

Challenges of Fracture Risk Assessment in Asian and Black Women

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Osteoporosis screening by bone mineral density (BMD) testing is a quality metric for older women.¹ The BMD T-score compares a woman's BMD with peak BMD in a reference population, with guidelines recommending the young adult non-Hispanic White (NHW) female reference for all women.² The BMD report can include findings from the Fracture Risk Assessment Tool (FRAX) calculator that incorporates age, race and ethnicity, clinical risk factors, and BMD to estimate 10-year probabilities of hip and major osteoporotic fracture. Primary prevention guidelines recommend pharmacologic therapy for postmenopausal women with BMD-defined osteoporosis and those with low bone mass and a high FRAX score.³ To account for known racial and ethnic variation in fracture risk,^{4,5} the US FRAX includes calibration factors for Black, Asian, and Hispanic race and ethnicity (0.43-0.53) based on epidemiologic studies demonstrating their much lower incidence of hip fracture compared with NHW women.⁶ This approach reduces potential overestimation of fracture risk,^{4,5} especially relevant for populations with lower BMD but lower fracture risk.⁷

To date, our understanding of skeletal health and fracture risk in US racial minority populations remains limited.⁸ Few studies have examined clinical BMD and FRAX results that inform care for those with lower (Asian women) or higher (Black women) BMD than NHW women. As the fastest-growing US racial group,⁹ Asian women represent an increasing subset undergoing BMD assessment. Their lower (areal) BMD^{10,11} is attributable partly to smaller bone size, and studies consistently demonstrate lower hip fracture incidence among US Asian women compared with NHW women.^{12,13} Black women represent another understudied population, with higher BMD^{14,15} and lower hip fracture incidence^{12,13,16} than NHW women. Optimizing fracture prevention in non-White populations is essential for personalizing effective intervention strategies.

As the US population becomes increasingly diverse,⁹ identifying knowledge gaps in fracture prevention care relevant to real-world populations is paramount. Using contemporary data from a western US population of women undergoing routine osteoporosis screening at the age target of 65 to 75 years,¹ we examined femoral neck BMD

ABSTRACT

OBJECTIVES: Bone mineral density (BMD) and fracture risk calculators (eg, the Fracture Risk Assessment Tool [FRAX]) guide primary prevention care in postmenopausal women. BMD scores use non-Hispanic White (NHW) reference data for T-score classification, whereas FRAX incorporates BMD, clinical risk factors, and population differences when calculating risk. This study compares findings among Asian, Black, and NHW women who underwent osteoporosis screening in a US health care system.

STUDY DESIGN: Retrospective cross-sectional study.

METHODS: Asian, Black, and NHW women aged 65 to 75 years who underwent BMD testing (with no recent fracture, osteoporosis therapy, metastatic cancer, multiple myeloma, metabolic bone disorders, or kidney replacement therapy) were compared across the following measures: femoral neck BMD (FN-BMD) T-score [normal ≥ -1 , osteoporosis ≤ -2.5], high FRAX 10-year hip fracture risk (FRAX-Hip $\geq 3\%$), FRAX risk factors, and diabetes status.

RESULTS: Among 3640 Asian women, 23.8% had osteoporosis and 8.7% had FRAX-Hip scores of at least 3% (34.5% among those with osteoporosis). Among 11,711 NHW women, 12.3% had osteoporosis and 17.2% had FRAX-Hip scores of at least 3% (84.8% among those with osteoporosis). Among 1711 Black women, 68.1% had normal FN-BMD, 4.1% had BMD-defined osteoporosis, and 1.8% had FRAX-Hip scores of at least 3% (32.4% among those with osteoporosis). Fracture risk factors differed by group. Diabetes was 2-fold more prevalent in Black and Asian (35% and 36%, respectively) vs NHW (16%) women.

CONCLUSIONS: A large subset of Asian women have discordant BMD and FRAX scores, presenting challenges in osteoporosis management. Furthermore, FN-BMD and especially FRAX scores identified few Black women at high fracture risk warranting treatment. Studies should examine whether fracture risk assessment can be optimized in understudied racial minority populations, particularly when findings are discordant.

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(FN-BMD) and FRAX scores to characterize the discordance in fracture risk–based scores among Asian, Black, and NHW women.

