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Navy Nuclear Recruiting Markets: Race-Ethnic/gender Qualification Rates

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

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Race-Ethnic/Gender Qualification Rates

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December, 1993

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This report presents exploratory model-building for identifying and analyzing the recruiting market for Navy occupations in the highly technical nuclear field. Variation in eligibility for nuclear occupations by race and gender subsets of the recruiting market is examined. Logistic regression models for race/gender market segments estimate the relationship of socioeconomic factors and geographic location to four classifications of mental qualifications: (1) high quality (mental category IIIA and above) eligible for Navy nuclear occupations, (2) high quality not eligible for these highly technical occupations, (3) mental category IIIB, and (4) not eligible for the military labor market (mental category IV and below). The results of these models are then used to estimate the size of nuclear qualified markets of 17 to 21 year old high school graduates at the county level. Great variation in nuclear qualification by gender and race-ethnic group is apparent in these estimates with while males qualifying at rates substantially above all other groups. Regional variation reflects these demographic characteristics.

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I. INTRODUCTION

Recruiting success is dependent predominantly on the nature of the civilian labor market, the level of military requirements, the quality mix of requirements, the availability of recruiting resources, and competition from colleges and civilian employers. As the U.S. domestic economy improves, a major issue for the military is whether it will be able to attract enough people who are able to handle complex weapon systems. The rivalry between civilian and military employers will become even more intense. Current population forecasts indicate that the workforce entry-age cohort will decline until the mid 1990s. The level of general intellectual achievement of high school graduates has been predicted to decline during this same period (Kocher and Thomas 1991). The Office of Technology Assessment (1990) estimates that 20% to 30% of the workforce is already deficient in the basic skills required to perform effectively in the workplace.

The recruiting environment will continue to change radically during the remainder of the 1990s. The desired quality mix of recruits will be revised as the military employs a smaller, smarter, more resilient force to match sophisticated weapon systems. The demand for high quality recruits may even increase while total requirements are decreasing. At the same time, national budget deficit reduction measures will substantially reduce recruiting resources available to the military. In addition, interest in the military has declined since the end of the cold war, and will probably continue to decline as the mission of the U.S. military remains unclear. If the dominant mission becomes intervention in regional conflicts, general interest in the military may decline even further.

Efficient recruiting for highly specialized military occupations requires identification of

the qualified military available and interested market for those occupations. The target market for military recruits generally is defined on the basis of age (17 to 21 years old), high school graduation, and physical, moral, and mental qualification. Mental qualification is usually indicated by a sufficiently high score on the Armed Forces Qualification Test (AFQT), an arithmetic composite of several sublists of the Armed Services Vocational Aptitude Battery (ASVAB). A distinct subset of the general qualified military available (QMA) market is eligible for highly technical military occupations. Qualification for technical occupational fields, including the nuclear field program, is based primarily on a candidate's score on specific subsets of the ASVAB. After passing additional qualification screens, some QMA recruits are eligible for the lengthy and expensive training that leads to the more technical and complex military occupations. Nuclear field rating also requires a minimum score on the Nuclear Field Qualification Test (NFQT), as well as educational background qualification.

The purpose of this report is to develop prototype models for identifying and analyzing the recruiting market for the highly technical Navy nuclear occupations. These econometric recruit qualification models are then used in determining what portion of the youth labor market in a local geographic region will qualify for these occupations. Recruiter management decisions such as recruiter allocation and goal setting are dependent upon appropriate measures of local recruiting markets. By providing improved market measures, these models can be used as a basis for more efficient use of recruiting resources.

This study develops statistical models for the achievement of the minimum test score required for entry into training for highly technical Navy nuclear ratings. Sociodemographic characteristics such as age, gender, race/ethnic group, educational background, economic status,

and family background have been shown to influence an individual's performance on the ASVAB (Gorman and Thomas 1993). These characteristics are utilized as explanatory variables in modeling eligibility for nuclear ratings. Because our ultimate goal is the application of the results to local labor markets, the explanatory variables are restricted to those for which measures are available nationwide at the local level (county and/or zipcode).

As updated forecasts of market segment population size and measures of local level explanatory variables become available over time, changes in qualification for these occupations can be predicted by county. Estimates developed from our models can also be compared with historical county level Navy nuclear enlistments.

II. OCCUPATIONAL CHANNELING AND ASVAB SCORES

A. ASVAB and AFQT

All four military services use the Armed Services Vocational Aptitude Battery, or ASVAB, to screen applicants (U.S. Department of Defense 1992). As shown in Table 1, the ASVAB contains ten subtests designed to measure the ability of recruits in separate general skill areas. The Armed Forces Qualification Test, or AFQT, is used by all the services as their primary screening device for mental qualification for entrance into the military. AFQT is a specific aptitude composite based on three ASVAB subtests:

- arithmetic reasoning
- word knowledge
- paragraph comprehension.

TABLE 1
ASVAB TEST FORMAT AND SKILL AREAS

SUBTEST	Minutes/ Questions	Description of Subtest Content
1. General Science (GS)	11 / 25	Physics and biology.
2. Arithmetic Reasoning (AR)	36 / 30	Arithmetic word problems.
3. Word Knowledge (WK)	11 / 35	Meaning of words.
4. Paragraph Comprehension (PC)	13 / 15	Obtain written inform.
5. Numerical Operations (NO)	3 / 50	Arithmetic speed test.
6. Coding Speed (CS)	7 / 84	Speed test.
7. Auto and Shop Info. (AS)	11 / 25	Knowledge about cars.
8. Mathematics Knowledge (MK)	24 / 25	High school mathematics.
9. Mechanical Comprehension (MC)	19 / 25	Mechanical & physical principles.
10. Electronics Information (EI)	9 / 20	Electricity & electronics.

Although the Air Force, Army, Marine Corps and Navy use the AFQT for their general recruit screening, separate ASVAB subtest or subtest composite scores are used to filter recruits into training pipelines for various occupational fields. Specific subfunctional areas each require

a specific set of minimum scores. However, the branches do not use uniform composites to screen recruits for similar training. ASVAB composites with the same aggregate classification may be composed of different groups of subtests for different branches; for example, the mechanical composites for Navy and Air Force are constructed in different ways (Eitelberg 1988, p. 71).

B. Categories of Technical Occupations

The services do not use uniform groupings of military occupations nor do they use uniform ASVAB composites for recruit screening and assignment. At present, the Navy uses 11 ASVAB classification composites: GT (General Technical), MECH (Mechanical), ELEC (Electronics), CLER (Clerical), AM (Aviation Structural Mechanic), BE/E (Basic Electricity/ Electronics), BT/EN/MM (Boiler Technician/Engineman/Machinists Mate), MR (Machinery Repairman), SUB (Submarine), CT (Communications Technician) and HM (Hospitalman). The recruiter encourages the applicant to sign up for the field to which he or she is best suited, given the surplus or shortage of personnel for different occupational specialties.

The Navy is the only service that differentiates occupations into the three general categories: semitechnical, technical, and highly technical. Data provided by the Defense Manpower Data Center indicate that about one third of all Navy enlisted personnel are assigned to the least technical job category (semitechnical). This category includes boatswains mate, boiler technician, ship's serviceman, and postal clerk. At the other end of the technical occupations are the highly technical Navy jobs. Examples include sonar technician, data systems technician, missile technician, air traffic controller, and cryptologic technician, as well as those occupations in the nuclear field program. Approximately 20 percent of all enlisted personnel

are assigned to jobs of this kind.

C. The Navy Nuclear Field Program

The Navy Nuclear Field Program was designed to recruit, assign, and train enlisted personnel to serve as propulsion plant operators on either nuclear submarines or nuclear surface warships. Because highly trained and qualified individuals are required to staff the nuclear powered fleets, screening, selection, and training are rigorous. Eligibility criteria for personnel operating nuclear engineering plants have been developed jointly by the Navy and the Department of Energy (U.S. Department of the Navy 1992).

Completion of the Nuclear Field Program leads to qualification as a mechanical operator, electrical operator, or reactor operator. These three operator ratings are drawn from the Machinist's Mate (MM), Electrician's Mate (EM), and Electronics Technician (ET) ratings, respectively. Nuclear operators are expected to serve ultimately as senior enlisted nuclear propulsion plant watch supervisors. All three operator positions require an understanding of all aspects of reactor plant design and thus must be cross-trained.

In order to be considered for the Navy nuclear field, an enlistee must be between 17 and 25 years of age, must not have a total active military service exceeding four years at time of enlistment, and must meet the Navy's physical and moral standards. In addition, candidates must be high school diploma graduates who have completed one year of high school or college level algebra with a grade of at least "C". There are additional ASVAB test score requirements, as well as a minimum achievement level on an additional test, the Nuclear Field Qualification Test (NFQT). Currently, the nuclear field is closed to women.

The required ASVAB scores include:

VE + AR = 113 with NFQT = 49 or higher, or

VE + AR = 108 to 112 with NFQT = 55 or higher.

These additional minimum ASVAB scores must also be achieved:

1. *MK + AS = 96*
2. *AR + 2MK + GS = 196*
3. *MK + EI + GS = 156*
4. *MK + EI + GS + AR = 218,*

as well as:

VE + NFQT = 110 or higher.

Our approach to estimating the size of the Navy nuclear field recruiting market is based on the results of a national sample survey of civilian youth that includes respondents' scores on the ASVAB. This survey, however, does not include a national sample of scores on the NFQT. Consequently, the criteria for Navy Nuclear Field Program eligibility for this report have been restricted to the minimum ASVAB requirement, VE + AR = 108 or higher, as well as the above four additional composite scores.

III. THE NLSY DATA

From 1979 to 1987 the National Longitudinal Survey of Youth (NLSY) collected data nationwide on education, training, labor force experience, financial status, and other characteristics for a statistically representative sample of the U.S. youth population (Center for Human Resources Research 1991). In 1980, sponsored by the Department of Defense, the Armed Services Aptitude Battery (ASVAB) was administered to both the civilian and military youth samples in the NLSY. The Department of Defense used these test results to develop current norms for the ASVAB (U.S. Department of Defense 1982).

The NLSY sample consists of three groups: (1) a cross-section national sample of American youth, aged 14 to 21 as of January 1, 1979 in their proper population proportions; (2) a sample designed to over represent civilian Hispanics, blacks, and economically disadvantaged whites, and (3) a military sample designed to represent the population aged 17 - 21 as of January 1, 1979 who were serving in the military as of September 30, 1978. Of the original 12,686 NLSY respondents, 11,914 took the ASVAB in 1980. Of this group, 5,969 respondents were male and 5,945 respondents were female. The military sample took the ASVAB test a second time, accounting for 823 males and 457 females. (They had taken the ASVAB for the first time on entering military service). Table 2 shows the distribution of the NLSY sample by race/ethnic group and gender.

Studies of test performance on the AFQT and the development of estimating equations for regional QMA has been pioneered in a research program at The Naval Postgraduate School: Sinkiewicz (1990), Peterson (1990), Snyder (1990), Woods (1990), Moreau (1991), Uslar (1991), Bicakaiz (1992), and Schultz (1992). Thomas and Gorman (1991) used a combination

TABLE 2
DISTRIBUTION OF THE NLSY SAMPLE BY GENDER AND RACE/ETHNIC GROUP

Cross-Section Sample 6,111	Supplemental Sample 5,295	Military Sample 1,280	TOTAL 12,686
Males	Males	Males	Males
White 2,439	Poor White 742	White 609	White 3,790
Black 346	Black 1,105	Black 162	Black 1,613
Hisp. 218	Hisp. 729	Hisp. 53	Hisp. 1,000
Females	Females	Females	Females
White 2,477	Poor White 901	White 342	White 3,720
Black 405	Black 1,067	Black 89	Black 1,561
Hisp. 226	Hisp. 751	Hisp. 25	Hisp. 1,002

Source: NLSY Handbook 1991

of AFQT scores and sociodemographic variables to predict both qualified military available for enlistment, and the size of local civilian labor markets likely to join the military for 1990 to the year 2010.

IV. NAVY NUCLEAR MARKET ESTIMATING MODELS

A. Theoretical Model

The ordered multinomial logit model was used to estimate nuclear rating/mental group distributions (Maddala 1983). The logit function

$$g(P) = \log \frac{P}{1-P}$$

is the inverse of the cumulative logistic distribution, which is given by $F(X) = \frac{1}{1+e^{-x}}$.

Suppose Y_i can take on ordered values 1,...,m where m is an integer greater than 1. P_{ij}, the probability that the ith individual has made choice j given the vector of personal characteristics $\mathbf{X_i}$, is

$$P_{ij} \equiv P(Y_i=j|\mathbf{X_i}) = \begin{cases} F(\alpha_1 + \mathbf{b}'\mathbf{X_i}) & \text{for } j=1 \\ F(\alpha_j + \mathbf{b}'\mathbf{X_i}) - F(\alpha_{j-1} + \mathbf{b}'\mathbf{X_i}) & \text{for } 1< j <m \\ 1-F(\alpha_{m-1} + \mathbf{b}'\mathbf{X_i}) & \text{for } j=m. \end{cases}$$

B. Selection of Explanatory Variables

Selection of explanatory variables was based on the joint criteria of (i) behavioral soundness, (ii) inclusion in the NLSY data set and (iii) the availability of similar county level variables on a nationwide basis. Socioeconomic and regional background characteristics influence the eligibility of the respondents for the prime market. Research by Bock and Moore (1984) has shown that parents' educational attainment, and especially mother's education, influences individual performance on the AFQT. Parents' education strongly affects certain ASVAB subtests such as Word Knowledge, Mathematics Knowledge, General Science,

Arithmetic Reasoning, and Paragraph Comprehension, but the effect on other subtests is more limited. A variable called "parents education" was constructed. If both parents' education was available, the average was used. If one parent's education was missing, the educational attainment of the other was used in order to maintain sample size. Higher parental educational level was expected to increase the probability of nuclear qualification.

The socioeconomic status of a respondent also was accounted for by a proxy variable indicating whether or not the individual's family was living in poverty. This poverty status variable was expected to have a negative influence on eligibility for the prime market and hence also for the nuclear high tech ratings.

As shown in the previous section, when the continental states are grouped into regions identified as Northeast, South, North Central and West, variation in the distribution of eligibility for the nuclear categories throughout the four regions is apparent. Eligibility was lowest in the South. In order to capture this effect, a dichotomous variable ("South") was used to indicate whether or not an individual resided in the South census region.

C. Empirical Models

The Navy nuclear qualification model estimates the likelihood of an individual being in each of four mental groups (1) Nuclear, (2) High Quality/Not Nuclear, (3) mental category IIIB, and (4) mental category IV or below, not eligible for the military labor market.

