

Sociodemographic Predictors of Muscle Strengthening Activity in U.S. Adults: NHIS 2022

Peter D. Hart*

Exercise Science, Glenville State University, Glenville, West Virginia, USA
Health Promotion Research, Havre, Montana, USA
Kinesmetrics Lab, Tallahassee, Florida, USA
*Corresponding author: pdhart@outlook.com

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Abstract Background: Current guidelines for muscle strengthening activity (MSA) include two or more days per week of physical activities specifically designed to strengthen muscles such as sit-ups, push-ups, or lifting weights. Knowledge regarding subpopulations of adults that are more or less likely to adopt MSA recommendations can be helpful for health promotion programming. The purpose of this study was to examine the sociodemographic predictors of MSA in U.S. adults. **Methods:** Data for this study came from the CDC's 2022 National Health Interview Survey (NHIS). A total of 27,651 adult participants 18+ years of age were initially included. The primary outcome variable was meeting MSA guidelines status of 2+ days per week of MSA. Sociodemographic predictor variables included age group, sex, race/ethnicity, education, income quartile, marital status, and school status. Poisson regression models with robust error variance were used to compute relative risk (RR) ratios and 95% confidence intervals (CIs). **Results:** Overall, less than a third of adults met recommended amounts of MSA (30.6%, 95% CI: 29.8 – 31.4) with significant differences ($p < .05$) found within all sociodemographic variables. Multivariate models showed that male, younger, Black, graduate degree holding, higher income, non married, and school attending adults were significantly more likely to meet MSA guidelines than their respective counterparts. Additionally, an income quartile-by-sex interaction effect ($p < .0001$) revealed a greater linear trend of modeled predicted probabilities for males across income quartiles than females. **Conclusion:** These results indicate that several different subpopulations engage in recommended amounts of MSA in greater proportion than others. All disparities remained after adjusting for all other sociodemographic variables. Health promotion and policy efforts to increase MSA should especially be directed toward older, less educated, and lower income adults

Keywords: Physical activity (PA), Muscle strengthening activity (MSA), NHIS, Demography

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1. Introduction

The Physical Activity Guidelines for Americans (2nd Edition) includes recommendations for aerobic physical activity (PA) as well as muscle-strengthening activity (MSA) [1]. MSA consist of resistance training exercises using machines, weights, elastic bands, or one's own body with the intent to improve or maintain muscular fitness. Similar to PA, MSA can take the form of a regimented exercise program or a less structured activity such as recreational play, work tasks, or household chores. The current guidelines for MSA recommend doing muscle-strengthening activities of at least moderate intensity involving all major muscle groups on 2+ days a week.

MSA is contained within these guidelines because of the overwhelming evidence supporting its positive effects on health and well-being [2,3,4]. Additionally, the U.S. Department of Health and Human Services has issued national-level goals to increase the percentage of adults

meeting MSA guidelines to over 36%, included in the *Healthy People 2030* program [5]. MSA has increased in U.S. adults in recent years, with approximately 17% meeting MSA guidelines in 1998 to approximately 27-30% meeting guidelines in 2018 [6,7]. With less than a third of adults meeting these important guidelines and given national-level goals prioritizing the activity, knowledge of specific subpopulations that are more or less likely to meet MSA guidelines can be helpful for health promotion intervention planning. Therefore, the aim of this study was to examine the sociodemographic predictors of MSA in the entire U.S. adult population.

2. Materials & Methods

Study Procedures

Cross-sectional data from the 2022 National Health Interview Survey (NHIS) were used for this study. Details regarding the NHIS are explained elsewhere [8,9]. Briefly, NHIS is conducted by the National Center for Health

Statistics (NCHS), Centers for Disease Control and Prevention (CDC). NHIS is a primary source of data on the health of the civilian noninstitutionalized population of the U.S., collected through personal household interviews. Health variables range from health behaviors (alcohol use, tobacco use, physical activity) to health status indicators (chronic diseases, blood pressure, cholesterol, BMI, etc.). This study used data from the *Sample Adult Interview* portion of NHIS. This resulted in 27,651 adult participants 18+ years of age entering the study's analysis.

Muscle Strengthening Activity

To assess MSA behavior, respondents were asked how many times (per day, week, month, year) they participated in leisure-time physical activities specifically designed to strengthen their muscles (such as sit-ups, push-ups or lifting weights). Answers to this question were then used to categorize participants into one of two MSA groups: 1) those meeting MSA guidelines (participating in MSA 2+ days per week) or 2) those not meeting MSA guidelines (participating in MSA < 2 days per week).

