A Systematic Review for Health Disparities and Inequities in Multiparametric Magnetic Resonance Imaging for Prostate Cancer Diagnosis

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Rationale and Objectives: Multi-parametric Magnetic Resonance Imaging (mpMRI) is a novel procedure recommended by the American Urological Association for Prostate Cancer (PCa) diagnosis. In radiology, differences in utilization of expensive screening techniques are described but never reviewed for mpMRI. Thus, our article aims at summarizing disparities relating to the expensive yet revolutionary mpMRI in United States men with PCa while highlighting needed research areas.

Material and Methods: Eligible articles were gathered via PubMed query, referred publications known to the authors or from the reference lists of the identified publications. We excluded studies that didn't specifically evaluate mpMRI technique, weren't conducted in the United States, or didn't directly assess the relationship between disparities and mpMRI. No date restrictions were applied, resulting articles were published through 2020.

Results: Out of 80 publications, 17 were selected. Two unique themes were identified: 1) disparities in mpMRI utilization, and 2) performance. While demographic factors such as race, age and socioeconomic status played a significant role in utilization, mpMRI demonstrated equal and sometimes superior performance in AAs.

Conclusion: Our findings illustrate the importance of disparity awareness in PCa mpMRI and highlight the need to examine additional mpMRI disparities across other races and social determinants. A new area of inequity in PCa was theoretically illustrated, as lower utilization of mpMRI was detected in a group that could potentially benefit from it the most. Major limitation was the selected search terms. Our review is unique as disparities related to mpMRI were found to be multilayered, affecting utilization and performance. Continued research is needed to discover additional areas in efforts to reduce disparity gaps related to mpMRI and PCa.

KEY WORDS: Disparities; Inequities; Prostate Cancer; Imaging; Screening; Radiology.

Abbreviations: PCa Prostate Cancer, **AA** African American, **SEER** Surveillance, Epidemiology, and End Results Program, **mpMRI** Multiparametric Magnetic Resonance Imaging

INTRODUCTION

Multi-parametric Magnetic Resonance Imaging (mpMRI) is a novel procedure recommended recently by the American Urological Association for Prostate Cancer (PCa) diagnosis (1). This expensive technique is a promising tool for better PCa detection and outcomes (1). Unfortunately, health disparities in PCa diagnosis, treatment and survival exist (2,3). In fact, African Americans

(AA) are 1.7 times more likely to have PCa and possess a mortality rate twice as high as non-Hispanic Whites (4). This difference has resulted in a call for separate PCa guidelines for AAs subgroups (5).

Interestingly, the most studied disparities in radiology are related to cancer screening by imaging especially when it comes to novel and expensive techniques (6,7). In fact, recent evidence affirms the presence of health disparities and inequities in diagnostic imaging utilization of PCa (8). Further, a Surveillance Epidemiology and End Results (SEER) dataset unraveled higher imaging utilization amongst men living in urban areas and those having higher income (9). Additionally, age, race and socioeconomic status were identified as main factors leading to disparities in PCa imaging utilization (8). However, despite underlying variations in social determinants, recent evidence suggests that disparities in PCa outcomes no longer exist when equitable access to care is achieved (10,11). As such, identifying principal causes of

disparities in mpMRI can potentially forge the way for more equitable health outcomes in this area.

To date, there is no systematic knowledge in the potential disparities in mpMRI utilization, the most advanced, yet the most expensive diagnostic test for PCa. In addition, it is yet unknown whether disparities in mpMRI utilization could potentially contribute to further inequities in PCa outcomes. In fact, disparities and inequities are often used interchangeably in the literature. Although disparities refer to a certain "difference", inequities express "injustice" (12,13). Hence, this paper aims at systematically reviewing relevant publications discussing mpMRI disparities in PCa. Our objectives are to condense valuable information on disparities in mpMRI utilization and collective performance across the demographically and socio-economically diverse PCa patient population groups in the United States (US) as well as to identify future needs in this realm by summarizing retrospective and prospective studies discussing mpMRI disparities across adult men diagnosed with PCa and/or received a prostate mpMRI. This paper will also touch base on potential health inequities in this area and could possibly constitute a key model for research in health disparities and inequities.