Separate models were estimated by gender and race/ethnic group. A priori, it was expected that being black or Hispanic would decrease the likelihood of being eligible for technical military occupations for both males and females. Furthermore, poverty status (0=not poverty, 1=poverty) and the residence in the South census region were expected to decrease the

probability of classification in the higher mental groups.

Table 3 presents the standardized estimated multinomial logit coefficients by gender and race for mental category as a function of poverty status, parents' education and region. A negative coefficient implies decreasing nuclear qualification associated with an increase in an explanatory variable. For all gender/race ethnic group models except that for Hispanic women, living in poverty had a significant negative impact on nuclear/mental group qualification (0.01 level for white males, white females, black males, black females, and Hispanic males; 0.05 level for Hispanic females). Residence in the South census region was also negatively significant for white men (0.10 level), white women (0.05) and for black men (0.05). As expected, the level of parents' education was positively and strongly associated with mental qualification for all

TABLE 3
STANDARDIZED LOGISTIC REGRESSION COEFFICIENTS FOR NAVY NUCLEAR QUALIFICATION BY GENDER AND RACE/ETHNIC GROUP, NLSY HIGH SCHOOL GRADUATES AGE 17-21

Variable	WM	WF	BM	BF	HM	HF
Sample size	944	961	98	102	95	59
Poverty status (living in poverty=1	-.086***	-.074***	-.186***	-.161***	-.146**	.005
Census region (South=1)	-.048*	-.065**	-.125**	.027	-.043	.091
Parents' education (highest year, either parent)	.353***	.420***	.324***	.383***	.267***	.324***
Model chi-square	177.03***	256.30***	69.62***	83.79***	25.34***	26.41***

* p<.10
** p<.05
*** p<.01
Note: WM indicates white male; WF indicates white female; BM indicates black male; BF indicates black female; HM indicates Hispanic male; HF indicates Hispanic female.

models (0.01 level). The model chi-square (difference between full model and intercepts only) was significant (0.01 level) for all models.

V. APPLICATION OF NAVY NUCLEAR MODELS TO NATIONAL MARKETS

A. County Level Estimating Procedure

The logistic regression equations derived in section IV were used to calculate the probabilities of a county's high school graduate population being classified into each mental group for each gender/race-ethnic group segment of a county's population using the values for poverty and parent's education[1] for each market segment in the county. For example, the percent of blacks in poverty in county K, average parents' education for blacks in county K, and South/not South location for county K were substituted in the logit equation to yield probabilities for mental group category membership for black males in county K. (Probabilities sum to one across mental groups for black males in county K).

The model results were then combined with county-level population estimates for each gender/race-ethnic group segment to estimate the number of high school graduates qualifying for each mental category by gender, race, and geographic region in a particular year. The number of high school graduates of a gender/race-ethnic group residing in a county was multiplied by the probability of belonging to a particular mental group category within a gender/race-ethnic group segment:

$$CAT_{ijk} = (HSG_{jk})(PCAT_{ijk} \mid \text{county}_{jk}),$$

where CAT_{ijk} is the number of individuals in mental group/nuclear qualification category i in each market segment j (gender/race-ethnic group) in county k. HSG_{jk} is the number of high school graduates in market segment j in county k, and $PCAT_{ijk}$ is the probability of an

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[1] The county value of educational attainment of adults 25 years or older was used as a proxy for parent's education for each race-ethnic category.

individual being classified in CAT i given the socioeconomic characteristics of market segment j in county k.

Thus, the number of black male high school graduates in county K in 1990 was multiplied by the probability of a black male with the average black male socioeconomic characteristics in county K scoring in a particular mental group to yield an estimate of the number of black males who would meet this criterion in county K in 1990. Estimates for each mental group/nuclear qualification category were then summed across a county to yield total high school graduates for the gender/race-ethnic group segment.

B. Population Data

Woods & Poole Econometrics, Inc. (W&P)[2] provided estimates of high school graduates between 17 and 21 who were not in the military for each county in the continental United States for 1990-2010. Six estimates for each county were included, one for each race-ethnic group (white, black, Hispanic) within gender groups. (Estimates of high school graduate gender/race population segments from other sources can be used in conjunction with our nuclear rating/mental group estimating equations).

The population estimates developed by W&P are for high school graduates (both diploma graduates and GED holders). This population is appropriate for this study because, in recent years, the military services have limited recruiting almost exclusively to high school graduates. Such a restriction, however, does give rise to some confusion when these estimates

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[2] The W&P population estimates used for this report are not based on the 1990 census results. We recommend that updated population and sociodemographic estimates be used to update the specific county level market estimates. However, such updates would have no effect on the race/gender relationships in our estimating models.

are compared with alternative data sources that include all residents, regardless of degree status. Many 17 to 21 year olds are not high school graduates - some are enrolled in high school and will eventually receive a diploma; others will eventually obtain a GED; and still others will not achieve either a diploma or a certificate. W&P estimates for 17 and 18 year olds are much smaller than those based on total residents, since a large proportion of total residents in this age group are high school students who have not yet graduated. This will tend to understate market size.

Another area in which the version of W&P estimates used for this report differ from other estimates used for estimating recruit market size is the inclusion of college students in the W&P forecasts. While recruiting resources tend to be directed at high school seniors, the prime market age group considered here includes those up to 21 years old, many of whom are full-time or part-time college students. This will tend to overstate market size.

The starting point for the W&P forecasts for <u>total</u> white, black and other population are the Current Population Reports Series P-25 No. 952. <u>Total</u> Hispanic population estimates are based on CPR Series P-25, No. 995. The forecast for <u>total</u> Hispanic population assumes that counties with large Hispanic populations in the early 1980s will experience the largest growth in Hispanic population through 2010. The Census Bureau defines Hispanic population as persons of Spanish origin, regardless of race and W&P take the same approach. We have adjusted the W&P forecasts to prevent double counting by treating Hispanics as a separate, mutually exclusive race/ethnic group category. Our white category includes all nonblacks and nonHispanics.

<u>County</u> residential population forecasts are derived from W&P's proprietary

forecasting models. This approach is largely econometric, rather than strictly an extrapolation of demographic trends. The models have three components:

(1) County employment by industry forecasts based on a macroeconomic model of total U.S. employment by industry, a regional export-base model for 183 "Economic Areas," and county export-base employment models.

(2) Initial estimates of total county population based on changes in employment derived from (1) above.

(3) Estimates of county population by age, gender, and race based on a cohort-survival model and a net migration model that is employment driven, rather than an extrapolation of historical migration patterns.

Based on the W&P forecasts, the 17 to 21 year old population is expected to decline during the 1990s and to begin to increase early in the next century. The race/ethnic group composition of the youth population is anticipated to reflect a larger proportion of blacks and Hispanics and thus a smaller proportion of whites. Educational attainment is expected to fall through 2010 with a slight decline in the proportion of high school graduates among 17 to 21 year olds.

Largely due to the fact that the W&P county forecasting model is based on employment driven migration rather than on historical migration patterns, the regional distribution of the forecast youth population differs somewhat from the Census projections. W&P forecasts greater population growth for the West, Midwest and Northeast, and somewhat slower growth for the South.

VI. ESTIMATES OF MENTAL GROUP/NUCLEAR QUALIFICATION RATES

A. National Estimates by Gender and Race/Ethnic Group

Table 4 shows the gender/race-ethnic group distribution of nuclear qualification estimated for 1990. One view of the pattern of qualification rates for the U.S. as a whole may be gained from the "shrinkage" of a pool of qualified individuals as the qualification criteria become more stringent. Figure 1 traces a hypothetical group of 20 million high school graduates 17 to 21 years old, from the qualification criteria for membership in mental category IV and below through eligibility for Navy nuclear ratings. Race-ethnic group proportions for these 20 million reflect the race-ethnic group distribution of the civilian population of 17-21 year old high school graduates. Men and women show similar qualification patterns until the nuclear qualification stage is reached. Out of 10 million males and 10 million females, there would be 7.3 million men and 7.1 million women who qualify as IIIB and above. The IIIA and above group would have 800 thousand more men than women. For the nuclear category, 2.6 million out of 10 million men qualify, but only 300 thousand women from an original group of the same size qualify. That is, over eight times as many male high school graduates would qualify for such highly technical ratings as would women.

Figure 1 masks the disparity in qualification rates among race-ethnic groups. Figure 2 illustrates the distribution of nuclear qualification rates and mental categories within gender/race-ethnic group segments using W&P population estimates for 1990. It is striking that white males qualify for the highly technical nuclear ratings at three times the rate of the next largest group, Hispanic males. White females qualify at less than half the rate of Hispanic males, and black males at less than a third the rate of white females. Black and Hispanic women have extremely

TABLE 4
1990 ESTIMATED OCCUPATIONAL QUALIFICATION
HIGH SCHOOL GRADUATES AGE 17 TO 21
BY GENDER AND RACE-ETHNIC GROUP
(percent)

	Nuclear Qualified	High Quality/ Not-Nuclear	IIIB	Below IIIB	Total
White male (n=3,587,232)	30.8	31.1	19.2	18.9	100.0
White female (n=4,252,084)	3.7	50.7	25.8	19.7	100.0
Black male (n=476,423)	2.1	12.3	15.6	70.0	100.0
Black female (n=726,924)	0.3	11.3	18.2	70.2	100.0
Hispanic male (n=386,468)	10.5	23.3	22.8	43.4	100.0
Hispanic female (n=414,645)	0.6	19.1	27.5	52.8	100.0
All males (n=4,450,121)	26.0	28.4	19.1	26.5	100.0
All females (n=5,393,653)	3.0	43.0	24.9	29.1	100.0
Total (n=9,843,776)	13.4	36.4	22.3	27.9	100.0

Shrinkage of Hypothetical Pool of 20 Million High School Graduates Age 17 to 21 By Gender

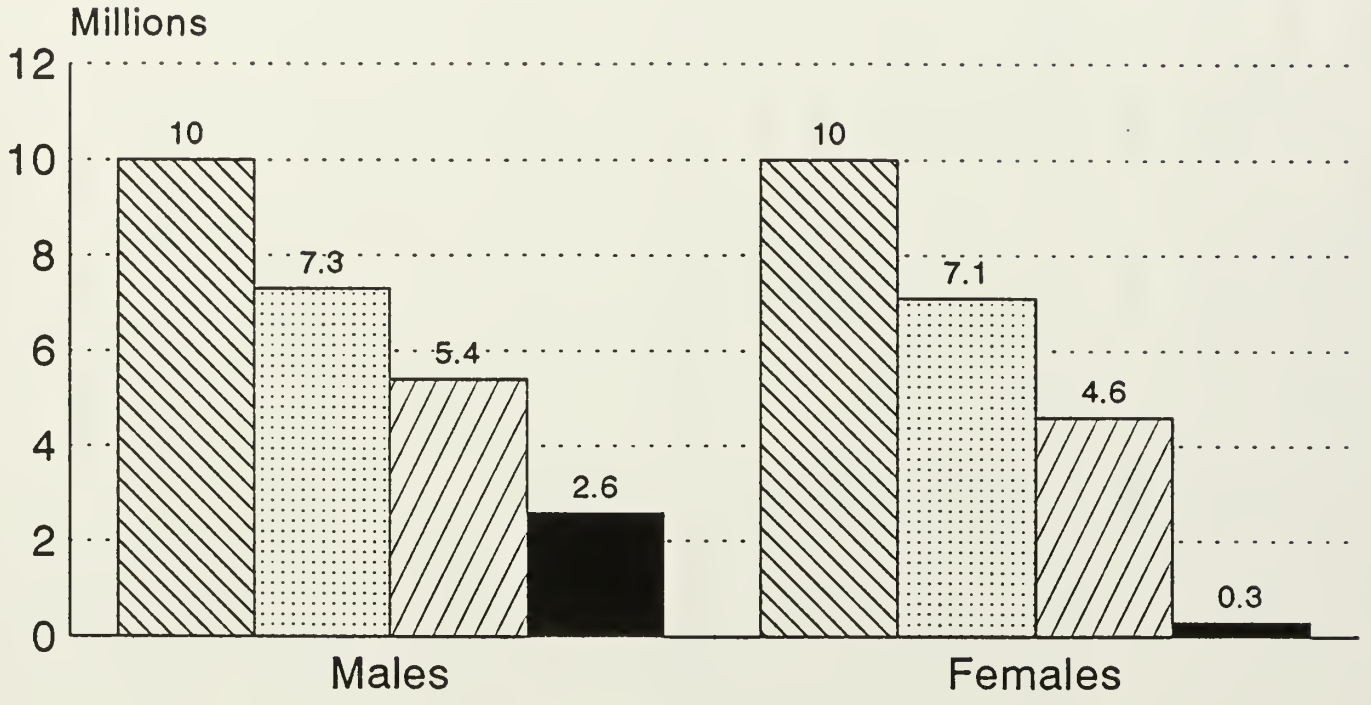

Figure 1

Estimated Nuclear Rating / Mental Group Qualification
High School Graduates Ages 17 to 21
By Race and Gender

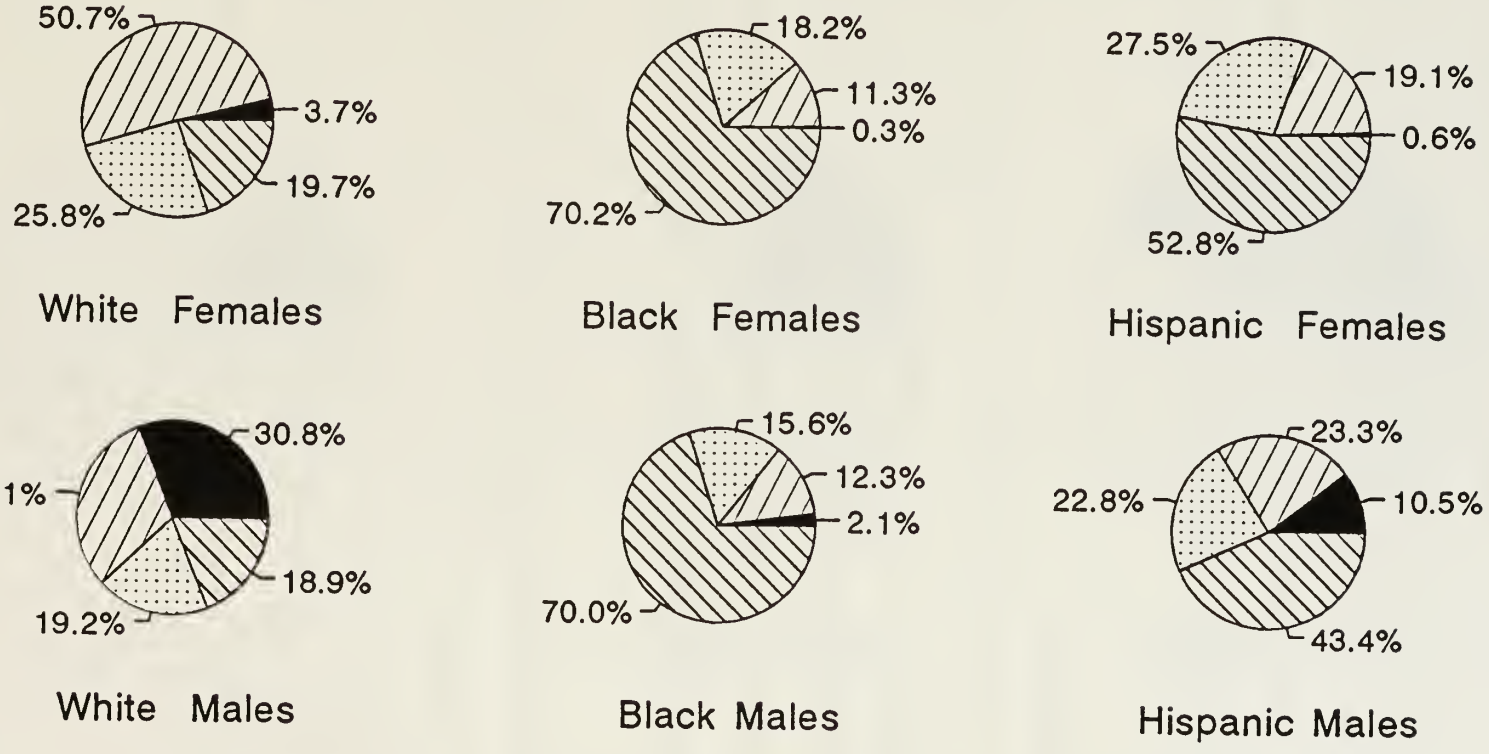

Figure 2

low qualification rates, less than one percent.