Sociodemographic variables

All sociodemographic variables in this study were used as categorical variables and included age group, sex, race/ethnicity, education, income quartile, marital status, and school status. Age was categorized as three distinct groups: 1) 18 to 44 years, 2) 45 to 54 years, and 3) 65 to 85+ years. Sex was used as 1) male and 2) female. Race/ethnicity was categorized as four distinct groups: 1) White, 2) Black, 3) Hispanic, and 4) Other. Education was categorized as four distinct groups: 1) less than high school (HS) graduate, 2) HS graduate to Associate degree, 3) Bachelor's degree, and 4) graduate degree. Income was categorized into quartiles using the ratio of family income to poverty threshold variable. Income quartiles were not exactly evenly distributed and should be considered approximate, ranging from the lowest household incomes (1st quartile) to the highest household incomes (4th quartile). Married status was categorized into two groups: 1) those that are married or living together with a partner as an unmarried couple, and 2) those not married. School status was categorized into two groups of 1) those attending school and 2) those not. For this variable, school was considered high school, college, trade, or professional school and could be part-time or full-time status.

Statistical Analysis

Statistical analysis for this study included descriptive statistics in the form of weighted percentages with 95% confidence intervals (CI). The Rao-Scott chi-square statistic was used to test for dependence/difference between bivariate categorical variables. The relationships between MSA status and the sociodemographic variables were examined using four different sets of regression models: a) bivariate unadjusted logistic regression models, b) all demographics adjusted logistic regression models, c) bivariate unadjusted Poisson regression models, and d) all demographics adjusted Poisson regression models. Logistic regression models were used to estimate odds ratios (ORs) and 95% CIs. Poisson regression models were used to estimate relative risk (RR) ratios (aka, prevalence ratios [PRs]) and 95% CIs. The main difference between the OR and RR is that the OR

compares the *odds* of two different groups and the RR compares the *risk* estimates (or prevalences) of two different groups. The RR is sometimes preferred because of the difficulty interpreting an odds. However, each odds in an OR assesses a group's risk relative to its non-risk and the OR can then be intuitively interpreted as a proportion that compares two odds. Regardless, Poisson models were modified to include a robust error variance procedure to adjust for equidispersion [10,11]. Finally, to test the moderating effect of sex on the income quartile and MSA relationship, an income quartile-by-sex interaction term was tested with linear contrasts added for a trend test across the income quartile categories. Significance was set to $p < .05$ and SAS version 9.4 with survey procedures used for all analyses [12,13].

3. Results

Table 1 contains the weighted percentages of adult MSA status within sociodemographic subpopulations in 2022. Overall, less than a third of adults met recommended amounts of MSA (30.6%, 95% CI: 29.8 – 31.4) with significant differences ($p < .05$) found in all sociodemographic variables. Specifically, adults 65 to 85+ years of age (20.7%, 95% CI: 19.6 – 21.8), with education less than a HS degree (16.2%, 95% CI: 14.5 – 17.8), and from lower household income (20.4%, 95% CI: 19.1 – 21.7) had the lowest rates of meeting MSA guidelines.

Table 2 contains the unadjusted bivariate models associating sociodemographic predictors with MSA status, with the lowest MSA prevalence groups serving as reference. These models indicate that adult males (RR: 1.31, 95% CI: 1.26 – 1.37), aged 18 to 44 years (RR: 1.85, 95% CI: 1.75 – 1.96), of Black race (RR: 1.13, 95% CI: 1.04 – 1.24), with graduate degrees (RR: 2.55, 95% CI: 2.28 – 2.86), of highest household income (RR: 2.00, 95% CI: 1.87 – 2.14), who are not married (RR: 1.10, 95% CI: 1.06 – 1.15), and are in school (RR: 1.63, 95% CI: 1.53 – 1.74) were most likely to meet MSA guidelines, as compared to their associated reference group. The same sociodemographic groups had increased odds of meeting MSA guidelines with moderately greater magnitude than RR values, representing greater chance of higher odds for meeting guidelines.

Table 3 contains the adjusted multivariate models relating sociodemographic predictors to MSA status, with the lowest adjusted MSA prevalence group serving as reference. Similar results were found as those from the bivariate models. Specifically, adult males (RR: 1.28, 95% CI: 1.22 – 1.33), aged 18 to 44 years (RR: 1.67, 95% CI: 1.58 – 1.77), of Black race (RR: 1.24, 95% CI: 1.13 – 1.37), with graduate degrees (RR: 2.05, 95% CI: 1.82 – 2.30), of highest household income (RR: 1.70, 95% CI: 1.58 – 1.84), who are not married (RR: 1.16, 95% CI: 1.11 – 1.21), and are in school (RR: 1.36, 95% CI: 1.27 – 1.46) were most likely to meet MSA guidelines, as compared to their associated reference group. Again, the same sociodemographic groups had increased odds of meeting MSA guidelines with moderately greater magnitude than RR values, representing greater chance of higher odds for meeting guidelines.