METHODS

Search Method

We queried the PubMed search engine for original articles published on health disparities and inequities on the use of mpMRI in PCa. The query terms we have used are the following: prostate AND cancer AND diagnostic AND imaging AND magnetic resonance imaging OR (MRI) OR Multiparametric OR mpMRI) AND (inequities OR disparities OR socioeconomic OR race).

Article Selection

The population-intervention-comparison-setting method was used to determine the eligibility of studies. In our reviewed articles, the participants were "adult men in the US diagnosed with PCa and/or received mpMRI," intervention was the receipt of mpMRI, comparative groups were men from varying demographic/socio-economic backgrounds, outcomes were mpMRI utilization (yes/no) and collective performance, and finally studies included were retrospective and prospective cohorts. Eligible studies were all publications resulting from the PubMed query, referred publications known to the authors and others gathered from the reference lists of the identified publications. Out of these eligible publications, we further conducted an article selection process according to specified inclusion and exclusion criteria. Inclusion criteria used were articles that are peer reviewed, originally published in the English language and discussed disparities in mpMRI specifically. Exclusion criteria were publications that were not conducted in the US or did not directly assess the relationship between disparities and

mpMRI. No date restrictions were applied, and thus, resulting articles were published through the end of 2020. Our last date of search for relevant articles was the end of December 2020. All included articles were rightfully downloaded, managed and screened using Zotero.

Eighty publications were deemed eligible, all published between 1994 to 2020. After article selection according to our inclusion and exclusion criteria, 17 studies met our requirements and were included in this review. The use of mpMRI as the technique was directly mentioned in all but three of the included articles, which were dated from 2010 to 2016 suggesting mpMRI as the established clinical routine technique. No specific mpMRI technique was required as all selected papers were clinical papers that involved data from routine clinical mpMRI procedure. No potential biases were identified in the individual studies that met our inclusion criteria as all resulting studies were evaluated based on reproducibility, methodological quality and credibility.

Due to the nature of our research question that aims at reviewing discovered mpMRI disparities in research, publication bias may have arisen. It is likely that studies with no significant findings for mpMRI disparities weren't published, and thus included publications overrepresented disparities. However, the large population-based studies in this review tend to limit this potential overrepresentation. Our systematic review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist for evidence-based reporting and principal summary measures were odds ratios and difference in percentage along with their respective *p*-values.

RESULTS

Study Characteristics

The vast majority of our resulting articles were published between 2014 and 2020. The 17 studies that met the inclusion criteria are presented in Table 1. Five publications were population based, 10 were single-institutional and two were multi-institutional (14–30). Datasets analyzed included the SEER, large private health insurance database in the US - the OptumLabs Data Warehouse, National Medicare claims data and several single and multi-institutional data. Two main themes were identified; seven articles examined underlying factors responsible for disparities in mpMRI utilization, while 10 articles studied disparities in mpMRI performance. The two unique disparity areas identified were first related to disproportionate distribution of mpMRI usage among different population groups and second discussed differences in performance once the technique was administered.

Disparities in mpMRI Utilization

Disparities were present across race, age, income, time of PCa diagnosis, region and insurance status (14–20) (Table 2). The majority of studies describing demographic data were

TABLE 1. Studies Meeting Inclusion Criteria Regarding Health Disparities and Inequities in the Utilization of Multiparametric Magnetic Resonance Imaging for Prostate Cancer

