JACC: CARDIOVASCULAR IMAGING
VOL. 9, NO. 4, 2016

ISSN 1936-878X/$36.00
PUBLISHED BY ELSEVIER
http://dx.doi.org/10.1016/j.jcmg.2016.01.001

Gender Differences in Radiation Dose From Nuclear Cardiology Studies Across the World

Findings From the INCAPS Registry

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ABSTRACT

OBJECTIVES The aim of this study was to investigate gender-based differences in nuclear cardiology practice globally, with a particular focus on laboratory volume, radiation dose, protocols, and best practices.

BACKGROUND It is unclear whether gender-based differences exist in radiation exposure for nuclear cardiology procedures.

METHODS In a large, multicenter, observational, cross-sectional study encompassing 7,911 patients in 65 countries, radiation effective dose was estimated for each examination. Patient-level best practices relating to radiation exposure were compared between genders. Analysis of covariance was used to determine any difference in radiation exposure according to gender, region, and the interaction between gender and region. Linear, logistic, and hierarchical regression models were developed to evaluate gender-based differences in radiation exposure and laboratory adherence to best practices. The study also included the United Nations Gender Inequality Index and Human Development Index as covariates in multivariable models.

RESULTS The proportion of myocardial perfusion imaging studies performed in women varied among countries; however, there was no significant correlation with the Gender Inequality Index. Globally, mean effective dose for nuclear cardiology procedures was only slightly lower in women (9.6 ± 4.5 mSv) than in men (10.3 ± 4.5 mSv; $p < 0.001$), with a difference of only 0.3 mSv in a multivariable model adjusting for patients' age and weight. Stress-only imaging was performed more frequently in women (12.5% vs. 8.4%; $p < 0.001$); however, camera-based dose reduction strategies were used less frequently in women (58.6% vs. 65.5%; $p < 0.001$).

CONCLUSIONS Despite significant worldwide variation in best practice use and radiation doses from nuclear cardiology procedures, only small differences were observed between genders worldwide. Regional variations noted in myocardial perfusion imaging use and radiation dose offer potential opportunities to address gender-related differences in delivery of nuclear cardiology care. (J Am Coll Cardiol Img 2016;9:376–84) © 2016 by the American College of Cardiology Foundation.

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There are fundamental differences in the pathophysiology, risk factors, and clinical presentation of coronary artery disease (CAD) in women compared with men (1). Indeed, women are more likely to have angina from coronary microvascular dysfunction, whereas men are more likely to have angina from epicardial CAD (2). Women are more likely to be susceptible to psychosocial risk factors than men (3). Further, medical tests used to detect CAD may have limitations associated with sex. For example, the sensitivity and specificity of an exercise test are lower in women than in men (4–6), although the addition of myocardial perfusion imaging (MPI) with single-photon emission computed tomography (SPECT) can improve the diagnostic performance of exercise testing regardless of a patient's sex (4–6). With SPECT MPI, breast attenuation artifact is often increased in women compared with men, whereas spatial resolution is decreased (7). Because positron emission tomography (PET) uses attenuation correction routinely and provides higher spatial resolution and lower radiation dose compared with SPECT, it may be preferable to use PET in women who need MPI (8). PET MPI, however, is more expensive and much less available compared with SPECT. Regardless of whether SPECT or PET is used, the benefits of MPI in the diagnosis and risk assessment (9) of CAD are unequivocal in both women and men (7,10–12).

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Controversy exists, however, regarding the long-term health consequences after exposure to ionizing radiation for MPI and medical imaging (13), particularly in women (14,15). An Institute of Medicine report identified ionizing radiation from computed tomography (CT) as a contributing factor for breast cancer in women (15). Similarly, a higher hazard of radiation-related solid cancer has been estimated in women compared with men (16). Such concerns of greater radiosensitivity in women have the potential to affect patterns of use differentially, in particular radiation dose reduction protocols for diagnostic testing, in women compared with men (17).

Given the impact of biological factors, as well as gender differences between women and men that may affect MPI, several questions arise: What is the current proportion of women compared with men undergoing MPI? Are there differences in the way these studies are performed from a global perspective? Does the broader context of social, environmental, and community factors play a role in best practices? Are women more likely to have PET rather than SPECT? To date, gender-based patterns of radiation exposure across nuclear cardiology laboratories have been unknown. Accordingly, in this report, we compared the rates of radiation exposure in women to men through a multinational observational cross-sectional study, INCAPS (International Atomic Energy Agency Nuclear Cardiology Protocols Study), which examined worldwide nuclear cardiology practices (17). The purpose of this report is to determine whether differences in radiation dose from MPI exist between women and men and to examine the use of radiation dose reduction practices in women compared with men in diverse societies across the spectrum of gender equality and human development status.

ABBREVIATIONS AND ACRONYMS

CAD = coronary artery disease

GII = Gender Inequality Index

HDI = Human Development Index

MPI = myocardial perfusion imaging

PET = positron emission tomography

SPECT = single-photon emission computed tomography

^{99m}Tc = technetium-99m

^{201}Tl = thallium-201

METHODS

Details of INCAPS have been previously reported (17). In brief, INCAPS was an observational cross-sectional study of protocols used for each of the 7,911 MPI studies performed in 308 participating laboratories in 65 countries (**Figure 1**) during a single week in March or April 2013. A waiver for Institutional Review Board approval was provided by the Institutional Review Board at Columbia University Medical Center (New York, New York), where all data analysis was conducted.

DATA COLLECTED. Anonymized patient-specific data including gender, age, body weight, scanner, and MPI protocol used were collected from diverse regions of the world including Africa (n = 348), Asia (n = 1,469), Europe (n = 2,381), Latin America (n = 1,139), North America (n = 2,135), and Oceania (n = 439). Protocol

Hospital, New York, New York; and the [m]Department of Radiology, Columbia University Medical Center and New York-Presbyterian Hospital, New York, New York. Funding was provided by the National Institutes of Health-National Heart, Lung, and Blood Institute Summer Research Program at Columbia University (5T35HL007616-34); the International Atomic Energy Agency; and the Margaret Q. Landenberger Research Foundation in memory of Professor A. Donny Strosberg; and the Irving Scholars Program. Dr. Dorbala has received an institutional research grant from Astellas; and owns stock in GE. Dr. Einstein has received institutional research grants for other research from GE Healthcare, Philips Healthcare, Spectrum Dynamics, and Toshiba America Medical Systems. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose. Heinrich Schelbert, MD, served as the Guest Editor for this article.

Manuscript received December 30, 2015; revised manuscript received January 6, 2016, accepted January 7, 2016.