At the lower end of the mental group distribution, white men and women fail to qualify above category IV at about the same rates (18.9% and 19.7%, respectively). Black males and females are much less likely to score above Category IV, with 70.0% and 70.2%, respectively, failing to meet this criterion and, consequently, ineligible for military service. Hispanic youth fall between the two extremes, with 43.4% of men and 52.8% of women in this lowest category.

B. Regional Estimates

Variation in mental group qualification and nuclear rating by census region is described in the tables in Appendix A. The East and North Central census regions display very similar rates of nuclear qualification while the South has a slightly lower percent eligible for nuclear occupations and the West has a slightly higher percent. These distributions within regions are similar for male and female high school graduates. Appendix A identifies the states in each census region.

It is difficult to appreciate the differences in occupational qualification among geographic areas from such a broad aggregate as census region. To demonstrate local market variation in occupational qualification, we show the distributions of nuclear rating and mental group qualification for men and women civilian high school graduates between 17 and 21 years of age for three counties in Figures 3 and 4[3]. Los Angeles county, with 22 percent of males nuclear

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[3]As shown in Figure 1, the national male civilian nuclear qualification rate is about 26%.

Estimated 1990 Nuclear Rating/Mental Group Qualification
Civilian Male High School Graduates Age 17 to 21
For Selected Counties

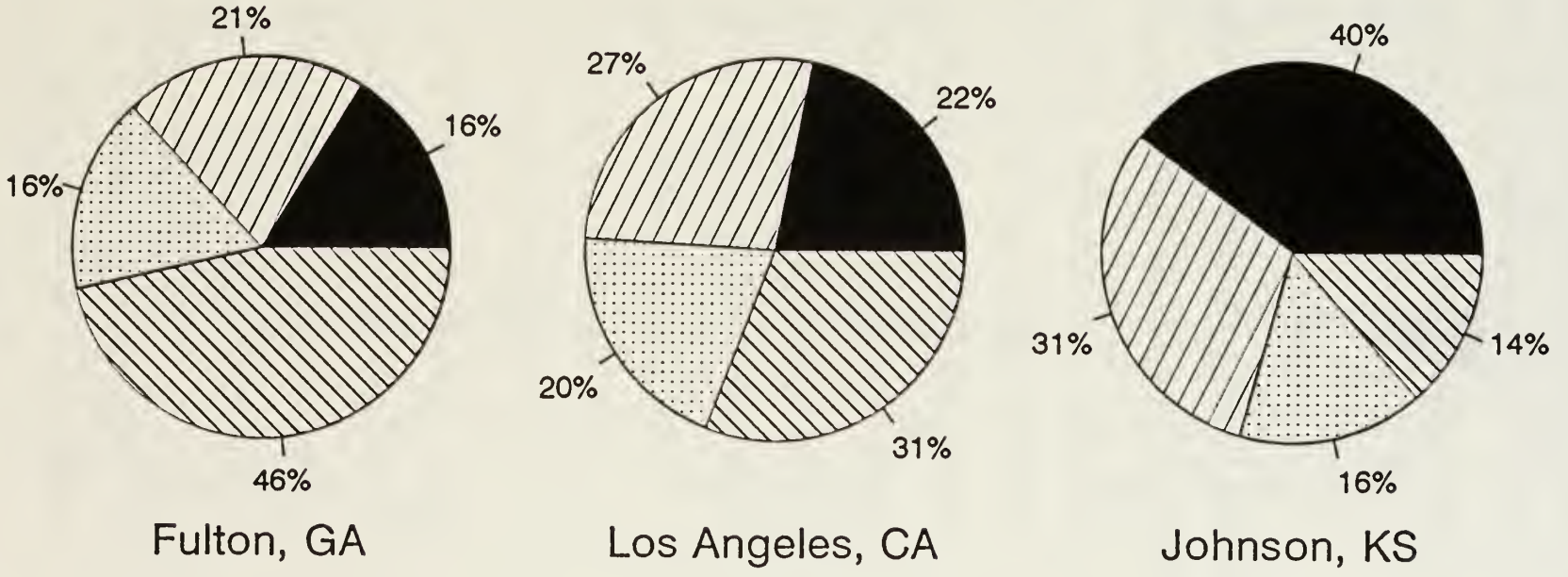

Figure 3

Estimated 1990 Nuclear Rating/Mental Group Qualification
Civilian Female High School Graduates Age 17 to 21
For Selected Counties

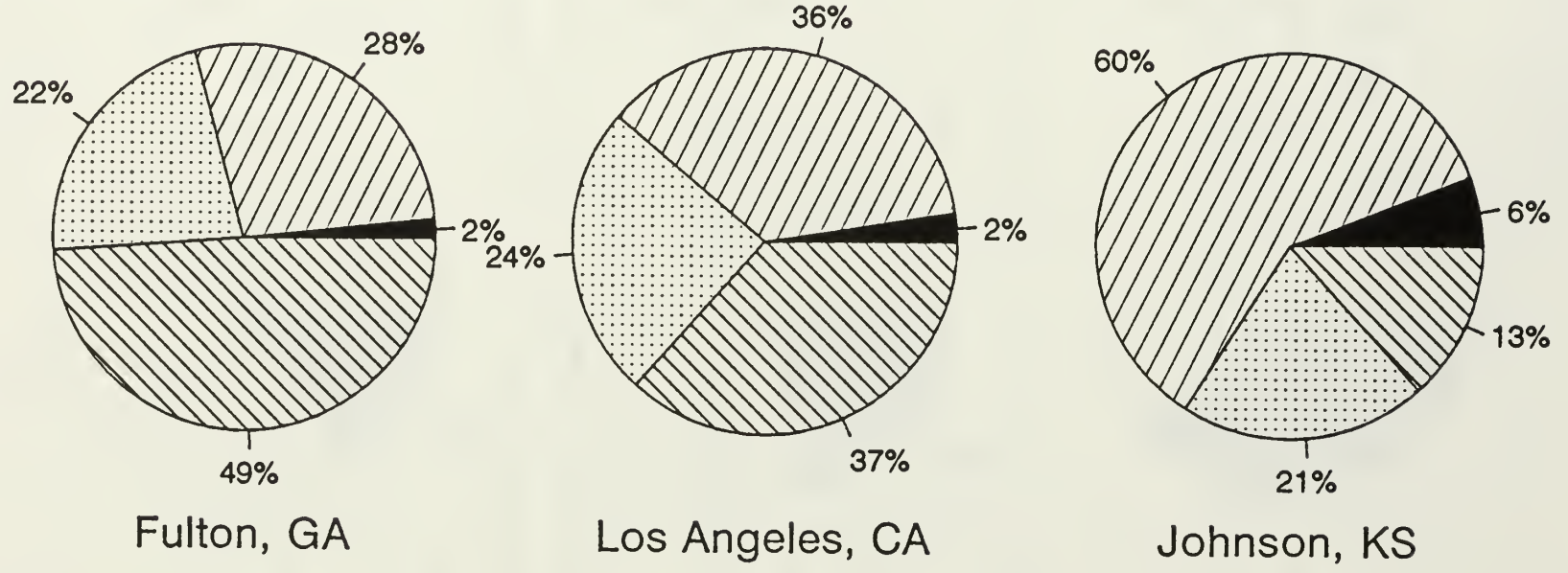

Figure 4

qualified, falls between Fulton county (16 percent) and Johnson county (40 percent)[4].

The county distributions for women show only 2 percent of female high school graduates to be nuclear qualified in Fulton and Los Angeles counties, whereas 6 percent are qualified for nuclear occupations in Johnson county[5].

C. Underlying ASVAB Subtest Score Differentials

A pattern of differential ASVAB subtest and subtest composite scores accounts for these estimated disparities in nuclear qualification by gender and race-ethnic group. When ASVAB subtest scores for men and women civilian high school graduates ages 17 to 21 are compared, within each race-ethnic group, men scored significantly higher than women on all composites used to channel enlistees into highly technical jobs. These composites are: (i) VE+AR, where VE=(PC+WK), scaled to the mean for individual subtests; (ii) MK+AS; (iii) AR+2MK+GS; (iv) MK+EI+GS; and (v) MK+EI+GS+AR. Of the subtests in these screens, women scored significantly lower on AR, AS, GS and EI, while their scores on MK and VE were not significantly different from those of men. Those subtests on which women's scores are significantly higher than men's (PC,NO, and CS), or where there is no significant difference (VE, MK, and WK), have very limited (MK and VE), or no (NO and CS) influence on composites used for nuclear screenings (based on Bonferroni t-tests for all six gender/race-ethnic groups, $p \leq 0.05$). The arithmetic reasoning (AR) subtest has by far the greatest differential effect on qualification by gender, followed to a much more limited extent by electronics

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[4]If highly technical enlistees are a target market, then recruiting resources should parallel these markets, after accounting for size and other market differences.

[5]The national female civilian nuclear qualifications rate is about 3%, as shown in Figure 1.

information (EI) and auto shop information (AS).

When race-ethnic group scores within gender groups are compared (based on the same Bonferroni t-tests), white civilian high school graduates between 17 and 21 years old have significantly higher scores than Hispanics or blacks on all subtests (and composites) for men and women. High school graduate Hispanics, in turn, have significantly higher scores than blacks on all subtests (and composites) for men and all but four subtests (MK, GS, EI, and MC) for women. The arithmetic reasoning (AR) subtest, again, has the most influential role in nuclear qualification differentials by race-ethnic group.

VIII. MENTAL GROUP/NUCLEAR RATING ELIGIBILITY FOR 1990 ACCESSIONS

The pool of civilian youth qualified for miliary service discussed in Section VII provides a base population for recruiting purposes. Interest in joining the military, physical and moral qualification standards, alternative civilian labor market and educational opportunities, and recruiting practices are all influential in determining who actually will enlist in the armed services. High quality recruits are needed to fill the Navy's highly technical jobs but they are also the subset of the youth population that schools and civilian employers are anxious to attract. A comparison of the estimated national civilian distribution of nuclear rating and mental group qualification with actual accessions for 1990 yields a picture of a very high quality cohort entering the military. A great diversity by gender and race is readily apparent in the qualification of actual accessions for highly technical occupations such as those in the Navy nuclear program.

A. Qualification at Accession by Gender and Race/Ethnic Group

Tables 5 and 6 show nuclear rating/mental group qualification rates for 1990 actual accessions. The "shrinkage" of the pool of all-service enlistees as qualification criteria become more stringent as can be seen in Figure 5. There was a much higher proportion of nuclear qualified among men (34 percent for all-service accessions) than among women (20 percent for all-service accessions). Navy accessions (Figure 6) followed the same pattern, with 33 percent of male enlistees and 18 percent of female enlistees eligible for nuclear ratings. Figure 1 indicated that only 26 percent of male and 3 percent of female high school graduates in the civilian population would qualify on the same basis.