Author (year)	Article Title	Design	Population and Time Frame	Sample Size	Key Findings	Reference #
Gross et al. (2020)	Variation in Magnetic Resonance Imaging-Ultrasound Fusion Targeted Biopsy Outcomes in Asian American Men: A Multicenter Study.	Multicenter, prospective cohort	Men who underwent magnetic resonance imaging targeted and systematic biopsy for elevated prostate specific antigen from 2010 to 2018	2571	Asian Americans have lower diagnosis rates of clinically significant prostate cancer on targeted biopsy after mpMRI in comparison to non-Asian Americans. This illustrates the difference in PI-RADS performance in this population.	30
Hoge et al. (2020)	Racial disparity in the utilization of multiparametric MRI-ultrasound fusion biopsy (FBx) for the detection of prostate cancer	Retrospective single institution	Black and White men who presented with suspicion of PCa and required biopsy from January 2014 to December 2018.	619	Black race was significantly associated with lower rates of fusion biopsy when presenting with PCa suspicion as well as in biopsy-naive patients.	20
Falagario et al. (2020)	Staging Accuracy of Multiparametric Magnetic Resonance Imaging in Caucasian and African American Men Undergoing Radical Prostatectomy.	Retrospective single institution	Patients who underwent radical prostatectomy with preoperative multiparametric magnetic resonance imaging between January 2013 and April 2019	975	The accuracy of mpMRI in staging PCa was similar in AA and Caucasian American patients and no difference existed between races in pathological outcomes after undergoing radical prostatectomy.	24
Henning et al. (2019)	Diagnostic Performance of Prostate Multiparametric Magnetic Resonance Imaging in African American Men.	Retrospective single institution	Men who underwent prostate mpMRI prior to biopsy between October 2014 and June 2017.	601	Findings show that AA men have similar outcomes in PCa detection using mpMRI as compared to White men; no significant difference in test performance as similar sensitivity, specificity, negative predictive value and positive predictive value were found.	22
Bloom et al. (2019)	Use of multiparametric magnetic resonance imaging and fusion-guided biopsies to properly select and follow African American men on active surveillance.	USA study cohort from the National Cancer Institute (NCI)	Men who had undergone mpMRI and FB	542	Amongst men with a prior 12−core systematic biopsy (SB), AA men with Gleason Grade (GG) 1 disease were nearly twice as likely to be upgraded by targeted mpMRI fusion−guided biopsy compared with non−AA men.	28

TABLE 1. (Continued)

Author (year)	Article Title	Design	Population and Time Frame	Sample Size	Key Findings	Reference #
Deebajah et al. (2019)	A propensity score matched analysis of the effects of African American race on the characteristics of regions of interest detected by magnetic resonance imaging of the prostate.	Retrospective single institution	Individuals who underwent mpMRI in the course of being considered candidates for active surveillance for PCa between October of 2015 and October of 2017.	592	AA men exhibited a higher number of regions of interest (ROI) as compared to Caucasian counterpart mpMRI.	27
Mahran et al. (2019)	Observed racial disparity in the negative predictive value of multi-parametric MRI for the diagnosis for prostate cancer.	Retrospective single institution	All mpMRI between January 2014 and June 2017	638	AAs with Grade 1 or II PCa, compared to Caucasians, had a lower negative predictive value for mpMRI, while it remained comparable in more aggressive disease.	29
Walton et al. (2019)	Barriers to obtaining prostate multi-parametric magnetic resonance imaging in African American men on active surveillance for prostate cancer.	Retrospective. Single institution. (Academic)	Men with prostate mpMRI ordered from August 2015 to October 2017.	793	Access to mpMRI for AAs presents more barriers than white patients (accessibility, affordability, affordability, accommodation, acceptability).	14
Fam et al. (2019)	Increasing Utilization of Multi-parametric Magnetic Resonance Imaging in Prostate Cancer Active Surveillance.	Retrospective. Population-based analyses (*SEER)	Men diagnosed with localized prostate cancer diagnosed between 2008 and 2013 and managed with active surveillance	9467	Utilization of mpMRI increased over the study period. Greater odds of mpMRI utilization were for patients who were younger, white, had lower comorbidities, lived in the northeast and west, had higher income and lived in more urban areas. MpMRI utilization rate was not significantly associated with Gleason score nor education.	18