METHODS

Kaiser Permanente Northern California (KPNC) is a large integrated health care delivery system that has championed osteoporosis screening among older women for more than 20 years. This report examines Asian, Black, and NHW women aged 65 to 75 years with at least 2 years of KPNC membership and initial BMD testing (2016-2017) on a Hologic densitometer who did not have recent fracture, osteoporosis therapy, metastatic cancer, multiple myeloma, metabolic bone disorders, or kidney replacement therapy, as previously described.¹⁰ BMDs for Asian and NHW women were reported in a larger study.¹⁰ This study was approved by the KPNC Institutional Review Board, with a waiver of informed consent.

Self-reported race and ethnicity were determined from health record/administrative databases, concordant with race and ethnicity in BMD records. Height, weight, body mass index (BMI), FN-BMD, FRAX 10-year probability of hip fracture (FRAX-Hip), and FRAX risk factors (prior fracture, parental hip fracture history, smoking, alcohol ≥ 3 units/day, rheumatoid arthritis, glucocorticoid therapy, and secondary osteoporosis conditions) were obtained from BMD data. Diabetes was defined by at least 2 outpatient or problem-list diagnoses or at least 1 diagnosis with diabetes pharmacotherapy within 2 years prior to BMD testing.

FN-BMD T-score using the Third National Health and Nutrition Examination Survey (1988-1994) young adult NHW female BMD reference (mean [SD], 0.849 [0.111] g/cm²) for Hologic densitometers¹⁷ was classified as normal (≥ -1.0), low bone mass or osteopenia (< -1 to > -2.5), or osteoporosis (≤ -2.5).^{2,17} For Black women, non-Hispanic Black female reference (mean [SD], 0.951 [0.142] g/cm²)¹⁷ T-scores were also calculated, consistent with an earlier era.¹⁸

Groups were compared using Student *t* test or Wilcoxon rank sum test and χ^2 or Fisher exact tests. Analyses were performed using SAS 9.4 (SAS Institute Inc).

RESULTS

The cohort comprised 3640 Asian women, 1711 Black women, and 11,711 NHW women aged 65 to 75 years. Compared with NHW women, Black women were slightly older and more likely to have higher body weight (mean +7 kg), obesity, and rheumatoid arthritis, and to currently smoke but less likely to have prior fracture or parental hip fracture history (Table). Asian women had lower height (mean -7 cm)¹⁰ and body weight (mean -16 kg) and were less likely to smoke and have obesity, prior fracture, or parental hip fracture history compared with NHW women. Diabetes prevalence was

TAKEAWAY POINTS

Bone density, Fracture Risk Assessment Tool (FRAX)-defined hip fracture risk, and their relationship differ by race among US women aged 65 to 75 years screened for osteoporosis.

- ▶ Twenty-four percent of Asian women screened met osteoporosis criteria, but only 9% had high FRAX-defined hip fracture risk. FRAX accounts for lower hip fracture risk despite lower bone mineral density.
- ▶ Twelve percent of non-Hispanic White women screened met osteoporosis criteria, and 17% had high FRAX-defined hip fracture risk.
- ▶ Few Black women had osteoporosis (4%), and fewer still (2%) had high FRAX-defined hip fracture risk.
- ▶ Eighty-five percent of non-Hispanic White women with osteoporosis had high FRAX-defined hip fracture risk compared with 34% of Asian and 32% of Black women.

more than 2-fold higher among Black (34.7%) and Asian (36.3%) women compared with NHW women (16.0%).

FN-BMD T-scores were higher for Black women but lower for Asian vs NHW women (Table). T-score differences (median 0.4 units lower) for Asian women yielded a 2-fold higher prevalence of FN osteoporosis compared with NHW women (23.8% vs 12.3%), whereas T-score differences (median 0.8 units higher) for Black women yielded a 3-fold lower prevalence of FN osteoporosis (4.1% vs 12.3%). Differences between Black and NHW women were partly attenuated with the young adult Black female reference for FN-BMD T-score in Black women (6.8% vs 12.3%). Only 1.8% of Black women had FRAX-Hip scores of at least 3% (treatment threshold),³ whereas the proportion of Asian women with FRAX-Hip scores of at least 3% (8.7%) was half that of NHW women (17.2%). Most Black women (89.3%) had FRAX-Hip scores below 1% compared with 43.8% of NHW women, pointing to large differences in risk assignment by BMD and especially FRAX compared with NHW women.