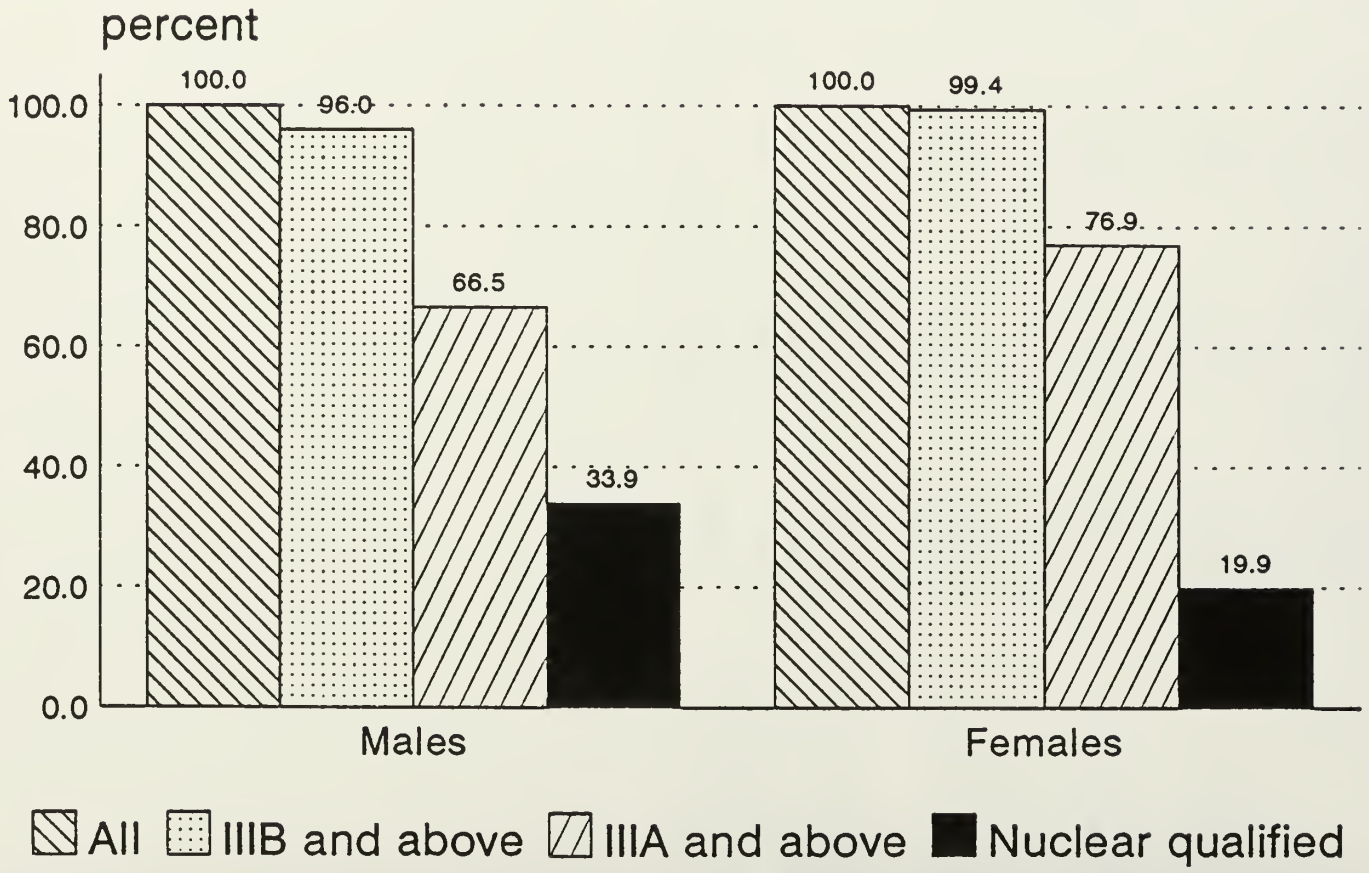
TABLE 5
NUCLEAR RATING/MENTAL GROUP QUALIFICATION
1990 HIGH SCHOOL GRADUATE ALL-SERVICE ACCESSIONS AGE 17 TO 21
BY GENDER AND RACE/ETHNIC GROUP
(Percent)

	Nuclear Qualified	High Quality/ Not Nuclear	IIIB	Below IIIB	Total
White Male (n=119,719)	41.0	32.5	24.0	2.5	100.0
White Female (n=15,040)	26.3	55.9	17.4	0.4	100.0
Black Male (n=30,748)	10.3	31.2	48.9	9.6	100.0
Black Female (n=6,280)	6.2	58.3	34.4	1.1	100.0
Hispanic Male (n=10,844)	22.1	37.2	35.7	5.0	100.0
Hispanic Female (n=1,344)	12.5	63.4	23.7	0.4	100.0
All Males (n=161,311)	33.9	32.6	29.5	4.0	100.0
All Females (n=22,664)	19.9	57.0	22.5	0.6	100.0
All Accessions (n=183,975)	32.2	35.6	28.6	3.6	100.0

TABLE 6
NUCLEAR RATING/MENTAL GROUP QUALIFICATION
1990 HIGH SCHOOL GRADUATE NAVY ACCESSIONS AGE 17 TO 21
BY GENDER AND RACE/ETHNIC GROUP
(Percent)

	Nuclear Qualified	High Quality/ Not Nuclear	IIIB	Below IIIB	Total
White Male (n=37,520)	40.9	28.8	24.8	5.5	100.0
White Female (n=3,968)	23.0	48.7	27.4	0.9	100.0
Black Male (n=10,351)	9.1	23.6	48.5	18.8	100.0
Black Female (n=1,605)	5.5	49.5	42.5	2.5	100.0
Hispanic Male (n=4,568)	27.6	34.4	29.4	8.4	100.0
Hispanic Female (n=585)	14.5	60.0	24.6	0.9	100.0
All Males (n=52,439)	33.4	28.3	29.9	8.4	100.0
All Females (n=6,158)	17.7	50.0	31.0	1.3	100.0
All Navy Accessions (n=58,590)	31.8	30.6	30.0	7.6	100.0

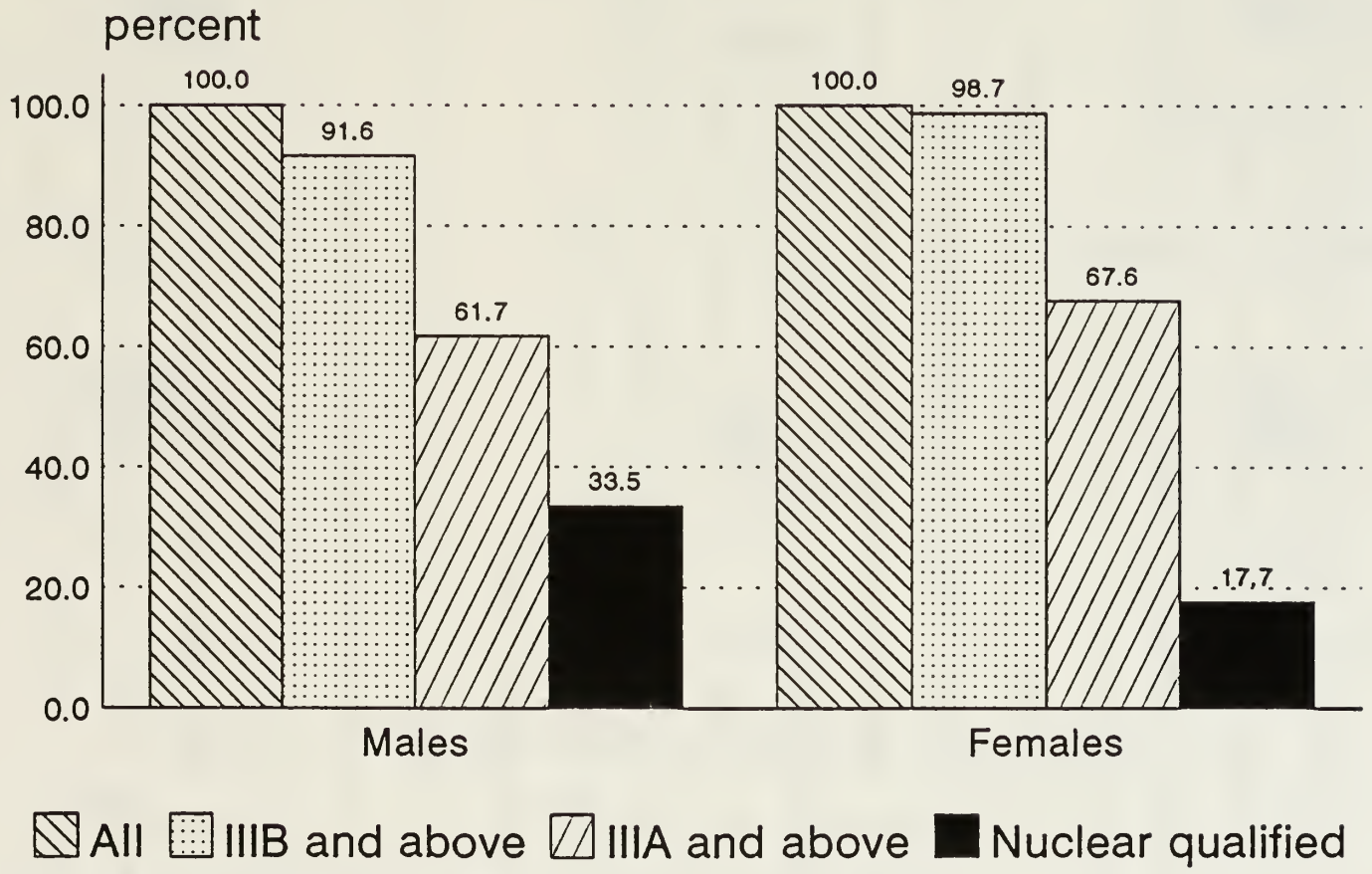
Percent Nuclear Rating/Mental Group Qualification
1990 High School Graduate All-Service Accessions Age 17 to 21
By Gender



Note: Males, N=161,311 ; Females, N=22,664.

Figure 5

Percent Nuclear Rating/Mental Group Qualification
1990 High School Graduate Navy Accessions Age 17 to 21
By Gender



Note: Males, n=52,432 ; Females, n=6,158.

Figure 6

The distribution of mental group qualification within race/ethnic group and gender categories for 1990 accessions (Figure 7 [All-Service] and Figure 8 [Navy] varies substantially from that of the gender distribution. The proportions of 1990 all-service recruits qualifying for nuclear occupations among while males (41.0 percent) and white females (26.3 percent) were greater than those among Hispanic men and women (22.1 percent and 12.5 percent, respectively) which, in turn, were greater than those among black males (10.3 percent) and black women (6.2 percent). Navy enlistees were similarly distributed.

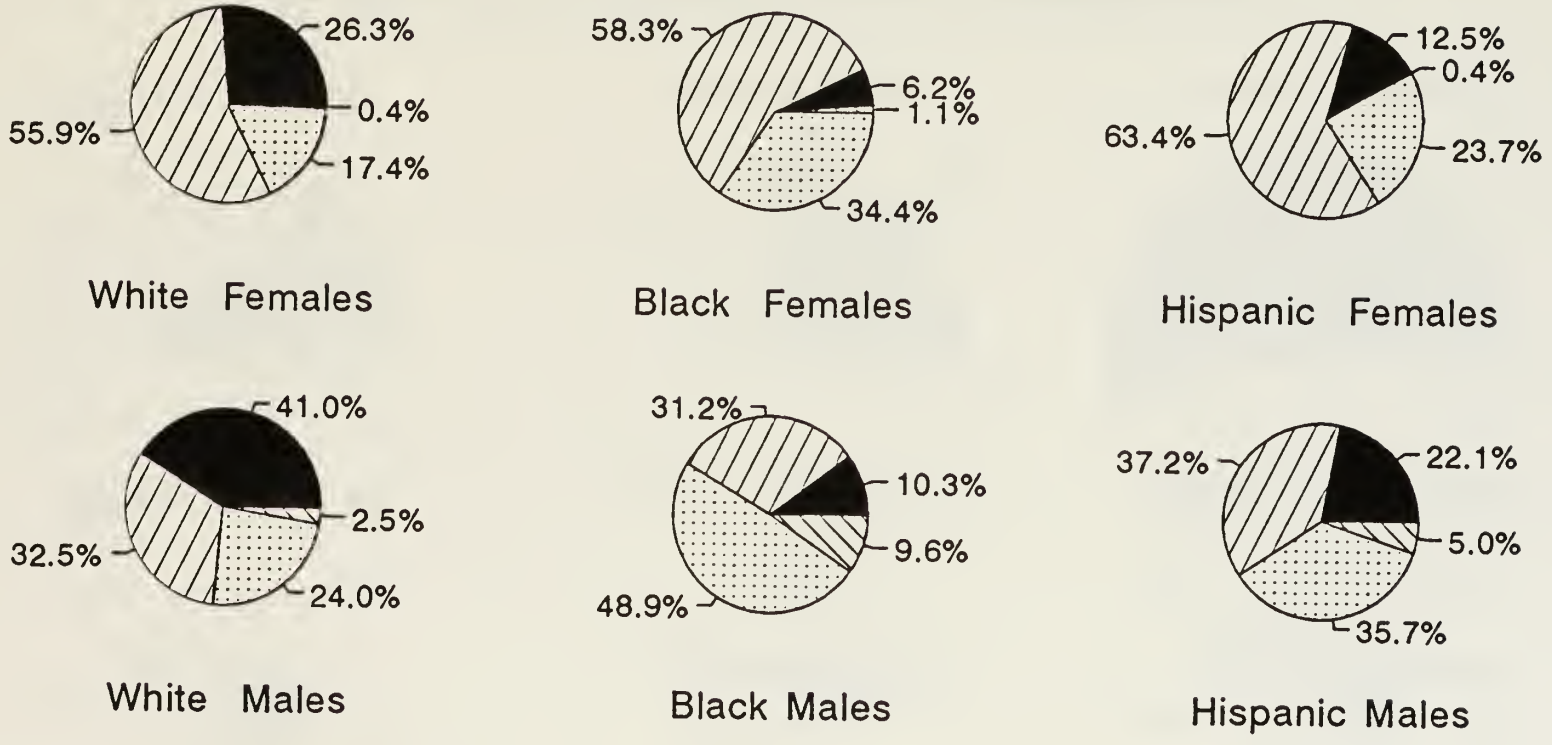
A major conclusion which may be drawn from comparison of the female qualification rates among enlistees with those for the civilian population the same age group is that the Navy and the other armed services attract a much higher proportion of women with the potential to fill highly technical jobs than is present in the population, regardless of race.

The more rapid "shrinkage" of qualified accessions for minorities, compared with whites, indicated in Figures 7 and 8, can be seen in additional detail in the cumulative histograms in Appendix B for both all-service and Navy 1990 accessions.