TABLE 1. (Continued*)*

Author (year)	Article Title	Design	Population and Time Frame	Sample Size	Key Findings	Reference #
Kim et al. (2019)	Contemporary Trends in Magnetic Resonance Imaging at the Time of Prostate Biopsy: Results from a Large Private Insurance Database	Retrospective, population based from a large private health insurance database in the USA—the OptumLabs Data Warehouse	Men 40 yr of age who underwent index prostate biopsies from 2010 through 2016	119 202	While the use of MRI-guided at the time of biopsy rose markedly, it was not associated with a higher detection rate of PCa. Black patients compared with whites had a lower likelihood of MRI-guided utilization. Privately insured patients had higher odds of MRI-guided utilization versus patient insured by Medicare Advantage.	15
Walton et al. (2019)	Effect of Lesion Location on Prostate Cancer Detection Rate with Magnetic Resonance Imaging Targeted Biopsy in African Americans.	Retrospective. Single institution. (Academic)	Men who underwent magnetic resonance imaging targeted biopsy (MRI-TB) from October 2015 to February 2018 with lesions on MRI greater than PI-RADS 2. Diverse population in a metropolitan area.	125	MRI-TB is equally effective in AAs and Caucasians. The rate of cancer upgrade was not significantly different between racial groups. Anterior lesions lead to higher cancer detection rate and cancer upgrade rate.	23
Leapman et al (2019)	Association Between Prostate Magnetic Resonance Imaging and Observation for Low-risk Prostate Cancer.	Retrospective. Population-based analyses (*SEER-Medicare)	Men diagnosed with low-risk PCa during 2010-2013	8144	Use increased by more than three times between 2010 and 2013. Lower MRI receipt was associated with nonwhite race, age older than 75 years, residence outside of the Northeast and higher urologist density. Higher receipt was associated with diagnosis in later years, highest zip code-level median household income, and clinical tumor stage T2.	17

TABLE 1. (Continued*)*

Author (year)	Article Title	Design	Population and Time Frame	Sample Size	Key Findings	Reference #
Rosenkrantz et al. (2018)	Evolving Use of Prebiopsy Prostate Magnetic Resonance Imaging in the Medicare Population	Retrospective, population based on national Medicare claims data	Fee-for-service male beneficiaries at least 65 years old who were located in the US. Then, all such men who underwent prostate biopsy from 2011 to 2015.	N/A	Dramatic increase in adoption of MRI-targeted biopsy. Utilization was greater among Caucasians compared to AAs as well as in the Northeast than in the Midwest.	16
Shin et al. (2017)	Detection of prostate cancer using magnetic resonance imaging/ultrasonography image-fusion targeted biopsy in African-American men.	Retrospective. Multi-institution analysis. (Academic)	Men diagnosed with prostate cancer who had mpMRI before biopsy and then underwent MRI/US image-fusion targeted biopsy between October 2012 and August 2015.	661	No racial differences in the detection rate of overall and clinically significant PCa for men who underwent mpMRI and then MRI/US image-fusion targeted biopsy between AAs and Caucasians.	21
Kongnyuy et al. (2017)	Multiparametric MRI/ultrasound fusion-guided biopsy decreases detection of indolent cancer in African American men.	Prospective single institution cohort study	Men suspected of PCa who underwent an mpMRI and FBx with concurrent SBx from 2007 to 2015	1262	AAs exhibited a benefit of mpMRI and FBx alone in detection of more clinically significant PCa compared to White/Other races. FBx when used in combination with SBx detected more clinically significant PCa while not significantly increasing the diagnosis clinically insignificant PCa.	26
Ajayi et al. (2016)	Disparities in staging prostate magnetic resonance imaging utilization for non-metastatic prostate cancer patients undergoing definitive radiation therapy.	Retrospective single academic institution	Non-metastatic patients with prostate cancer from 2005 to 2013	705	Demographic characteristics such as age, race, poverty, and insurance type were associated with mpMRI utilization, however most clinical parameters were not.	19
Kongnyuy et al. (2017)	The significance of anterior prostate lesions on multiparametric magnetic resonance imaging in African American men.	Retrospective. Single institution. (Academic)	All patients who received an mpMRI followed by fusion guided biopsy at NIH from 2007 to 2015	1267	AAs with prior negative standard transrectal ultrasound guided biopsy are twice as likely to harbor concerning anterior prostate lesions (APL). Comparable APLs rates on mpMRI were observed in AAs and White/other.	25