Because higher BMI is associated with higher BMD and because BMI differs by race, we compared findings by obesity status (BMI ≥ 30 kg/m²). In each racial group, proportions with BMD-osteoporosis and high FRAX-Hip scores ($\geq 3\%$) were lower for those with vs without obesity ($P < .01$), and racial differences persisted regardless of weight status (Table). Women with diabetes were more likely to have obesity, higher BMD, and lower FRAX scores than women without diabetes ($P < .01$).

The Figure compares FRAX-Hip score by FN-BMD T-score categories. Both Asian and Black women with T-scores of -2.0 to -2.4 had very low proportions with FRAX-Hip scores of 3% or higher (2.2% and 4.3%, respectively) compared with NHW women (29.7%). For T-scores of -2.5 to -3.0 (17.1% of Asian women, 9.4% of NHW women, and 3.4% of Black women), the proportion with FRAX-Hip scores of 3% or higher remained much lower for Asian (14.6%) and Black (25.9%) vs NHW (80.2%) women. These findings reflect lower (calibrated) FRAX scores for Asian and Black women at every BMD level, yielding differences in BMD-osteoporosis and FRAX risk assignment by race. Among all women with FN-BMD osteoporosis (T-score ≤ -2.5), 34.5%, 32.4%, and 84.8% of Asian, Black, and NHW women, respectively, had FRAX-Hip scores of 3% or higher.

TRENDS FROM THE FIELD

TABLE. Characteristics of US Asian and Black Women Compared With NHW Women Aged 65 to 75 Years Undergoing Osteoporosis Screening by BMD Testing

	Asian women (n=3640)	NHW women (n=11,711)	Black women (n=1711)	
Age (years), mean (SD)	67.1 (2.7) ^a	67.1 (2.7)	67.4 (2.9) ^a	
Height (cm), mean (SD)	155.5 (5.7) ^a	162.8 (6.6)	163.1 (6.6)	
Weight (kg), mean (SD)	61.7 (11.3) ^a	77.6 (18.2)	84.7 (19.1) ^a	
BMI (kg/m ²), mean (SD)	25.5 (4.4) ^a	29.3 (6.7)	31.8 (6.7) ^a	
Obesity (BMI ≥ 30.0 kg/m ²)	528 (14.5%) ^a	4641 (39.6%)	961 (56.2%) ^a	
Diabetes	1320 (36.3%) ^a	1879 (16.0%)	593 (34.7%) ^a	
Current smoker	62 (1.7%) ^a	683 (5.8%)	170 (9.9%) ^a	
Alcohol intake ≥ 3 units/day	7 (0.2%) ^a	175 (1.5%)	22 (1.3%)	
Previous fracture	198 (5.4%) ^a	1487 (12.7%)	134 (7.8%) ^a	
Parental history of hip fracture	230 (6.3%) ^a	1538 (13.1%)	90 (5.3%) ^a	
Rheumatoid arthritis	64 (1.8%) ^a	156 (1.3%)	63 (3.7%) ^a	
Glucocorticoid therapy	35 (1.0%) ^a	388 (3.3%)	63 (3.7%)	
Secondary osteoporosis	191 (5.2%) ^a	743 (6.3%)	148 (8.6%) ^a	
FN-BMD (g/cm ²), mean (SD)	0.656 (0.109) ^a	0.705 (0.119)	0.800 (0.141) ^a	
FN-BMD T-score (standard NHW reference)	^a		^a	
Normal (T-score ≥ -1.0)	792 (21.8%)	4322 (36.9%)	1165 (68.1%)	
Low bone mass or osteopenia (-2.5 < T-score < -1.0)	1981 (54.4%)	5951 (50.8%)	475 (27.8%)	
Osteoporosis (T-score ≤ -2.5)	867 (23.8%) ^a	1438 (12.3%)	71 (4.1%) ^a	
FN-BMD T-score, median (IQR)	-1.8 (-2.4 to -1.1) ^a	-1.4 (-2.0 to -0.7)	-0.6 (-1.3 to 0.3) ^a	
FRAX-Hip score	^a		^a	
< 1%	1962 (53.9%)	5132 (43.8%)	1528 (89.3%)	
1% to < 2%	997 (27.4%)	3047 (26.0%)	119 (7.0%)	
2% to < 3%	363 (10.0%)	1518 (13.0%)	34 (2.0%)	
≥ 3%	318 (8.7%) ^a	2014 (17.2%)	30 (1.8%) ^a	
FRAX-Hip score, median (IQR)	0.9% (0.4%-1.6%) ^a	1.1% (0.5%-2.3%)	0.2% (0.1%-0.5%) ^a	
FN-BMD T-score and FRAX-Hip score by obesity status (BMI ≥ 30 kg/m²)				
No obesity	FN osteoporosis (T-score ≤ -2.5)	815 (26.2%) ^a	1231 (17.4%)	63 (8.4%) ^a
Obesity	FN osteoporosis (T-score ≤ -2.5)	52 (9.8%) ^a	207 (4.5%)	8 (0.8%) ^a
No obesity	FRAX-Hip score ≥ 3%	302 (9.7%) ^a	1644 (23.3%)	22 (2.9%) ^a
Obesity	FRAX-Hip score ≥ 3%	16 (3.0%) ^a	370 (8.0%)	8 (0.8%) ^a
No obesity	Diabetes	1023 (32.9%) ^a	600 (8.5%)	198 (26.4%) ^a
Obesity	Diabetes	297 (56.3%) ^a	1279 (27.6%)	395 (41.1%) ^a
FN-BMD T-score and FRAX-Hip score by diabetes status				
No diabetes	FN osteoporosis (T-score ≤ -2.5)	624 (26.9%) ^a	1304 (13.3%)	56 (5.0%) ^a
Diabetes	FN osteoporosis (T-score ≤ -2.5)	243 (18.4%) ^a	134 (7.1%)	15 (2.5%) ^a
No diabetes	FRAX-Hip score ≥ 3%	227 (9.8%) ^a	1797 (18.3%)	25 (2.2%) ^a
Diabetes	FRAX-Hip score ≥ 3%	91 (6.9%) ^a	217 (11.5%)	5 (0.8%) ^a
No diabetes	Obesity (BMI ≥ 30.0 kg/m ²)	231 (10.0%) ^a	3362 (34.2%)	566 (50.6%) ^a
Diabetes	Obesity (BMI ≥ 30.0 kg/m ²)	297 (22.5%) ^a	1279 (68.1%)	395 (66.6%)