B. Qualification by Region

The distributions of actual accessions qualified for nuclear occupations and mental group categories for the four Census regions are included in Appendix A. Figures 9 and 10 show the all-service and Navy distributions of male accessions for three selected counties, yielding more insight into variation among recruiting environments than can be gleaned from the large aggregate census regions. The largest county, Los Angeles county, had 23 percent of all service male accessions in the nuclear qualified category. Johnson county, Kansas, had a higher proportion of male recruits in this category (54 percent), and Fulton county, Georgia, a lower

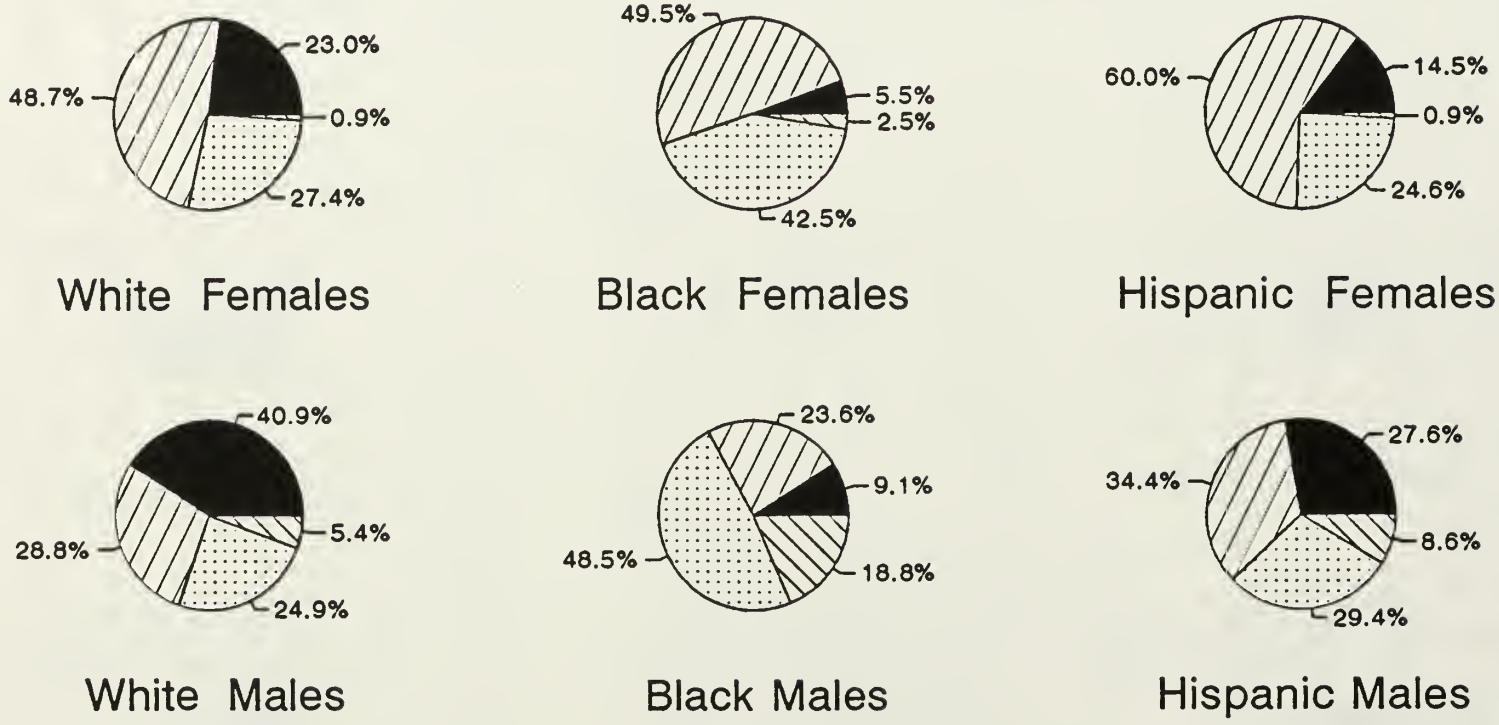
Nuclear Rating/ Mental Group Qualification by Race and Gender
1990 All-Service Accessions, High School Graduates Age 17 to 21



Note: See Table 9 for number in each gender/race-ethnic group segment.

Figure 7

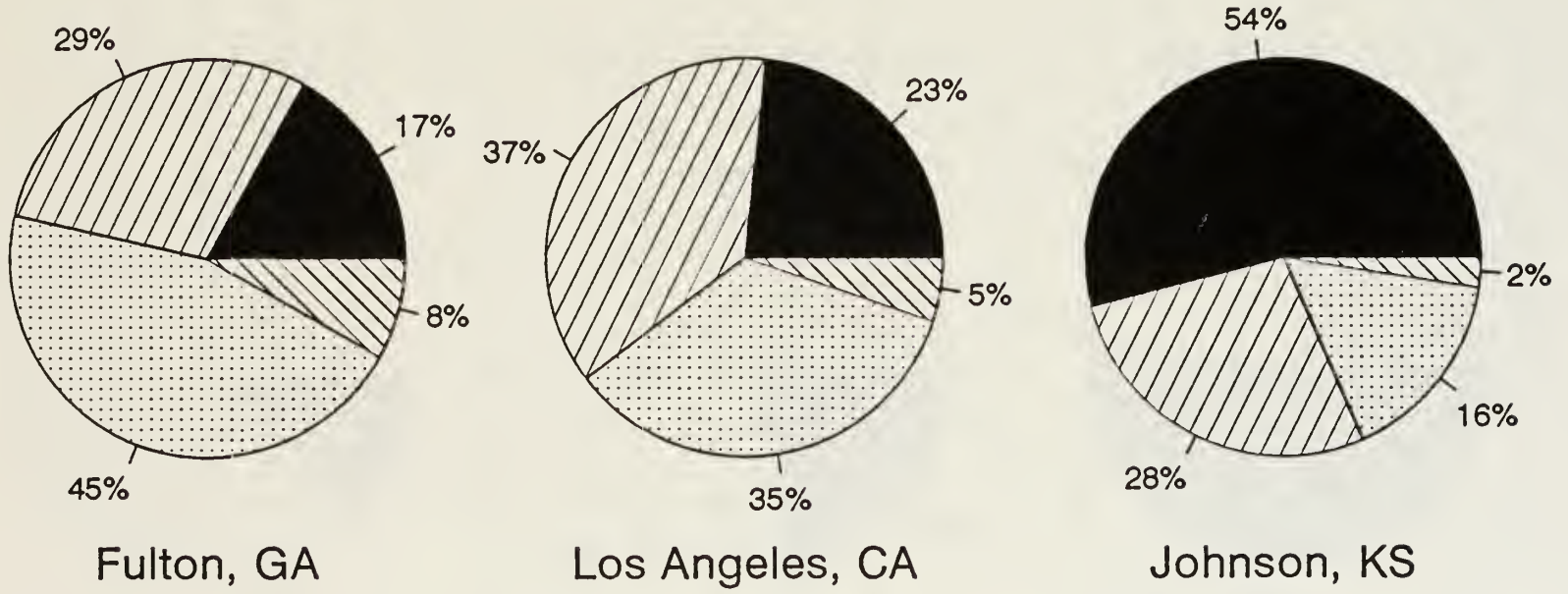
Nuclear Rating / Mental Group Qualification by Race and Gender
1990 Navy Accessions, High School Graduates Age 17 to 21



Note: See Table 10 for number in each gender/race-ethnic group segment.

Figure 8

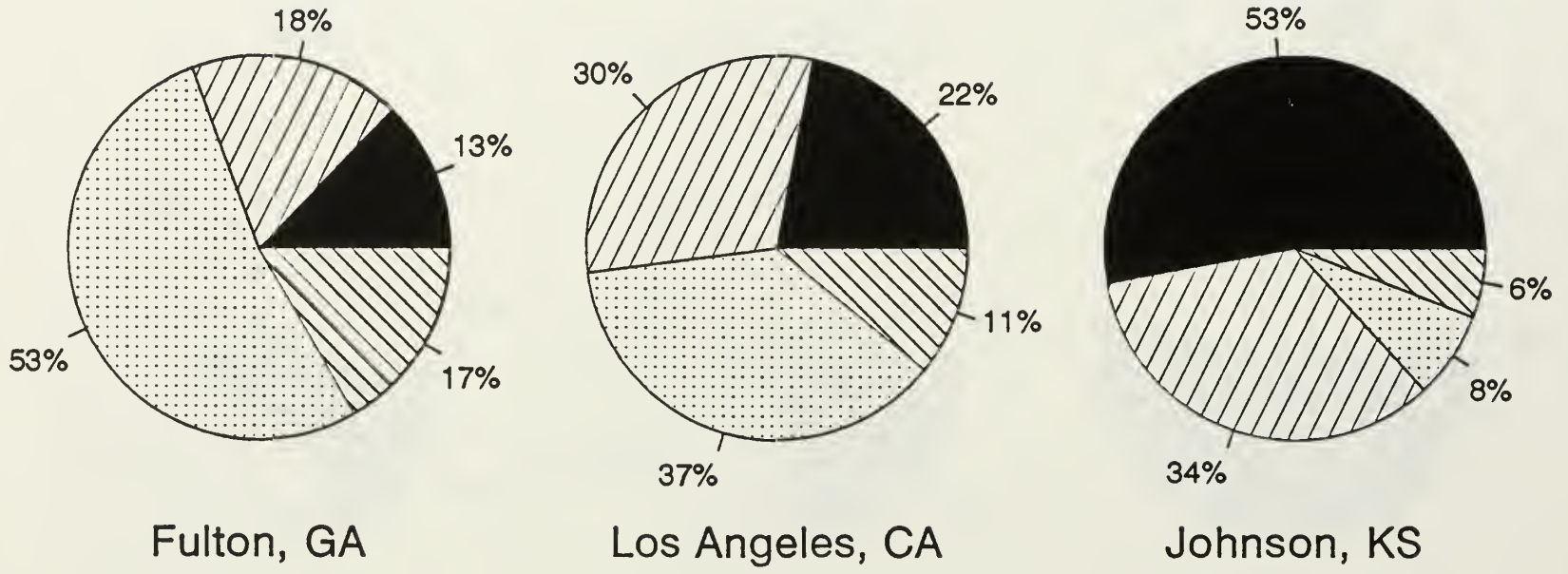
Nuclear Rating/Mental Group Qualification
1990 Male All-Service Accessions, High School Graduates Age 17 to 21
For Selected Counties



(Fulton, n=451; Los Angeles, n=3,456; Johnson, n=167)

Figure 9

Nuclear Rating/Mental Group Qualification
1990 Male Navy Accessions, High School Graduates Age 17 to 21
For Selected Counties



(Fulton, n=173; Los Angeles, n=1,216; Johnson, n=53)

Figure 10

percentage (17 percent). Navy male enlistees from these three counties were similarly distributed among nuclear rating/mental group qualification categories. The number of female accessions in all but the largest counties was so small that similar county comparisons were not feasible.

C. Underlying Enlistee ASVAB Subtest Scores

Underlying the greater similarity in qualification rates among men and women enlistees when compared with their civilian counterparts are more limited gender differences in ASVAB subtest scores used in the composites that screen for highly technical jobs. The relevant composites are: (i) VE+AR; (ii) MK+AS; (iii) AR+2MK+GS; (iv) MK+EI+GS; and (v) MK+EI+GS+AR. Among white all-service enlistees, men score significantly higher than women on all but one (i) of these composites (based on Bonferroni t-tests for all six gender/race-ethnic groups, $p < 0.05$). Black women recruits score significantly higher than black men on two (i and iii) of five composites, but significantly lower on the others. Hispanic women enlistees' scores are not significantly different from Hispanic men's for one (iii) of the composites, but are significantly higher for one (i) and significantly lower for the remainder. For accessions, the electronics information (EI) subtest contributes most to differences in qualification between men and women in all race-ethnic groups.

For male all-service accessions, race-ethnic group differences in subtest scores which affect qualification for highly technical jobs show the same pattern as for civilians, i.e., whites score significantly higher than Hispanics who, in turn, score significantly higher than blacks (based on the same Bonferroni t-tests). Among women all-service accessions, the pattern is the same, with whites' scores significantly higher than Hispanics' on all composites and blacks

scoring significantly lower than Hispanics on all relevant composites. Differences in scores for the arithmetic reasoning (AR) subtest largely accounted for lower qualification rates for black recruits and the general science (GS) and electronic information (EI) subtests contributed to lower rates for Hispanics as well as blacks.

IX. CONCLUSIONS

A. Summary

Estimates of nuclear rating/mental group qualification for counties by gender and race/ethnic group segment were constructed on the basis of ASVAB component scores from the NLSY. A method was developed to utilize county-level sociodemographic values in logistic regression equations estimated with the NLSY data base. Resulting probability estimates for each nuclear rating/mental group category in each gender/race-ethnic group segment in each county were then multiplied by county population projections for each segment to yield county level forecasts. These forecasts of the civilian population distribution among nuclear rating/mental group qualification categories for 1990 were then aggregated and compared with Navy and all-service enlistments for the same year.

Great variation in qualification rates was observed in the civilian population estimates on the basis of gender and race. While 26 percent of men qualified for nuclear occupations, only 3 percent of women were similarly qualified. Eligibility for highly technical jobs was more limited for minorities than for whites. Almost 31 percent of white males and about 4 percent of white females qualified, but only 2.1 percent of black males and 0.3 percent of black females were eligible for nuclear ratings. Hispanics in the civilian population fell between blacks and whites with 10.5 percent of males and 0.6 percent of females in the nuclear qualified category.

Enlistments categorized by nuclear rating/mental group qualification show a pattern of variation by gender and race-ethnic group similar to that found in the civilian population. However, a much greater proportion of enlistees than civilians were nuclear qualified. Almost 34 percent of men and 20.0 percent of women joining the military services in 1990 were nuclear

qualified. The disparity between men and women is strikingly smaller than among the civilian population of high school graduates between 17 and 21 years old. Navy male accessions were 33.5 percent nuclear qualified and women entering the Navy were 17.7 percent qualified for these ratings.

White males were the most likely gender/race-ethnic group segment to be nuclear qualified among all-service recruits, with 41.0 percent in this category. White women were next highest with 26.3 percent, followed by Hispanic males (22.1 percent), Hispanic females (12.5 percent), black males (10.3 percent) and black women (6.2 percent). Qualification rates for nuclear occupations were thus much higher for enlistees than for the civilian population for all gender/race-ethnic group segments. Navy accessions showed the same pattern as all-service accessions by gender and race-ethnic group, but with Hispanic males qualifying at slightly higher rates than white women (27.6 percent vs. 23.0 percent).

B. Implications and Recommendations

A comparison of the 17 to 21 year old civilian high school graduate population with 17 to 21 year old high school graduate enlistments on the basis of nuclear qualification indicates that the pool of qualified white women and minorities of both genders is relatively limited, but that the services, including the Navy, have attracted a very "technically trainable" force with representation from all gender/race-ethnic group segments including larger proportions of nuclear rating eligible recruits in each segment than are present in the civilian population.

Enlistment standards, for the most part, limit recruits to mental categories IIIB and above. Recruiting effort and enlistment incentives directed toward high quality (IIIA and above) youth help in attracting these targeted individuals as may such exogenous factors as poor civilian

labor market conditions and the stagnant or slow growing level of general economic activity.

As the youth labor force changes in race-ethnic group composition over the next decade to include a larger proportion of minority members, the nuclear qualified civilians will make up a smaller percentage of the total market. Thus, the pool of qualified individuals will be (relatively) smaller at a time when technical requirements for military occupations are expected to increase.

The opening up of some nuclear fields to women may help to meet the demand for those qualified for highly technical fields, though a much smaller percentage of women than men in the civilian population are eligible. Although young women tend to have limited interest in nontraditional jobs, higher-ability women show a greater tendency to choose sex-atypical occupations (Waite and Berryman 1985). In addition, a larger percentage of the female youth labor force will be accounted for by minority women who have the lowest qualification rates among gender/race-ethnic group segments. Despite these barriers, minority women comprise a larger proportion of the military work force than they do of the civilian labor force and they are more likely to work in nontraditional jobs than their civilian counterparts (Moore 1991; Firestone 1992).