TABLE 2. Factors Correlated With Disparities in mpMRI Utilization

Disparity Factor	Effect on mpMRI Utilization	Number of Studies
Race	Lower utilization in AAs compared to other races	7
Time of PCa diagnosis	Higher utilization across time	4
Age	Higher utilization in younger age	3
Income/Poverty	Higher utilization with higher income/lower poverty	3
Region	Higher utilization for those residing in the Northeast and in more urban communities	3
Private insurance status	Higher utilization in privately insured individuals	2

TABLE 3. Factors Correlated With Disparities in mpMRI Performance

Presence of Disparity in mpMRI Performance	Designated Disparity in mpMRI Performance	Number of Studies
No	No difference in performance indicators between AAs and non-AAs	4
Yes	Better performance indicators in AAs	4
	Worse performance indicators in AAs	1
	Worse performance indicators in Asian Americans	1

population based entailing large sample sizes derived from datasets such as SEER, national claims data and insurance databases.

The most common predictor for mpMRI utilization was race. In fact, all analyses agreed that AAs were less likely to undergo mpMRI versus non-AAs (14-20). For example, a SEER-Medicare analysis of men suffering from PCa found that between 2010−2013, non-whites were less likely than whites to undergo mpMRI with an OR of 0.64 (95% CI 1.17−1.53) ($n = 8144$) (15). Similarly, in a single institutional study conducted by Ayaji et al. of 705 men, Black men with PCa were less likely to undergo baseline diagnostic mpMRI than White men (19). Also, upon examination of Electronic Medical Records, this group was found to have more cancelled appointments, which further hindered their mpMRI receipt (29% vs 10% in white men, $p= 0.0015$) (14).

Another prominent finding is the increased mpMRI utilization across time, indicating a rise in adoption of this novel technique throughout the past decade (15-18). Interestingly, patients undergoing mpMRI were more likely to be younger, have better income, reside in the Northeast and live in urban communities (16-18). Insurance status affected mpMRI utilization (15,19) as nonprivately insured individuals had lower chances to undertake this procedure versus individuals who had private insurance (OR:0.57, $p< 0.05$). Furthermore, level of education (18) did not significantly impact mpMRI utilization, while areas with higher urologist density (17) and areas closer to the facility (less than 45 miles) administering the technique were negative predictors (OR: 0.56, $p = 0.017$) (18). However, these associations were each only derived from a single study.

In contrast to demographic factors, clinical factors did not result in mpMRI disparities as Gleason score, Prostate Specific Antigen level in blood and International Prostate Symptom Score were not found associated with mpMRI utilization discrepancies (15,16). However, a positive association between stage T2 PCa (vs stage T1 PCa) and MRI-guided biopsy was captured in a single study (17).

Disparities in mpMRI Performance

Performance was mainly compared between AAs and Caucasians and/or Whites, with only one study examining Asian Americans as the race of interest and no studies examining ethnicities (i.e.: Hispanics vs Non-Hispanics) in relation with mp-MRI disparities Table 3. Majority of studies examining mpMRI performance used institutional data, entailing smaller sample sizes as compared to studies examining demographic factors. Sensitivity and specificity, Negative Predictive Value and Positive Predictive value as well as accuracy and detection rates were all found as collective indicators of mpMRI performance throughout the resulting studies.