Table 1. Sociodemographic characteristics of sample participants by MSA status, NHIS 2022

Characteristic	Meets MSA guidelines				Does not meet MSA guidelines				p
	%	SE	LL	UL	%	SE	LL	UL	
Overall (N = 26,494)	30.6	0.42	29.8	31.4	69.4	0.42	68.6	70.2	<.0001
Sex									<.0001
Male	34.8	0.56	33.7	35.9	65.2	0.56	64.1	66.3	
Female	26.6	0.48	25.6	27.5	73.4	0.48	72.5	74.4	
Age (yr)									<.0001
18 to 44	38.3	0.62	37.1	39.5	61.7	0.62	60.5	62.9	
45 to 64	26.4	0.61	25.2	27.6	73.6	0.61	72.4	74.8	
65 to 85+	20.7	0.55	19.6	21.8	79.3	0.55	78.2	80.4	
Race/Ethnicity									.0099
White	31.1	0.51	30.1	32.1	68.9	0.51	67.9	69.9	
Black	31.8	1.15	29.6	34.1	68.2	1.15	65.9	70.4	
Hispanic	28.1	0.94	26.2	29.9	71.9	0.94	70.1	73.8	
Other	29.9	1.06	27.8	32.0	70.1	1.06	68.0	72.2	
Education									<.0001
Less than HS graduate	16.2	0.83	14.5	17.8	83.8	0.83	82.2	85.5	
HS graduate to Associate degree	27.8	0.51	26.8	28.8	72.2	0.51	71.2	73.2	
Bachelor's degree	40.5	0.76	39.0	42.0	59.5	0.76	58.0	61.0	
Graduate degree	41.3	0.91	39.5	43.1	58.7	0.91	56.9	60.5	
Income quartile ^a									<.0001
1st	20.4	0.66	19.1	21.7	79.6	0.66	78.3	80.9	
2nd	26.2	0.70	24.8	27.5	73.8	0.70	72.5	75.2	
3rd	31.8	0.83	30.1	33.4	68.2	0.83	66.6	69.9	
4th	40.7	0.70	39.4	42.1	59.3	0.70	57.9	60.6	
Marital status ^b									<.0001
Married	32.4	0.60	31.3	33.6	67.6	0.60	66.4	68.7	
Not married	29.4	0.52	28.3	30.4	70.6	0.52	69.6	71.7	
School status ^c									<.0001
In school	47.3	1.54	44.3	50.3	52.7	1.54	49.7	55.7	
Not in school	29.0	0.42	28.2	29.8	71.0	0.42	70.2	71.8	

Note. ^aIncome quartile is approximate quartile categories for the ratio of family income to poverty threshold. ^bMarried status includes those that are living with a partner together as an unmarried couple. ^cSchool status includes high school, college, trade school, and professional school and may be enrolled part-time or full-time. p-value is for the Rao-Scott chi-square statistic. % is the weighted percentage estimate. SE is the standard error for the %. LL and UL are the lower and upper limits, respectively, of the 95% confidence interval (CI) estimating the %

Table 2. Bivariate models associating sociodemographic predictors with MSA status, NHIS 2022

Characteristic	Logistic			Poisson		
	OR	LL	UL	RR	LL	UL
Sex						
Male	1.48	1.40	1.57	1.31	1.26	1.37
Female	1.00		ref	1.00		ref
Age (yr)						
18 to 44	2.38	2.20	2.58	1.85	1.75	1.96
45 to 64	1.38	1.27	1.50	1.28	1.20	1.36
65 to 85+	1.00		ref	1.00		ref
Race/Ethnicity						
White	1.16	1.05	1.28	1.11	1.04	1.18
Black	1.20	1.05	1.37	1.13	1.04	1.24
Hispanic	1.00		ref	1.00		ref
Other	1.09	0.96	1.25	1.07	0.97	1.17
Education						

