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Association between secondhand smoke exposure and osteoporosis risk in postmenopausal women: a cross-sectional analysis of NHANES data

Background

This study aimed to investigate the association between smoke exposure and the risk of osteoporosis in postmenopausal women in the United States, using data from the National Health and Nutrition Examination Survey (NHANES).

Methods

A cross-sectional analysis was conducted using NHANES data from 2005 to 2010, 2013 to 2014, and 2017 to 2018. The study population consisted of postmenopausal women aged 18years and older. Their bone health status was assessed using self-reported osteoporosis and dual-energy X-ray absorptiometry (DXA) measurements, smoke exposure was evaluated through serum cotinine levels, and multivariate logistic regression models were used to examine the association between smoke exposure and osteoporosis risk, adjusting for sociodemographic factors, health behaviours, and comorbidities.

Results

The analysis comprised 4,140 postmenopausal women, and data analysis showed that active smoking was significantly associated with an increased risk of osteoporosis, with an adjusted odds ratio (OR) of 2.020 (95% confidence interval [CI]: 1.35–3.03), after adjusting for potential confounders. Additionally, age, race/ethnicity, socioeconomic status, marital status, and body mass index were identified as significant predictors of osteoporosis risk.

Conclusions

Smoke exposure, particularly active smoking, was associated with an elevated risk of osteoporosis among postmenopausal women in the United States. The findings underscore the need to address modifiable risk factors, such as smoking cessation, and implement targeted interventions to mitigate disparities in bone health.

Keywords: Osteoporosis; smoke exposure; postmenopausal women; NHANES; sociodemographic factors; bone health

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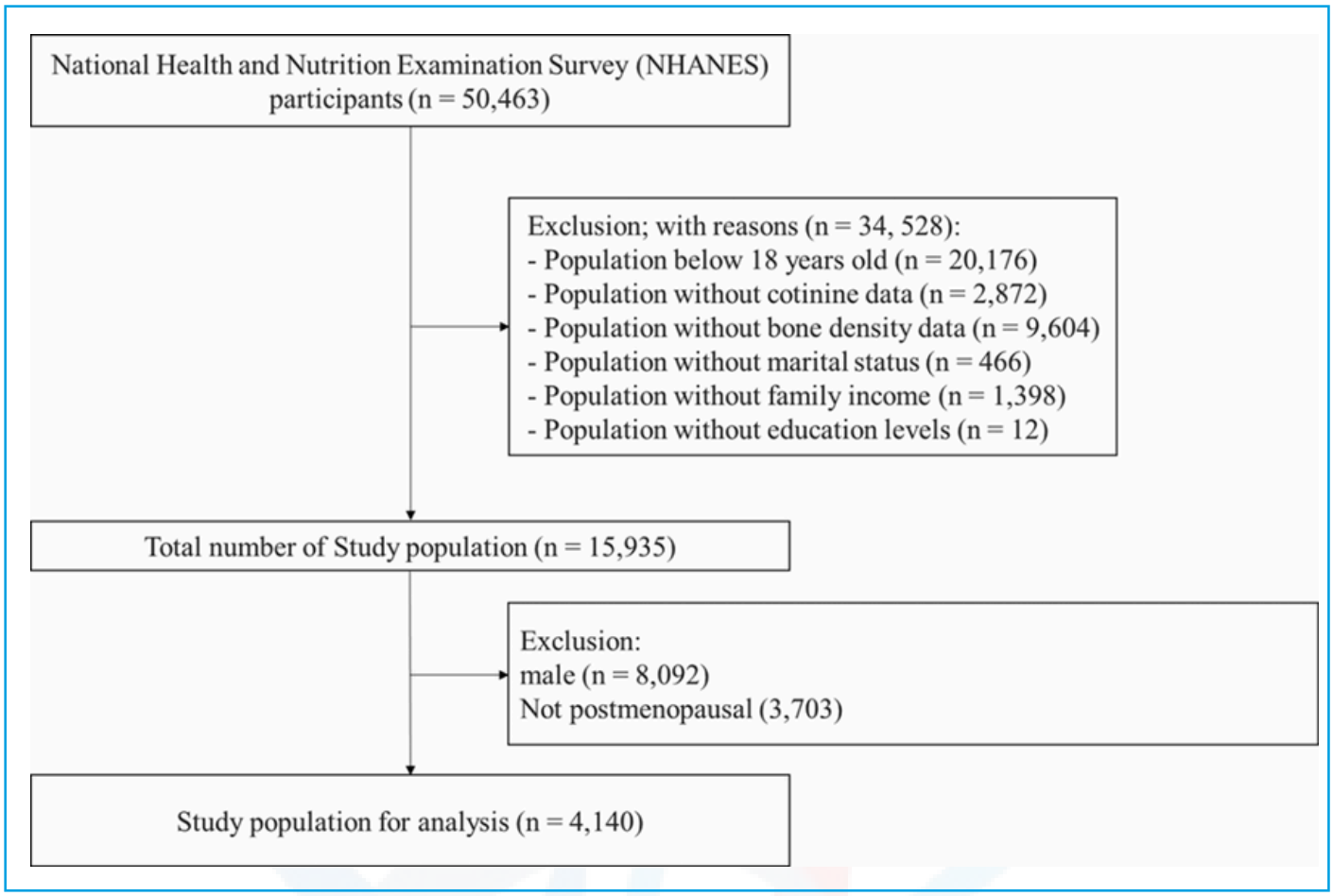