Evidence demonstrated either no differences in the performance of mpMRI between AA men and white men (21-24), or superior performance in AAs (25-28). In fact, Shin et al (2017) studied men diagnosed with PCa who had mpMRI before biopsy and found no racial differences in detection rate of PCa between AAs and Caucasians (21). Similar conclusions were reached two years later in two studies conducted by Walton et al (2019) and Henning et al (2019) (22,23). More importantly, mpMRI technique had similar specificity (89.2% vs 79.2%), sensitivity (22.22% vs 27.84%), negative predictive value (89.2% vs 83.4), and positive predictive value (89.2% vs 83.4%) across AA men and white men (24). More recently, accuracy of mpMRI procedure was assessed by Falagario et al (2020) where similar pathological outcomes were observed across both races post radical prostatectomy (24).

Interestingly, superior mpMRI performance in AA groups was noted (25-28). For instance, AAs were twice as likely to harbor concerning anterior prostate lesions (APL) than white and/or other men using mpMRI after having received a negative standard transrectal ultrasound biopsy (OR 1.81; $p = 0.04$) (25). In addition, mpMRI fusion biopsy combined with systemic biopsy provided a higher detection rate of clinically significant PCa in AA men versus white and/or other men while not increasing significantly the detection rate of clinically indolent PCa (26). More so, a higher number of regions of interest was detected on mpMRI for AA versus their Caucasian counterparts in matched cohorts (2 or more ROIs in 24% of AA men vs 12% in Caucasians, $p = 0.035$) (27). Finally, AA men were twice as likely to have upgraded tumors using the mpMRI fusion biopsy technique as compared to non-AA men in a retrospective cohort from the National Cancer Institute (28)

Despite all evidence pointing at either equal or better mpMRI performance in AAs versus others, only one study found worse mpMRI outcomes, as the negative predictive value of mpMRI among AA turned out to be lower than Caucasians. This finding was only detected in less aggressive disease (Grade I and Grade II) in a single institutional study with a significantly higher number of Caucasians compared to AAs (29).

As for other races, only a single study examined Asian American as the race of interest for mpMRI performance. Asian American men were found to be less likely to get diagnosed with clinically significant PCa (37% of Asian American vs 48% of other races; $p < 0.001$) suggesting additional disparities that might arise in Prostate Imaging Reporting and Data System (PI-RADS) performance across different populations (30).

DISCUSSION

In our systematic review of health disparities and inequities in mpMRI for PCa we found this technique was increasingly being adopted throughout the last decade, with two main disparities: 1) utilization and 2) performance.

Social determinants of health were implicated as common factors exacerbating underlying differences in mpMRI utilization. Race was the most common disparity factor highlighted overall. AAs specifically had lower rates of mpMRI utilization versus Whites and/or Caucasians. Nevertheless, younger patients were found to have higher utilization rates of mpMRI. This can be attributed to the less aggressive nature of the disease in older men as well as their preference to avoid expensive and complex diagnostic techniques. Collectively, having lower income, residing outside the Northeast of the US and in rural areas illustrated how poorer socioeconomic status affected mpMRI utilization negatively. This is no different than existing data relating lower socioeconomic status to decreased imaging utilization in PCa (8,9). Future research should address physician interaction and evaluate whether all imaging options are discussed.

Ideally, both the referring physician and the radiologist should share the task to completely inform their patients about imaging options in a way that is unbiased by patient's age, socioeconomic status and procedure cost. Therefore, emphasizing health disparities education for physicians is an important step in reducing unfair distribution of care. Generally, the Accreditation Council for Graduate Medical Education (ACGME) requires all physician trainees and teaching faculty to undergo training in health care disparities (31). A primer for such education tailored specifically for radiologists was published in 2018 and could lead the way towards more homogenous diagnostic imaging utilization and ultimately close the disparities gaps (32).