Characteristic	Logistic			Poisson		
	OR	LL	UL	RR	LL	UL
Less than HS graduate	1.00		ref	1.00		ref
HS graduate to Associate degree	2.00	1.76	2.27	1.72	1.54	1.92
Bachelor's degree	3.53	3.08	4.05	2.51	2.24	2.80
Graduate degree	3.65	3.19	4.16	2.55	2.28	2.86
Income quartile						
1st	1.00		ref	1.00		ref
2nd	1.38	1.24	1.54	1.28	1.19	1.39
3rd	1.82	1.63	2.03	1.56	1.44	1.69
4th	2.69	2.45	2.95	2.00	1.87	2.14
Marital status						
Married	1.00		ref	1.00		ref
Not married	1.16	1.08	1.24	1.10	1.06	1.15
School status						
In school	2.20	1.94	2.49	1.63	1.53	1.74
Not in school	1.00		ref	1.00		ref

Note. Logistic regression models estimate the odds ratio (OR) and its 95% CI. Poisson regression models estimate the relative risk (RR) and its 95% CI. Poisson models are modified to include a robust error variance procedure to adjust for equidispersion. OR and RR estimates are crude.

Table 3. Multivariate models associating sociodemographic predictors with MSA status, NHIS 2022

Characteristic	Logistic			Poisson		
	OR	LL	UL	RR	LL	UL
Sex						
Male	1.46	1.38	1.55	1.28	1.22	1.33
Female	1.00		ref	1.00		ref
Age (yr)						
18 to 44	2.13	1.95	2.31	1.67	1.58	1.77
45 to 64	1.28	1.17	1.40	1.21	1.14	1.28
65 to 85+	1.00		ref	1.00		ref
Race/Ethnicity						
White	1.17	1.04	1.32	1.11	1.03	1.20
Black	1.41	1.21	1.65	1.24	1.13	1.37
Hispanic	1.26	1.09	1.46	1.16	1.06	1.28
Other	1.00		ref	1.00		ref
Education						
Less than HS graduate	1.00		ref	1.00		ref
HS graduate to Associate degree	1.64	1.44	1.88	1.47	1.32	1.65
Bachelor's degree	2.59	2.23	3.00	1.97	1.76	2.21
Graduate degree	2.74	2.36	3.17	2.05	1.82	2.30
Income quartile						
1st	1.00		ref	1.00		ref
2nd	1.34	1.20	1.50	1.24	1.14	1.34
3rd	1.62	1.44	1.83	1.40	1.29	1.52
4th	2.24	2.02	2.50	1.70	1.58	1.84
Marital status						
Married	1.00		ref	1.00		ref
Not married	1.27	1.18	1.36	1.16	1.11	1.21
School status						
In school	1.70	1.49	1.95	1.36	1.27	1.46
Not in school	1.00		ref	1.00		ref

Note. Note. Logistic regression models estimate the odds ratio (OR) and its 95% CI. Poisson regression models estimate the relative risk (RR) and its 95% CI. Poisson models are modified to include a robust error variance procedure to adjust for equidispersion. OR and RR estimates are adjusted for all table variables