BMD, bone mineral density; BMI, body mass index; FN, femoral neck; FRAX-Hip, Fracture Risk Assessment Tool 10-year probability of hip fracture; NHW, non-Hispanic White.

^aP < .05 compared with NHW women.

DISCUSSION

Among Asian and Black women aged 65 to 75 years, there were large differences in BMD and FRAX compared with NHW women and expected within-group discordance. Although lower BMD in Asian women and higher BMD in Black women are well established in epidemiologic studies^{7,10,11,14,16} and greater BMD-FRAX differences result from US FRAX calibration for these groups,^{5,6} our findings point to challenges in caring for diverse populations and the potential limitations of FRAX with respect to race. Two-thirds of Black women had normal FN BMD, only 4.1% had FN osteoporosis, and even fewer (1.8%) had FRAX-Hip scores of 3% or higher. Hence, few Black women were identified with high fracture risk warranting treatment, even among those with relatively low BMD for this population. Although low FRAX scores reflected higher BMD, higher BMI, FRAX risk factors, and FRAX calibration, the accuracy of FRAX in identifying Black women at high fracture risk remains understudied. In contrast, 12.3% of NHW women had BMD-osteoporosis, and 17.2% had FRAX-Hip scores of at least 3%, whereas most (85%) with BMD-osteoporosis had FRAX-Hip scores of at least 3%. Finally, Asian women had a 2-fold greater prevalence of FN osteoporosis (23.8%), but only 8.7% had FRAX-Hip scores of at least 3%, including approximately one-third (34%) among those with BMD-osteoporosis. For Asian women, FRAX calibration helps account for lower hip fracture risk despite lower BMD (expected discordance), but guidelines recommend treatment of BMD-osteoporosis in Asian women and do not address their smaller bone size, which contributes to lower areal BMD and overestimation of osteoporosis.^{7,10,11}