The evolution to a system of job placement which favors white males is not surprising, given the historical predominance of white men in the U.S. military. It is similar to that found in the selection procedures of educational institutions and civilian employers and it challenges the military to construct cost effective screening criteria for technical training that permit an expanded opportunity for women and minorities. The Navy has made great strides in recent years in opening career fields to women and in recognizing the need to increase minority

representation in many occupations. Continued reliance on occupational screens emphasizing such dimensions as arithmetic reasoning, electronics information, and auto shop knowledge goes counter to the egalitarian philosophy of reducing gender and race-ethnic group membership as a basis for occupational eligibility in today's Navy. Such reliance should be altered or augmented to assure the acquisition and training of a highly skilled Navy of the future. A closer evaluation of the ASVAB subtest scores which are effectively screening out women and minorities from technical training and occupations is warranted. Alternative cost effective screening criteria and training programs that permit an expanded opportunity for females and minorities for technical occupations should be explored.

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APPENDIX A
REGIONAL NUCLEAR RATING/MENTAL GROUP QUALIFICATION DISTRIBUTIONS

TABLE A-1
U.S. BUREAU OF CENSUS CLASSIFICATION OF STATES BY REGION

Region	States	
NORTH CENTRAL	Illinois	Missouri
	Indiana	Nebraska
	Iowa	North Dakota
	Kansas	Ohio
	Michigan	South Dakota
	Minnesota	Wisconsin
NORTHEAST	Connecticut	New Jersey
	Maine	New York
	Massachusetts	Pennsylvania
	New Hampshire	Rhode Island
		Vermont
SOUTH	Alabama	Maryland
	Arkansas	Mississippi
	Delaware	North Carolina
	District of Columbia	Oklahoma
	Florida	South Carolina
	Georgia	Tennessee
	Kentucky	Texas
	Louisiana	Virginia
		West Virginia
WEST	Alaska	Montana
	Arizona	Nevada
	California	New Mexico
	Colorado	Oregon
	Hawaii	Utah
	Idaho	Washington
		Wyoming

Estimated Nuclear Rating/Mental Group Qualification
Male High School Graduates Age 17 to 21
By Census Region

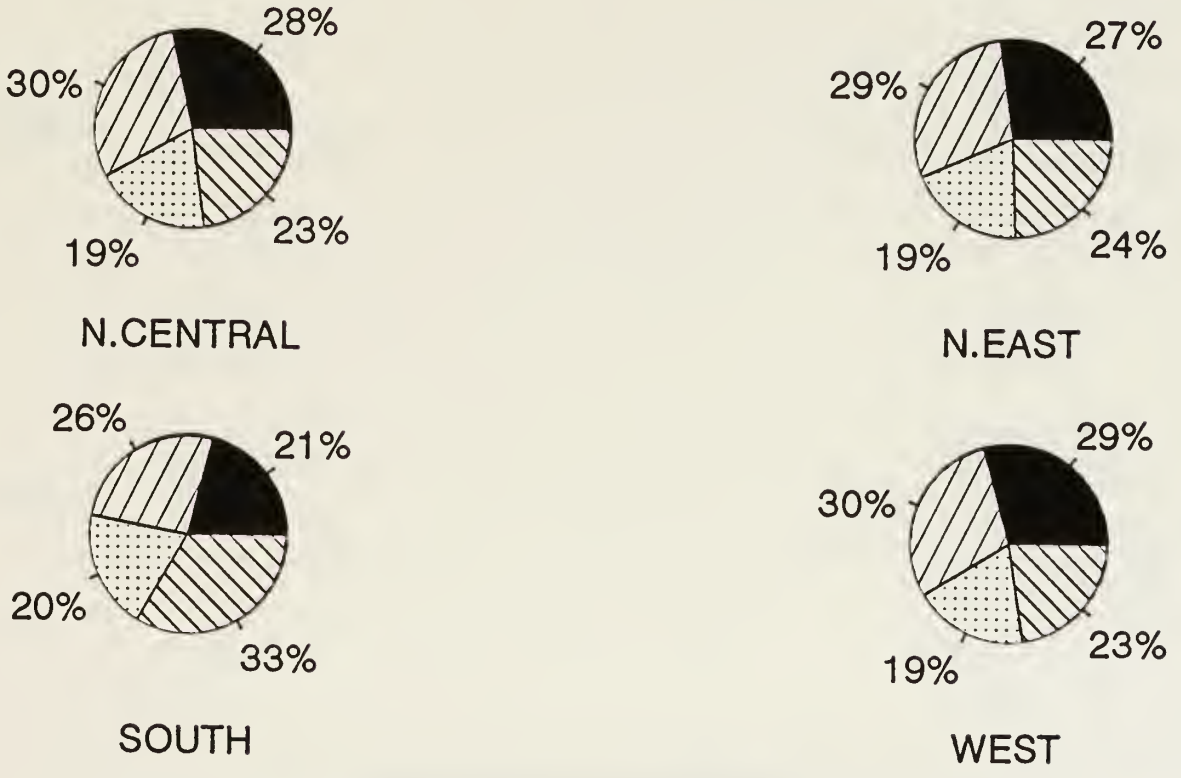


Figure A-1

Estimated Nuclear Rating/Mental Group Qualification
Female Civilian High School Graduates Age 17 to 21
By Census Region

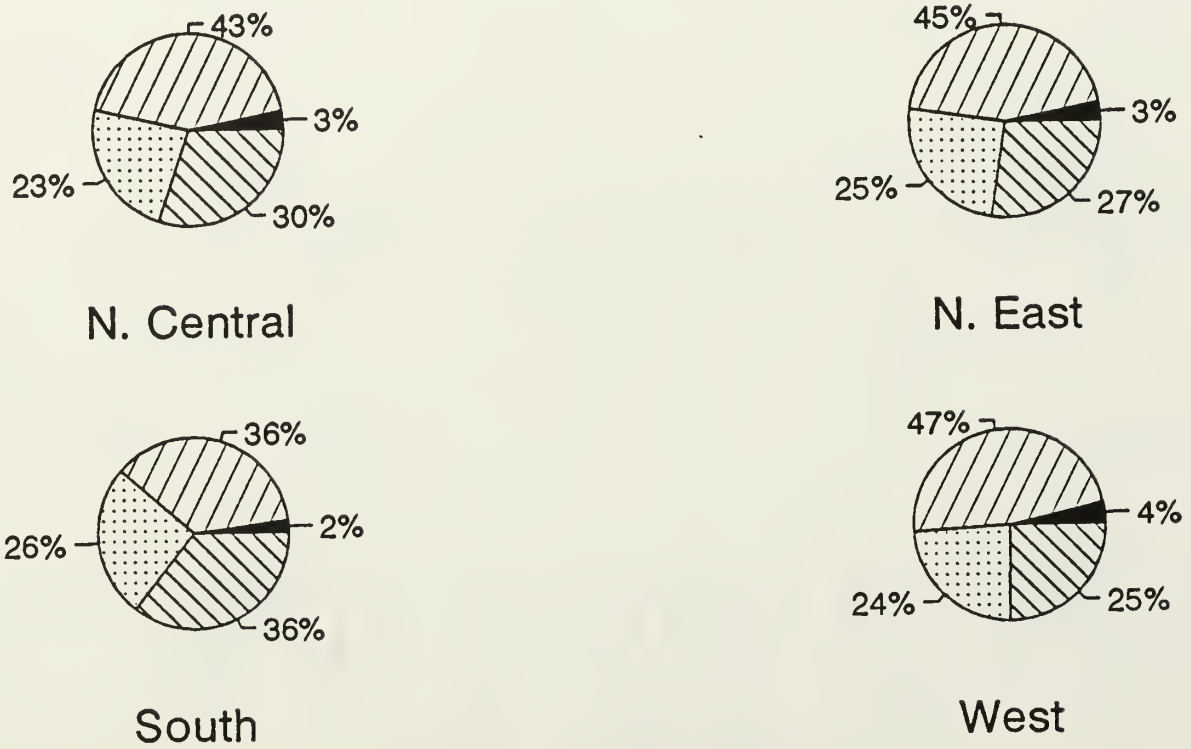
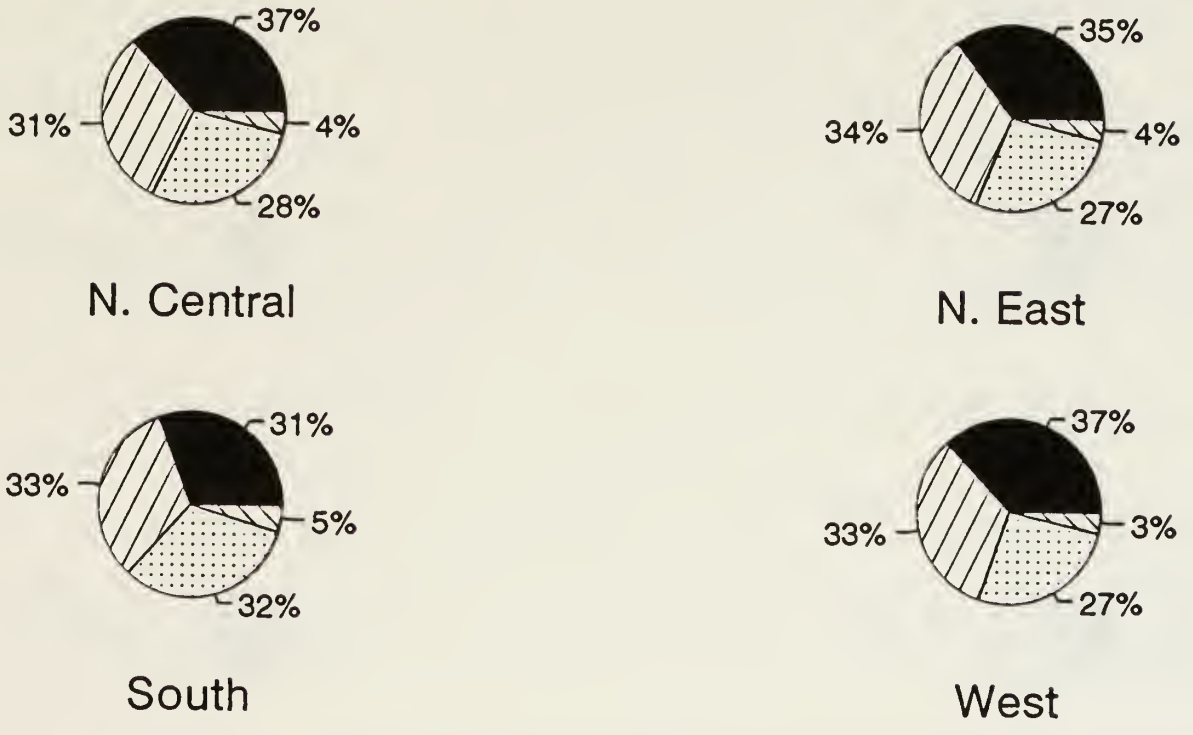


Figure A-2

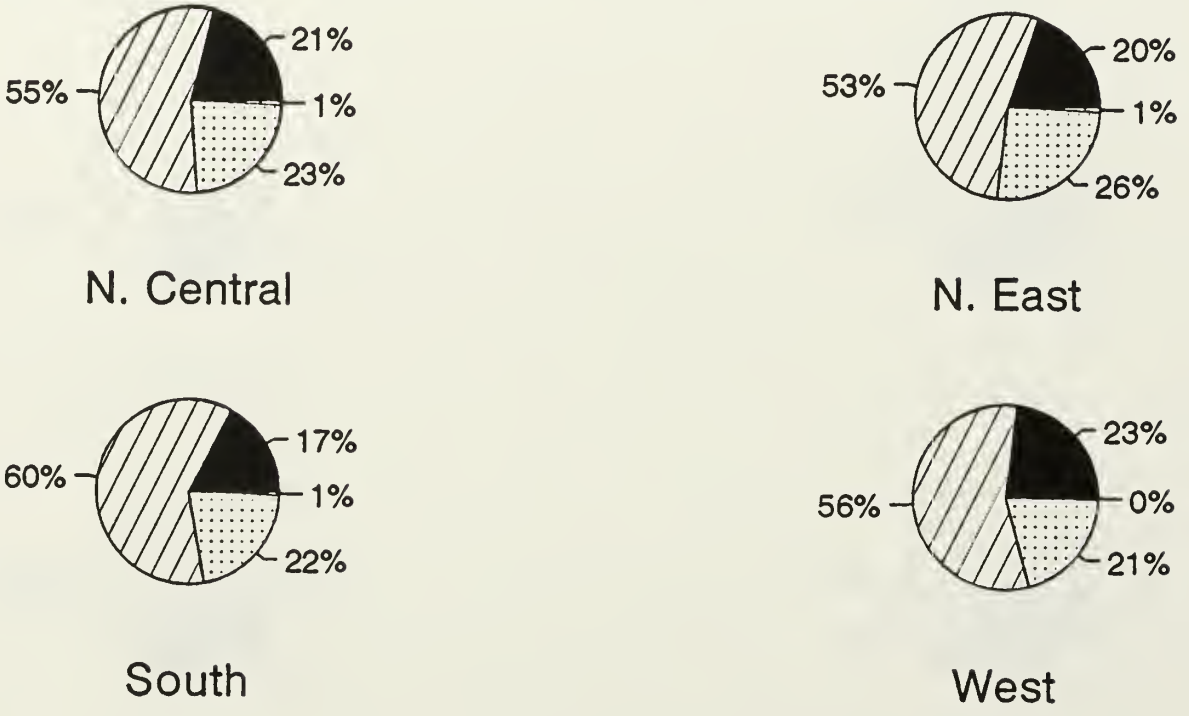
Nuclear Rating/Mental Group Qualification, 1990 All-Service Accessions
Male High School Graduates Age 17 to 21
By Census Region



(N. Central, N=42,009; N. East, N=24,060; South, N=65,804; West, N=29,418)