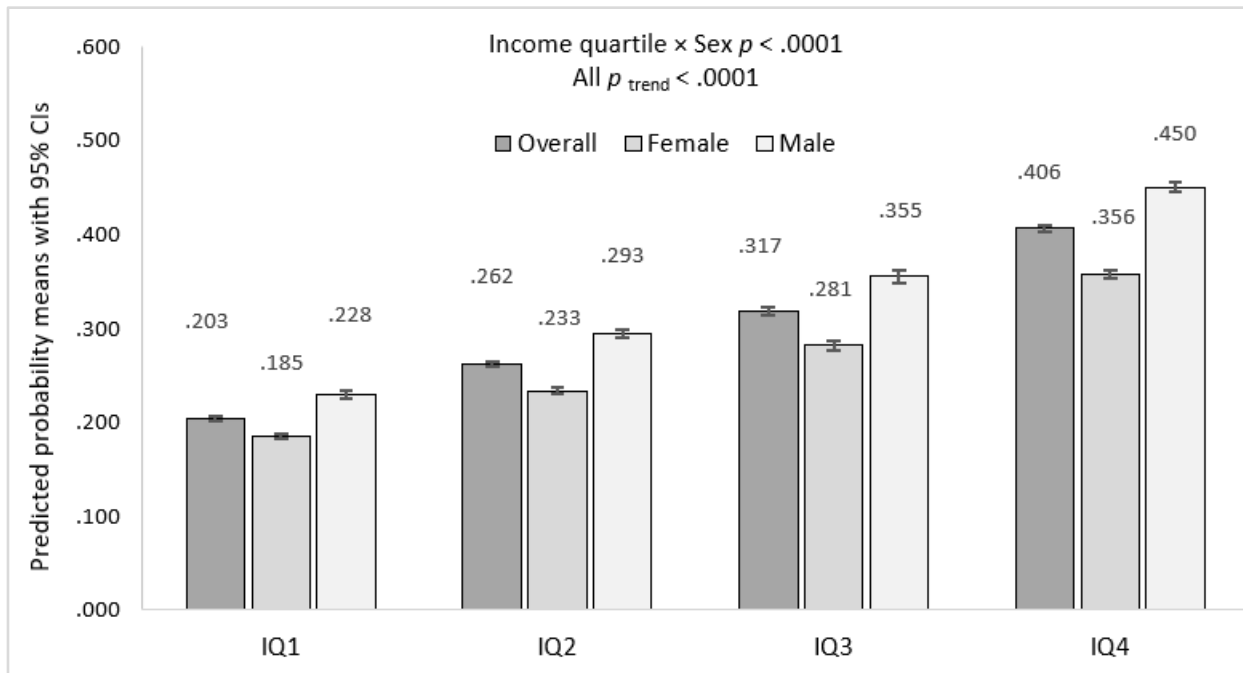


Figure 1. Predicted probabilities for meeting MSA guidelines across income quartile by sex, NHIS 2022

Figure 1 displays predicted probabilities from the fully adjusted Poisson regression model predicting MSA status clustered by income quartile overall and by sex. The graph clearly shows a direct trend between likelihood of meeting MSA guidelines and income, overall and for each sex group (all $p_{\text{trend}} < .0001$). Additionally, the income quartile-by-sex interaction effect ($p < .0001$) revealed a greater linear trend of modeled predicted probabilities for males across income quartiles than females.

4. Discussion

This study examined the associations between commonly assessed sociodemographic variables and MSA in U.S. adults. The findings showed that the lowest adult rates of MSA were in female, older, Hispanic, less educated, lower income, married, and not in school populations. In contrast, the highest rates of MSA were in male, younger, Black, highly educated, highest income, non married, and in school populations. These results remained after multivariate adjustment and are therefore independent predictors of MSA. The only exception was in the multivariate analysis of race/ethnicity, where adults in the other race category had the lowest rate of MSA. Older studies using population-level data do support many of these findings such as lower rates of meeting MSA guidelines in female, older, Hispanic, less educated, and non married (widowed) populations [6,14]. Thus, these updated findings can be considered consistent with previous knowledge of many sociodemographic predictors of MSA.

A secondary aim of this study was to examine the moderating effect of sex on the income and MSA relationship. These results, firstly, highlight the proportionally greater rate of MSA in adults with higher household income, as shown by the linear trend analysis. These results, secondly, highlight a greater rate of MSA in male populations as compared to female populations across each income quartile. Meaning, males had greater

MSA rates in each income quartile group. Finally, these results highlight a greater linear trend (slope) in the income and MSA relationship for males as compared to females. This latter finding indicates a greater income-related disparity in MSA in males as compared to females. No current studies have been found that corroborate these findings. However, similar trends were found in older data from 2005, with males displaying greater amounts (MET min/day) of PA in higher socioeconomic status (SES) groups than in lower SES groups with females showing the same trend but lower amounts of PA [15]. Albeit, SES classification in that study considered income, education, occupation, and a dependency ratio, and the sex-by-SES interaction effect was not explicitly tested.

This study has a few strengths worth mentioning such as 1) its large sample size of over 26,000 adult participants, 2) its large collection of variables including several different sociodemographic indicators, 3) its consistent use of PA assessments over survey periods including items for muscle strengthening exercise and the ability to assess the meeting of MSA guidelines, and 4) its ability to generalize to the entire civilian noninstitutionalized population of the U.S. This study also has limitations that should be acknowledged such as 1) its inability to draw cause-and-effect relationships between sociodemographic characteristics and MSA due to its cross-sectional survey design, 2) its inability to generalize to lower-level geographic regions, 3) its use of household surveys for data collection, and 4) its use of self-reported assessment of MSA for its main outcome variable. Therefore, the statistics in this study should be evaluated as approximations and findings considered with a certain degree of caution.

5. Conclusions

This study found that several different sociodemographic subpopulations engage in recommended amounts of MSA

in lower proportion than others. Many of these sociodemographic subpopulations were consistent with previous studies (female, older, Hispanic, and less educated). However, several new sociodemographic subpopulations were identified (lower income quartile, married, and not in school). All disparities found in this study remained after adjusting for all other sociodemographic characteristics. Health promotion and policy efforts to increase MSA should especially be directed toward older, less educated, and lower income adults.

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