Evidence-based guidance is necessary when counseling Asian women with BMD-osteoporosis. Their lower areal BMD is balanced by lower (calibrated) FRAX scores that reduce fracture risk overestimation. Hence, among Asian women aged 65 to 75 years with T-scores of -2.5 to -3.0, only 1 in 7 had FRAX-Hip scores of at least 3% compared with 4 in 5 NHW women. Ethnic T-scores,³ although contrary to guideline recommendations,² may reduce overestimation of osteoporosis among Chinese women in the US^{7,11} and increase osteoporosis prevalence among Black women. However,

the US Asian population is heterogeneous, and generational differences exist. In an earlier era, ethnic T-scores identified Black women in the US with relatively low BMD using a young adult US Black reference population.¹⁸

Use of race- and ethnicity-based calibration factors is debated,^{4,5,19,20} especially for Black women who have higher BMD than NHW women^{14,15} and lower hip fracture incidence.^{12,13} Avoiding risk overestimation in populations with lower fracture incidence is necessary, but underestimation is a concern if higher BMD and other risk factors contribute to the lower observed fracture incidence used to derive calibration factors.

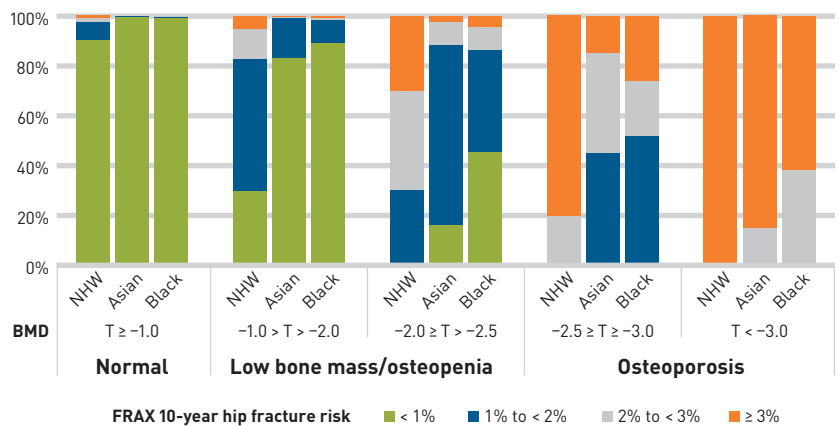
A 2008 survey in the southern US found that only 7% of Black women (vs 56% of White women) aged 65 to 74 years had FRAX-Hip scores of at least 3% using FRAX with BMI (no BMD).²¹ FRAX classified most Black women below the 3% treatment threshold until age 75 years, suggesting its low utility for identifying Black women younger than 75 years at high fracture risk.²¹ Among 3484 White and 1041 Black women in Alabama, Georgia, and Iowa with BMD testing, Black women were more likely to have normal BMD than White women (44.7% vs 20.9%, respectively) and less likely to have BMD-osteoporosis (11.6% vs 21.7%), and similar to our study, only 0.3% of Black women had high calculated fracture risk vs 23.7% of White women.²² Black women were also less likely to be on guideline-concordant therapy.²² Among Black adults with rheumatoid arthritis, FRAX risk stratified those 70 years and older regardless of weight status but not younger adults with obesity.²³ In our study, only 1% of Black women aged 65 to 75 years with obesity had high FRAX scores (or BMD-osteoporosis), indicating potential challenges in fracture risk assessment for this subset. Overall, two-thirds of Black women had normal FN BMD, so follow-up testing might not be indicated for another 10 years. Furthermore, a majority among the

4.1% of Black women with BMD-osteoporosis had FRAX-Hip scores below the treatment threshold; this larger discordance could potentially contribute to undertreatment despite low BMD. These findings are important to consider because despite higher BMD and lower fracture risk, Black women experience higher morbidity and mortality after major osteoporotic fracture.^{24,25}

FRAX performance is also limited in populations with diabetes,²⁶ which affected approximately one-third of Asian and Black women

in our study. Findings from a study conducted in Manitoba, Canada, demonstrate improved fracture risk prediction when diabetes is included as a rheumatoid arthritis risk equivalent in FRAX prediction,²⁶ supporting the need for similar studies in non-White populations.^{5,26,27} Women with diabetes have higher BMI (contributing to both higher BMD and lower FRAX scores), but high BMI can paradoxically contribute to limb fracture risk,^{13,28,29} highlighting the complexity of fracture risk estimation in adults with diabetes