Figure A-3

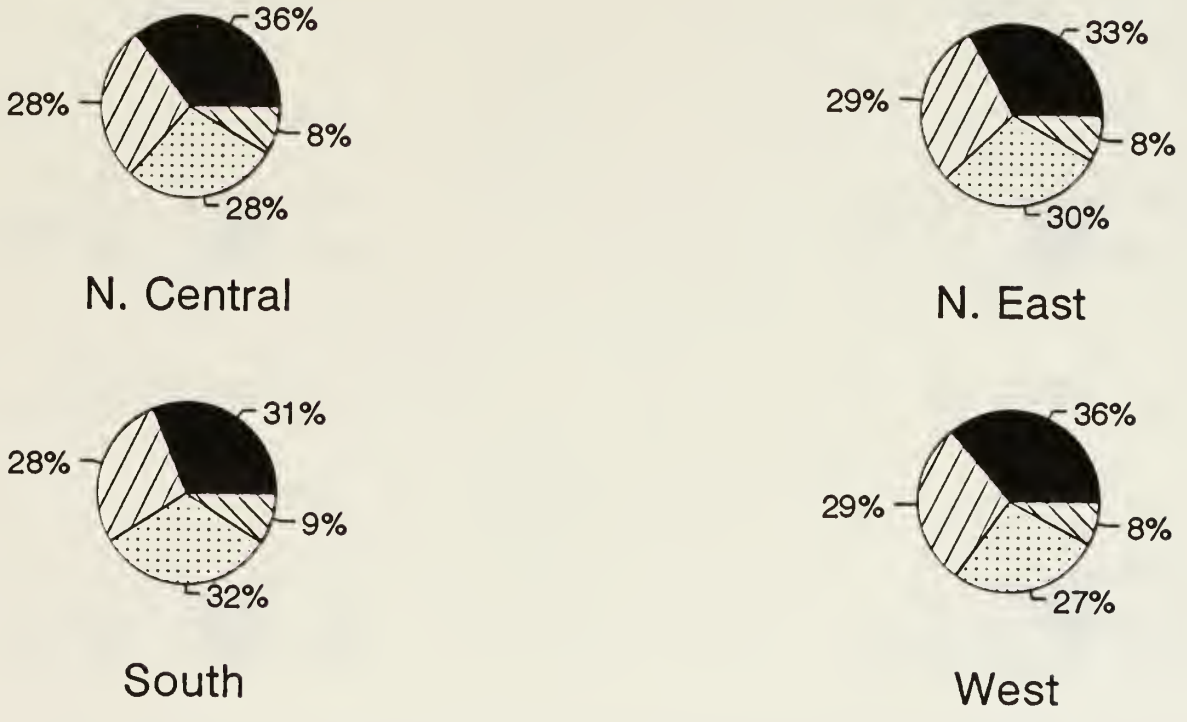
Nuclear Rating/Mental Group Qualification, 1990 All-Service Accessions
Female High School Graduates Age 17 to 21
By Census Region



(N. Central, N=5,919; N. East, N=3,195; South, N=9,310; West, N=4,233)

Figure A-4

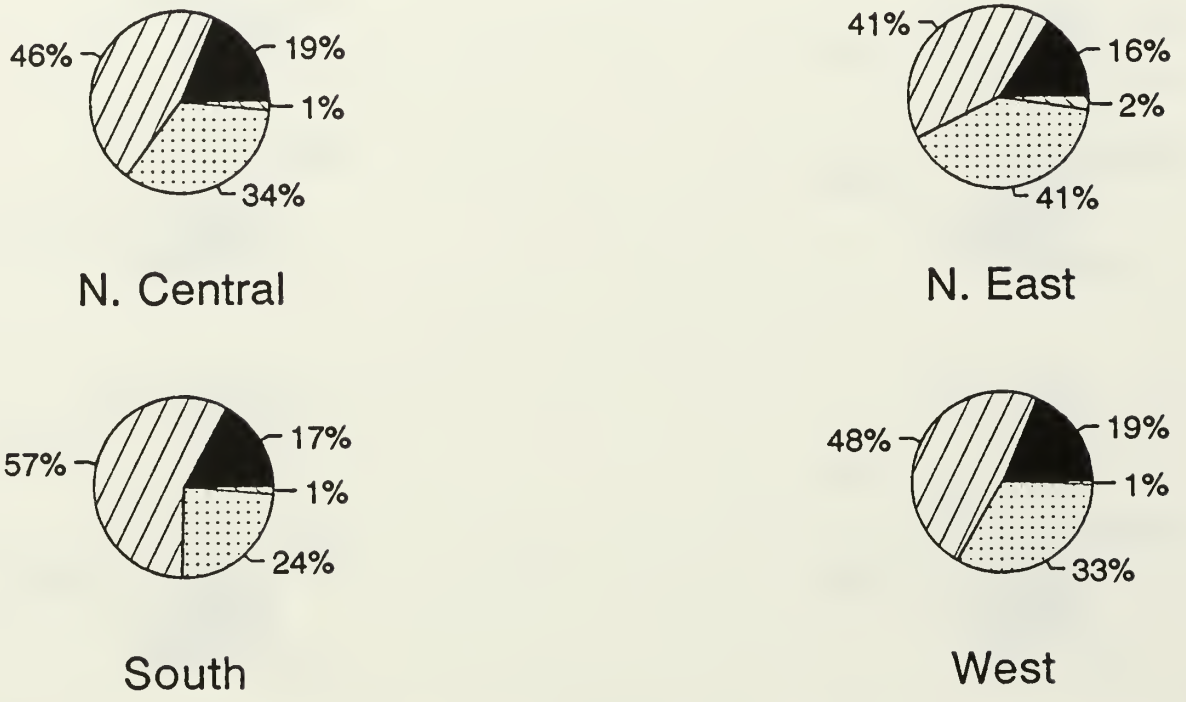
Nuclear Rating/Mental Group Qualification, 1990 Navy Accessions
Male High School Graduates Age 17 to 21
By Census Region



(N. Central, N=12,977; N. East, N=7,161; South, N=21,994; West, N=10,300)

Figure A-5

Nuclear Rating/Mental Group Qualification, 1990 Navy Accessions
Female High School Graduates Age 17 to 21
By Census Region



(N. Central, N=1,718; N. East, N=928; South, N=2,286; West, 1,222)

Figure A-6

APPENDIX B

SHRINKAGE OF 1990 ALL-SERVICE AND NAVY ACCESSIONS

Shrinkage of 1990 All-Service White Accessions
High School Graduates Age 17 to 21
By Gender

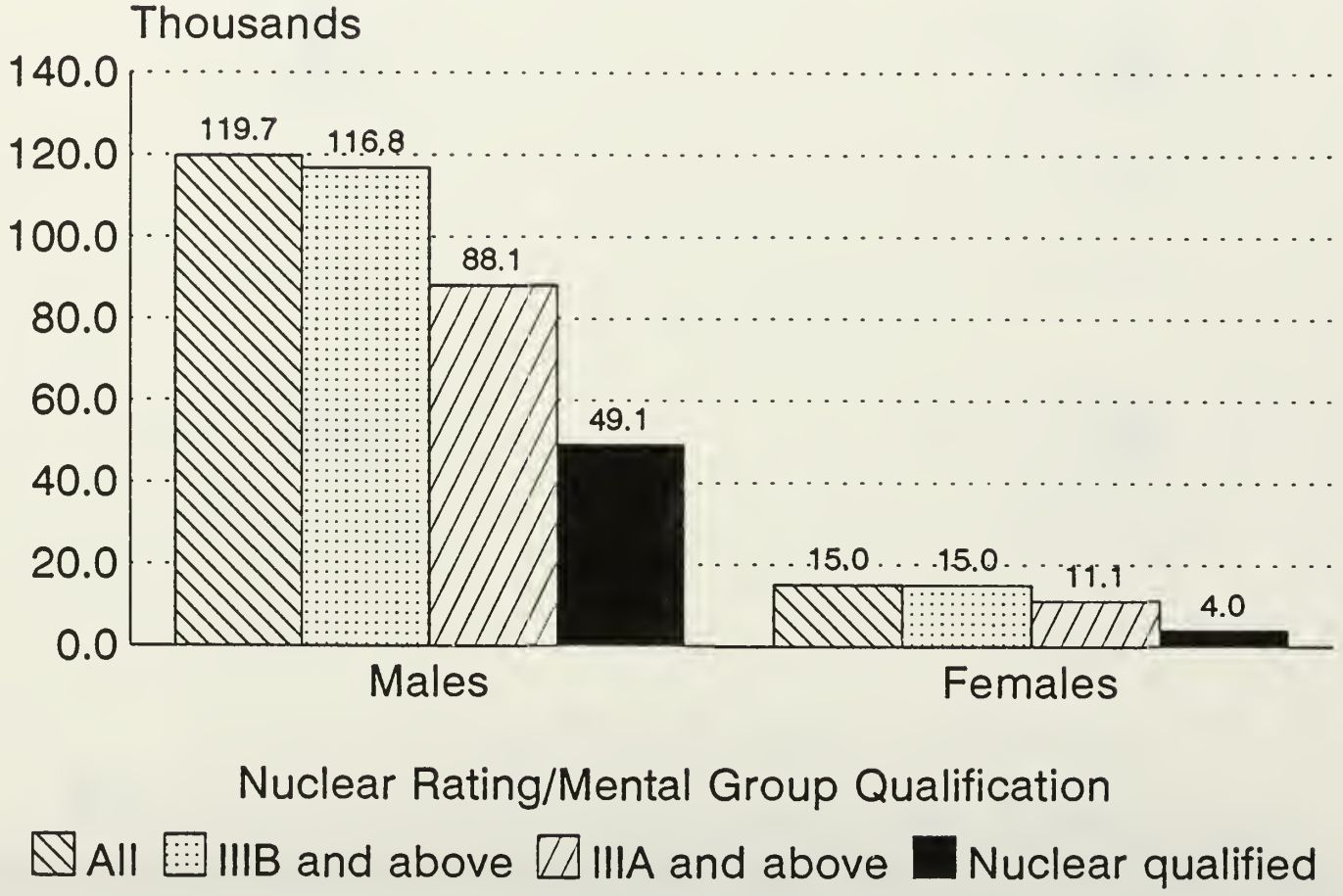


Figure B-1

Shrinkage of 1990 White Navy Accessions
High School Graduates Age 17 to 21
By Gender

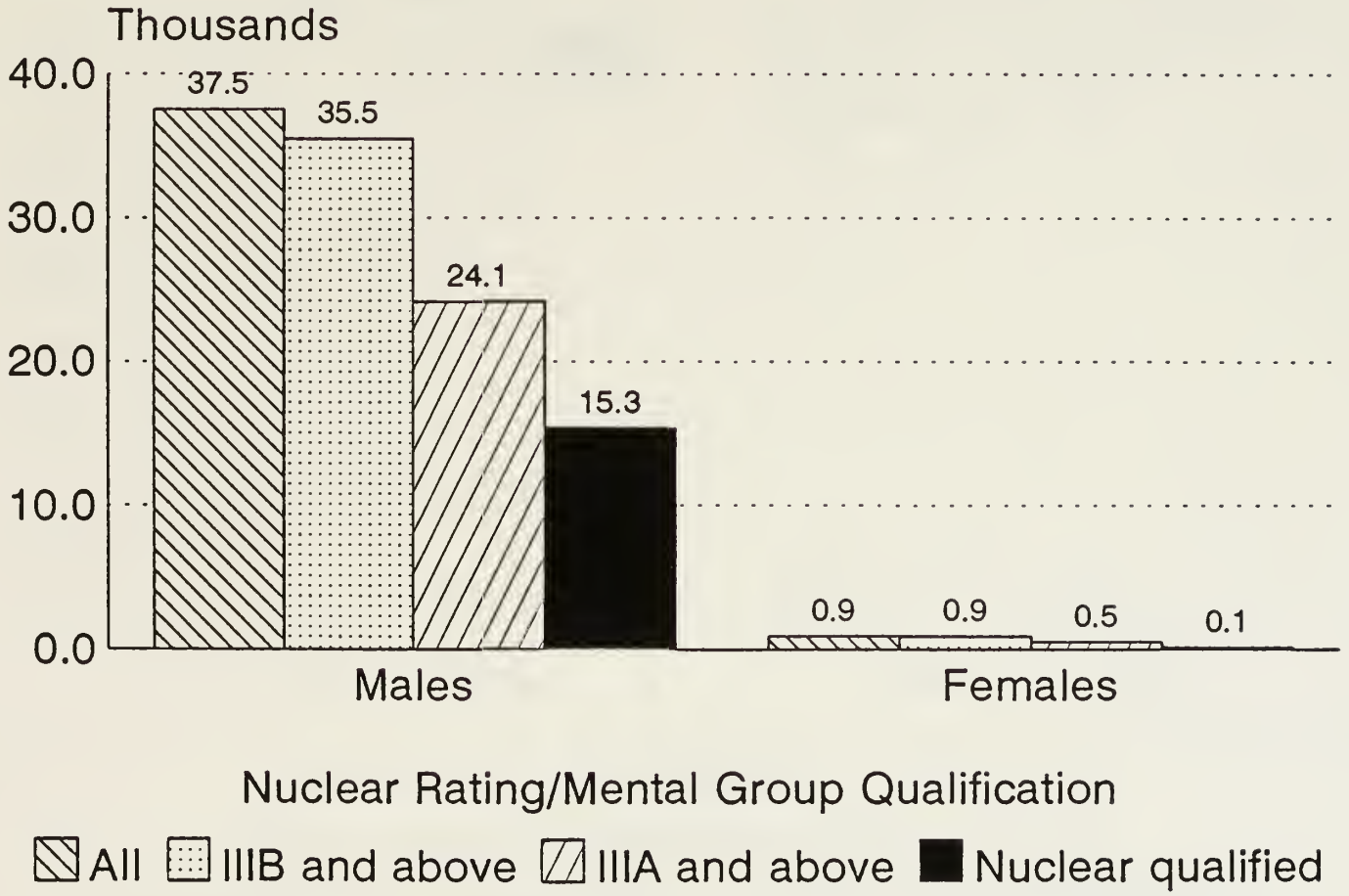


Figure B-2

Shrinkage of 1990 Black All-Service Accessions
High School Graduates Age 17 to 21
By Gender