Commonly, in health services research, the concepts attached to disparities and inequities are used interchangeably. However, we purposely stress the subtle difference between both terms and the interaction between them. In the specific example of mpMRI imaging in PCa, disparity represents a difference in distribution, illustrating variations in mpMRI utilization rates across different patient populations. In contrast, the term inequity refers to unnecessary and avoidable differences in care. Additionally, when health needs of individuals are significantly different from one another, treatment distribution should be tailored accordingly. As such, providing equal treatment distribution in this case can even become inequitable (13). Indeed, AA men are 76% more likely to be diagnosed with PCa and more than twice as likely to die from PCa as compared with non-AA men (4). On the other hand, mpMRI has been proven to be effective and promising in PCa diagnosis with added performance benefits in AAs (1, 25-28). Hence, despite higher need for effective diagnostic techniques for PCa in AA, published data demonstrates lower mpMRI utilization rates in AAs. As such, based on the gap between disparities in mpMRI utilization and differences in PCa burden, our review potentially detects a health disparity that has become an inequity in PCa diagnostic imaging.

Additionally, since mpMRI was found to have beneficial effects in AA by detecting anterior lesions (25), which are more prevalent in this population group (33) and by upgrading low risk disease (28), one could argue this technique presents clear benefits for a group naturally suffering from lower utilization of this test. On the other hand, key evidence was brought to light upon examining the detection abilities of the standard 12-core biopsy technique without mpMRI guidance. Findings suggest the negative predictive value of 12-core biopsy is lower in AA versus Caucasian men partly due to higher occurrence of anterior lesions in AA (34). Indirectly, this valuable information stresses on the added value of mpMRI utilization among AA since it is better at detecting anterior lesions and would thus result in higher performance in the AA group. This highlights the need for raising awareness to the benefits of increasing mpMRI, utilization in underserved groups. This would help in minimizing racial disparities in the Quality of Care received (QOC), as it has been shown that AA subgroups suffer more from lower QOC versus non-AAs. Stressing on the importance of discussing all

available treatment options for PCa, including mpMRI, is associated with less patient regret after treatment decisions and can lead to an enhanced QOC for PCa disease (35).

Since recommendations endorsing mpMRI in PCa diagnosis have only been published recently by the American Urological Associations in October 2019 (1), we would expect an even higher utilization rate in the future. As such, additional areas contributing to disparities in mpMRI utilization need to be studied as well. There is a need to evaluate mpMRI utilization across factors not yet studied, such as: health literacy, immigrant populations and English language proficiency, particularly since mpMRI is a revolutionary technique that requires an advanced level of medical understanding. Furthermore, only one single study addressed variations in mpMRI outcomes in Asian Americans, hence, we would encourage future research to include a wider range of races and/or ethnicities to better detect differences in mpMRI access and performance across a larger variety of patient populations and demographics. This is certainly valuable since it affects a malignancy where immigration trends to Western countries are increasing with known differences in PCa epidemiology. We like to stress the need for prospective trials examining performance disparities in minority groups in an attempt to refine the treatment choice selection.

Limitations of our analysis include mainly the search terms used to select our articles. We have used terms that might be new to the literature, and thus we might have missed historical articles describing the same initiative but using obsolete terminology. Also, we have restricted our selections to published articles only. By doing so, we might have missed valuable unpublished findings, especially since this area of research is evolving rapidly nowadays. Furthermore, access to the technology was not uniform for different population groups studies, however, geographical location as a variable was found to be an important determinant for disparities. Lastly, absence of mpMRI field strength and technique from our analysis could have resulted in potential confounders, however this review mainly focused on health disparities regardless of the imaging protocol used. Albeit all the studies examined followed routine clinical mpMRI protocol and no study involved any research protocol.

CONCLUSION

This is the first systematic review and summary on health disparities related to mpMRI in the diagnosis of PCa. Our review pioneers the distinction between disparities in utilization and performance of a diagnostic test. By highlighting the benefits of mpMRI in a disadvantaged subgroup, we were able to explore a new way to address socioeconomic disparities in access to expensive medical imaging tests. More importantly, having evidence that this revolutionary technique may particularly be more beneficial for a minority group already at a disadvantage in disease burden, constitutes a solid example of how disparities of mpMRI can lead to unfair treatment and thus health inequities. Future clinical

guidelines should be more inclusive and incorporate representative samples of different patient populations and socioeconomic backgrounds to better recommend the use of new and expensive diagnostic tests.

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