FIGURE. FN BMD T-Score and FRAX-Hip Score by Race Among US NHW, Asian, and Black Women Aged 65 to 75 Years



NHW women aged 65-75 years (n = 11,711)					
FRAX-Hip score	FN-BMD T-score category				
	≥ -1.0 (n = 4322)	-1.0 > T > -2.0 (n = 4080)	-2.0 ≥ T > -2.5 (n = 1871)	-2.5 ≥ T ≥ -3.0 (n = 1102)	< -3.0 (n = 336)
< 1%	90.5%	29.9%	<0.1%	0	0
1% to < 2%	7.4%	52.9%	30.4%	0	0
2% to < 3%	1.3%	12.2%	39.9%	19.8%	0.3%
≥ 3%	0.8%	5.0%	29.7%	80.2%	99.7%

Asian women aged 65-75 years (n = 3640)					
FRAX-Hip score	FN-BMD T-score category				
	≥ -1.0 (n = 792)	-1.0 > T > -2.0 (n = 1262)	-2.0 ≥ T > -2.5 (n = 719)	-2.5 ≥ T ≥ -3.0 (n = 622)	< -3.0 (n = 245)
< 1%	99.6%	83.5%	16.6%	0	0
1% to < 2%	0.3%	15.7%	71.8%	45.2%	0
2% to < 3%	0.1%	0.6%	9.5%	40.2%	15.1%
≥ 3%	0	0.2%	2.2%	14.6%	84.9%

Black women aged 65-75 years (n = 1711)					
FRAX-Hip score	FN-BMD T-score category				
	≥ -1.0 (n = 1165)	-1.0 > T > -2.0 (n = 359)	-2.0 ≥ T > -2.5 (n = 116)	-2.5 ≥ T ≥ -3.0 (n = 58)	< -3.0 (n = 13)
< 1%	99.1%	89.1%	45.7%	0	0
1% to < 2%	0.7%	9.5%	40.5%	51.7%	0
2% to < 3%	0.2%	0.8%	9.5%	22.4%	38.5%
≥ 3%	0	0.6%	4.3%	25.9%	61.5%

BMD, bone mineral density; FN, femoral neck; FRAX-Hip, Fracture Risk Assessment Tool 10-year probability of hip fracture; NHW, non-Hispanic White.

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and obesity. More research is needed among ethnically diverse populations to optimize fracture risk prediction.⁸

Strengths and Limitations

Our study from California, a state with a high diversity index,⁹ is the first to our knowledge to examine BMD and FRAX among contemporary Black women in the western US compared with NHW and Asian women in the same health care setting. We specifically chose women aged 65 to 75 years to reflect age targets for the Healthcare Effectiveness Data and Information Set Osteoporosis Screening in Older Women metric.¹ Although study limitations include the lack of fracture outcome data (to examine FRAX calibration and accuracy)^{8,19} and relevant biologic and social factors, these BMD and FRAX findings from real-world practice underscore the need for more research. Importantly, we recognize the limitations of race, a social construct that often includes a range of cultural and social determinants of health and does not account for social and genetic heterogeneity within and among groups. Our study lacked information on nativity, ancestry, and African admixture.³⁰ Nonetheless, awareness of clinical data from risk assessment tools and their potential impact on fracture prevention care in non-White populations is necessary.

CONCLUSIONS

Our observations may inform efforts to optimize fracture risk assessment among diverse populations. Our findings are timely because future updates to FRAX are planned, including pooled analyses that may support ethnicity-specific risk considerations.³¹ A deeper understanding of skeletal health among racial and ethnic minority populations will support health equity for all women at high risk for fracture. ■

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MR, MK, AW); drafting of the manuscript (JCL, WY, AW); critical revision of the manuscript for important intellectual content (JCL, WY, NT, CL, MR, MK, AW); statistical analysis (MC, CL); provision of patients or study materials (JCL, MR); obtaining funding (JCL, CL); administrative, technical, or logistic support (JCL); and supervision (JCL).

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