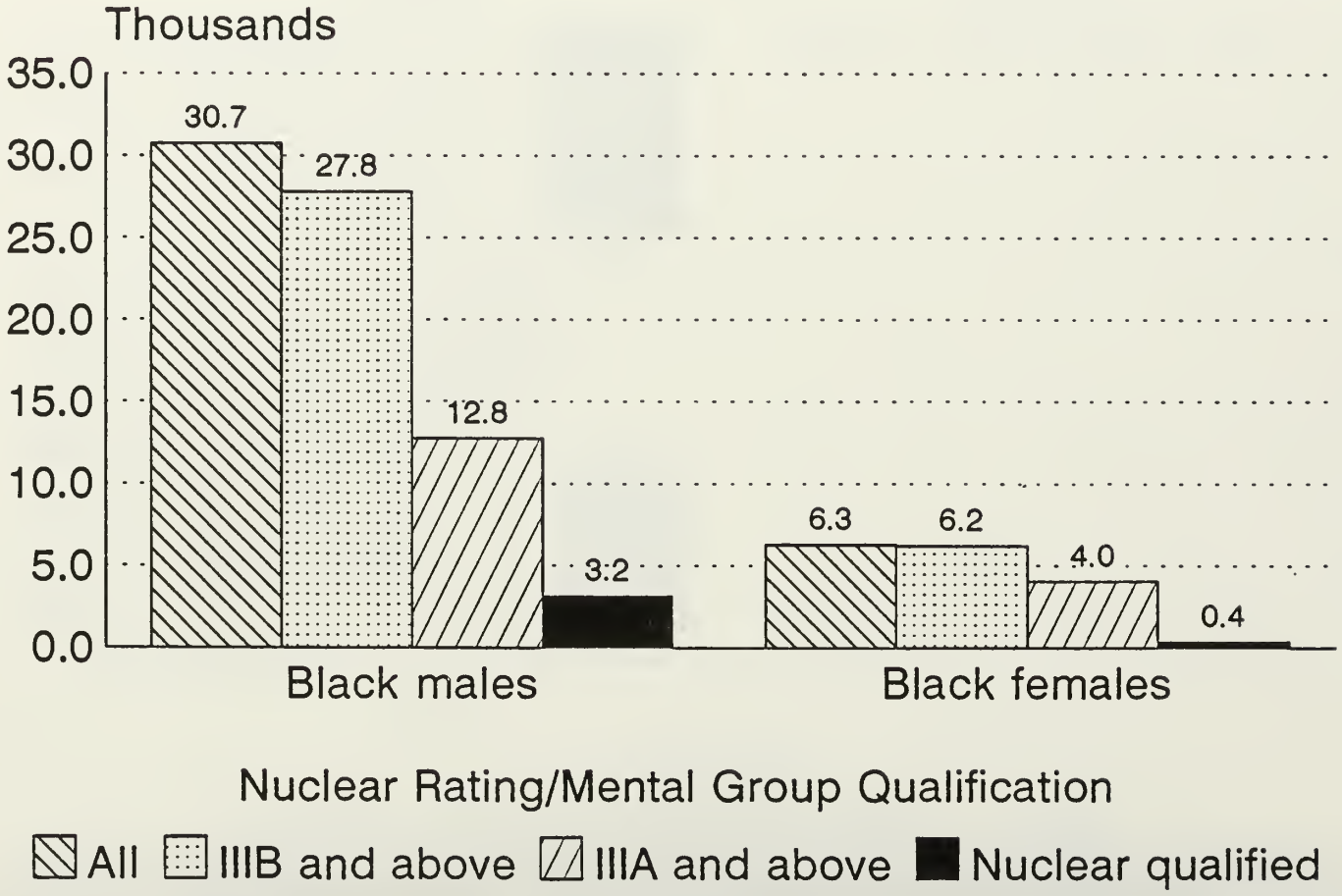


Figure B-3

Shrinkage of 1990 Black Navy Accessions
High School Graduates Age 17 to 21
By Gender

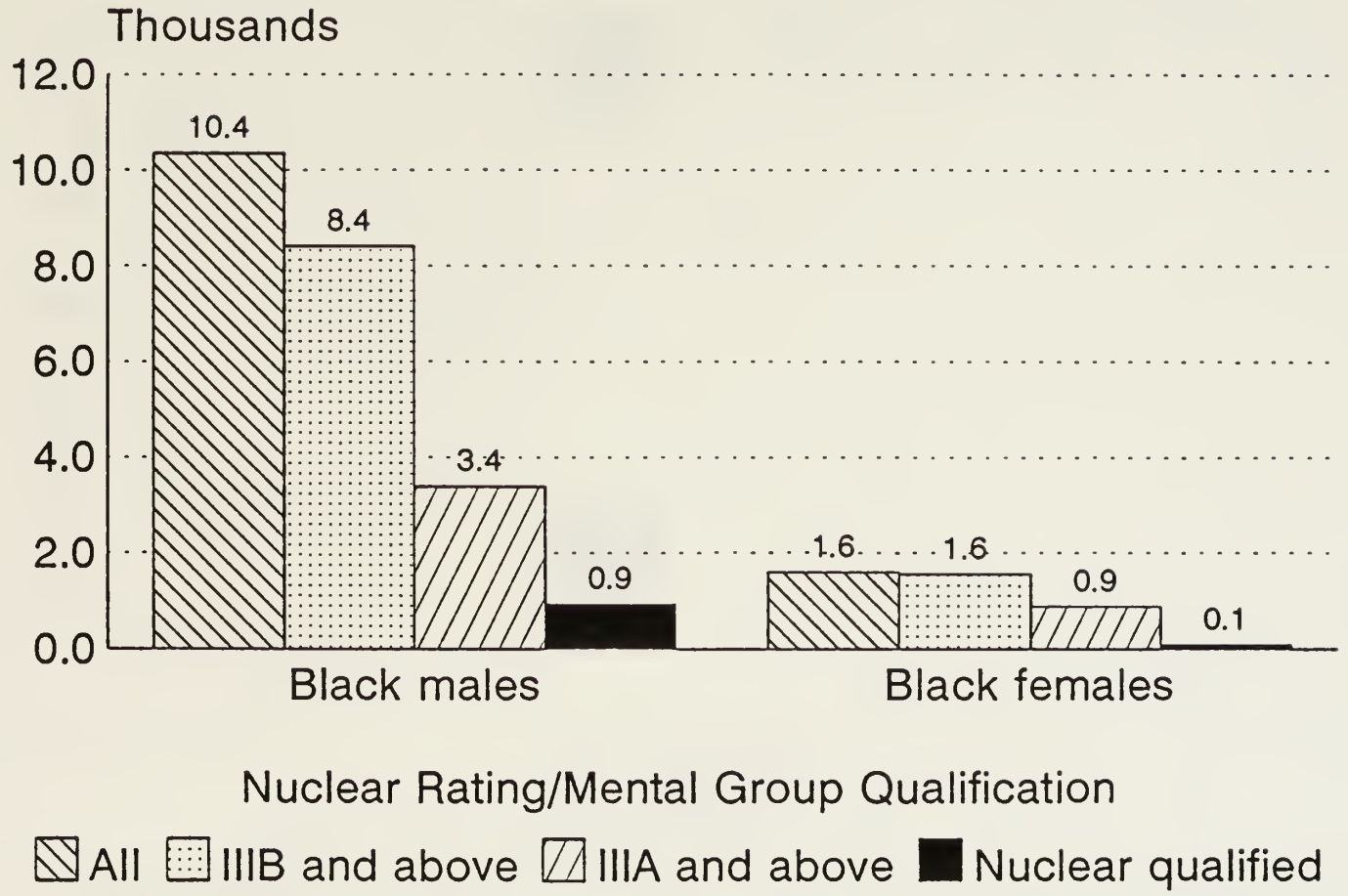


Figure B-4

Shrinkage of 1990 Hispanic All-Service Accessions
High School Graduates Age 17 to 21
By Gender

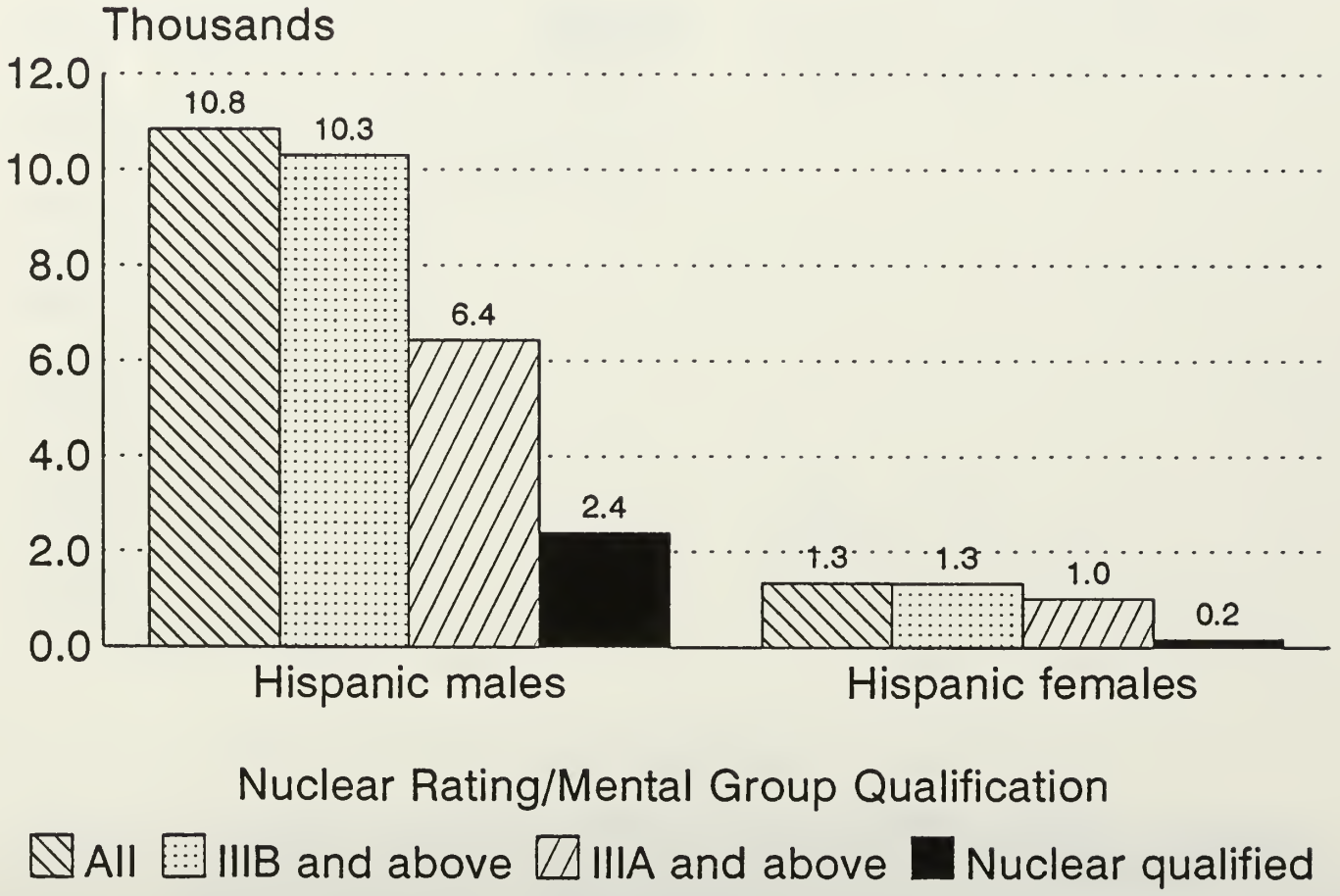


Figure B-5

Shrinkage of 1990 Hispanic Navy Accessions
High School Graduates Age 17 to 21
By Gender

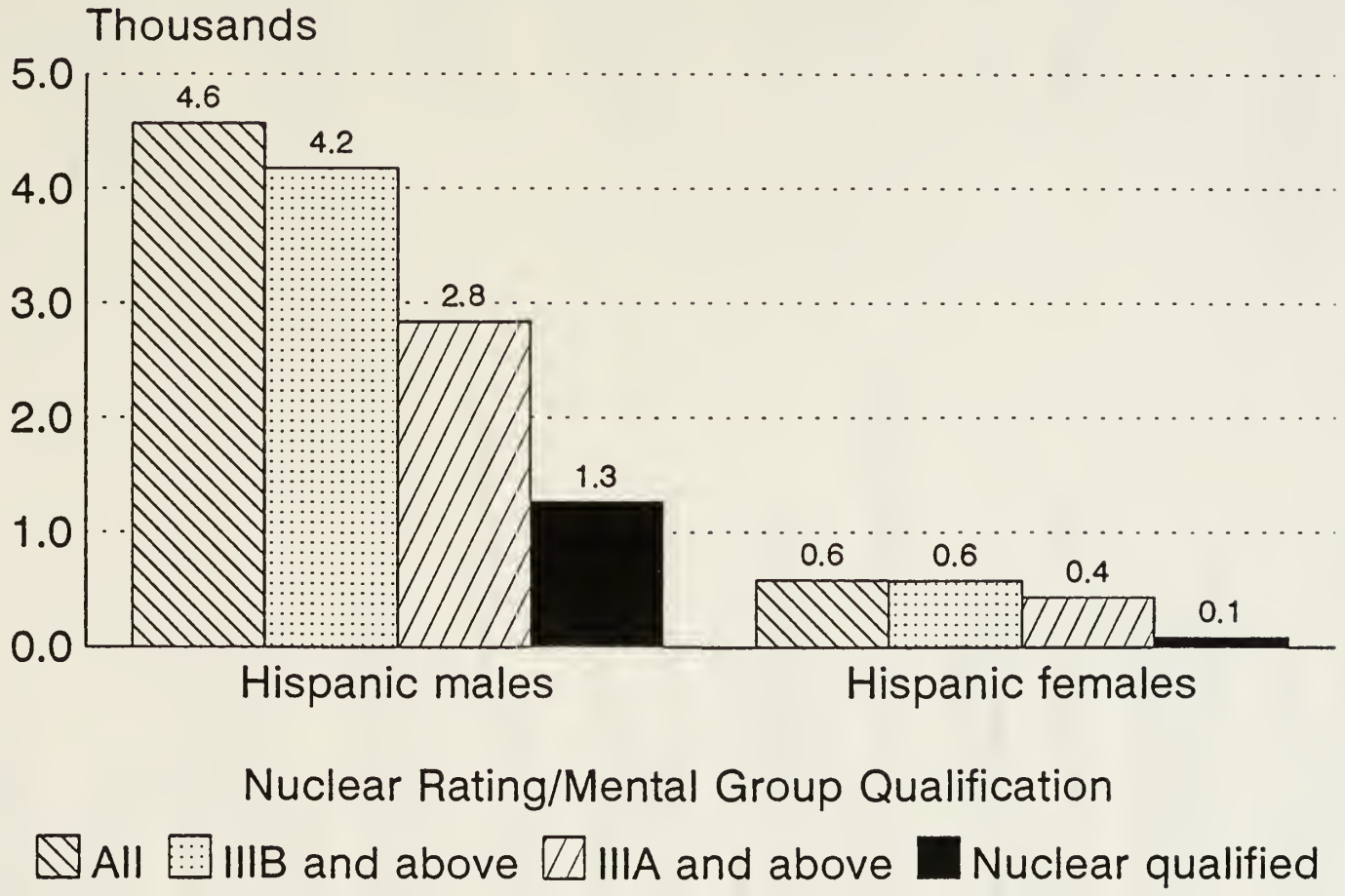


Figure B-6

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