has an established impact on consumer behavior and, therefore, represents 1 area that could serve to decrease noted disparities. Ultimately, greater inclusion by these companies that represent 92% of the market share [25] could serve to benefit them by increasing revenue in the form of an expanded patient population and greater public perception stemming from greater inclusion.

An important consideration is the for-profit nature of direct-to-consumer advertising. The marketing departments of companies have a vested interest in increasing shareholder value while also reflecting corporate social responsibility. Therefore, public perception and pressure have been shown to have direct impacts on company policy, and in fact, aligning with social movements can serve to satisfy customers, increase consumer base, and ultimately generate more profit. Therefore, we propose that advertisements with more diversity, including racial and body habitus representation, will actually serve to increase shareholder value by encouraging patients to feel more comfortable seeking surgical intervention, while having the—arguably more—important social benefit of reducing disparities in access to TJA.

Conclusions

Overall, this paper demonstrates that the leading US orthopedic medical device companies have not diversified the patients represented in their advertisements to include people who are obese and underrepresent communities of color. Given a patient's role in

Table 4
Advertisement model demographics by company.

Model demographics	Company (n = 116); N (%)					P value
	Total (n = 116)	A (n = 56)	B (n = 17)	C (n = 28)	D (n = 15)	
White	81 (69.83)	38 (67.86)	11 (64.71)	21 (75.00)	11 (73.33)	**<.001**
Obese	3 (2.59)	2 (3.57)	1 (5.88)	0 (0.00)	0 (0.00)	.554*
Elderly	76 (65.52)	39 (69.64)	8 (47.06)	18 (64.29)	11 (73.33)	.333
Male	65 (56.03)	29 (51.79)	11 (64.71)	16 (57.14)	9 (60.00)	.792
Male and female	48 (41.38)	20 (35.71)	8 (47.06)	11 (39.29)	9 (60.00)	.367
Non−white-focused	16 (13.79)	8 (14.29)	2 (11.76)	6 (21.43)	0 (0.00)	.279

Significance set at P < .05.
* n < 10, so no meaningful statistical results could be drawn.

Table 5
Advertisement model demographics by advertisement medium.

Model demographics	Total (n = 116)	Advertisement medium (n = 116); N (%)				P value
		Website banner advertisement (n = 24)	Pamphlet (n = 32)	Video (n = 11)	Website (n = 49)	
White	81 (69.83)	15 (62.50)	26 (81.25)	9 (81.82)	31 (63.27)	**<.001**
Obese	3 (2.59)	2 (8.33)	0 (0.00)	1 (9.09)	0 (0.00)	.067[*]
Elderly	76 (65.52)	10 (41.67)	28 (87.50)	7 (63.64)	31 (63.27)	**.005**
Male	65 (56.03)	17 (70.83)	21 (65.63)	6 (54.55)	21 (42.86)	.079
Male and female	48 (41.38)	8 (33.33)	18 (56.25)	6 (54.55)	16 (32.65)	.118
Non−white-focused	16 (13.79)	4 (16.67)	4 (12.50)	4 (36.36)	4 (8.16)	.101

Significance set at $P < .05$.

[*] n < 10, so no meaningful statistical results could be drawn.

decision-making with pursuing surgery, and research demonstrating that individuals are more likely to buy a product if they identify with the demographics of the model, the lack of representation of diverse models in need of TJA may be 1 player contributing to deeply engrained disparities in underutilization. While only a part of the complex surgical decision-making, these disparities may influence patient willingness to consider surgery. Further research is needed to directly explore this relationship. In the meantime, we advocate for a greater inclusion of obese, African American, and Hispanic models in advertising strategies by orthopedic TJA companies, as 1 possible way to help combat disparities in utilization of TJA in these populations. Given the potential for growing their consumer base, this will serve to increase shareholder value as well as address significant disparities in TJA utilization. Further research into the influence of direct-to-consumer advertising on patient willingness to consider surgical treatment and health disparities is warranted.

Conflicts of interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

M. I. O'Connor is a paid employee of Vori Health; is a paid consultant for Zimmer Biomet, Inc. and BONESUPPORT, Inc.; and has stock or stock options in Vori Health. All other authors have no conflicts to disclose.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2022.04.010.

Informed patient consent

The authors confirm that informed consent has been obtained from the involved patient, and the patient has approved this information to be published in this case report.

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