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Table 1. Baseline characteristics of participants stratified by bone health status in the National Health and Nutrition Examination Survey (NHANES).

	Overall (N=4140)		Osteoporosis (N=517)		Low bone mass (N=1539)		Normal (N=2084)			
Characteristics	%	SE	%	SE	%	SE	%	SE	P value	χ2
Smoke exposure									0.06	8.99
Normal	63.41	1.32	6.11	0.42	22.88	0.89	34.42	1.12		
Actively	17.99	0.89	2.39	0.27	6.33	0.51	9.26	0.67		
SHS	9.74	0.65	1.57	0.17	7.30	0.52	9.74	0.65		
Age									<.0001	19.01
18–45	4.62	0.50	0.16	0.09	0.74	0.16	3.72	0.46		
45–65	57.24	0.91	4.01	0.39	21.00	0.74	32.23	0.93		
65–75	24.39	0.87	3.07	0.34	9.19	0.42	12.14	0.70		
≥75	13.75	0.65	2.83	0.24	5.57	0.41	5.34	0.39		
Race and ethnicity									<.0001	64.90
Non-Hispanic white	30.78	2.04	3.00	0.43	11.24	0.86	16.54	1.27		
Non-Hispanic black	3.82	0.50	0.28	0.09	1.06	0.15	2.48	0.35		
Non-Hispanic Asian	2.08	0.30	0.52	0.12	1.01	0.14	0.55	0.10		
Mexican American, other Hispanic	4.12	0.46	0.59	0.08	1.90	0.28	1.63	0.22		
Multi-Racial	0.99	0.24	0.03	0.02	0.21	0.10	0.75	0.23		
Others	58.21	1.85	5.66	0.32	21.08	0.96	31.47	1.16		
Family income-to-poverty ratio									<.0001	50.09
< 130%	17.63	0.92	2.65	0.26	6.47	0.45	8.51	0.51		
130 to < 350%	36.35	1.03	4.47	0.38	13.64	0.58	18.24	0.76		
> 350%	46.02	1.31	2.95	0.37	16.39	0.80	26.68	1.02		
Education									0.00	20.03
High school or less	43.14	1.12	5.53	0.37	15.78	0.77	21.84	0.71		
Some college	31.66	1.08	2.45	0.28	11.00	0.54	18.20	0.91		
College Graduate	25.20	1.14	2.09	0.32	9.72	0.71	13.39	0.75		
Marital status									<.0001	38.02
Married	57.30	1.05	4.64	0.36	20.80	0.86	31.85	0.93		
Widowed	15.96	0.65	2.74	0.32	5.73	0.41	7.49	0.46		
Divorced	17.35	0.90	1.82	0.25	6.74	0.65	8.78	0.59		
Separated	2.00	0.24	0.13	0.04	0.84	0.14	1.02	0.16		
Never married	4.79	0.40	0.43	0.10	1.62	0.27	2.73	0.28		
Living with partner	2.61	0.31	0.30	0.11	0.77	0.21	1.55	0.26		
BMI, kg/m²									<.0001	233.05
Underweight	31.39	0.89	5.29	0.32	13.88	0.69	12.22	0.66		
Normal weight	32.03	0.99	3.62	0.34	12.68	0.67	15.72	0.68		
Overweight	21.12	0.79	0.94	0.16	6.28	0.55	13.91	0.69		
Obese	15.46	0.68	0.26	0.07	3.64	0.35	11.57	0.58		
Alcohol drinking status									0.76	0.56
No	83.17	2.18	9.05	1.25	29.19	2.25	44.93	3.25		
Yes	16.83	2.18	1.20	0.90	6.41	1.38	9.23	1.54		
Hypertension									0.04	6.36
No	35.79	0.96	3.78	0.39	14.15	0.65	17.86	0.77		
Yes	64.21	0.96	6.29	0.44	22.44	0.69	35.49	0.97		
CVD									0.57	1.14
No	88.52	0.73	8.94	0.44	32.03	0.82	47.55	1.03		
Yes	11.48	0.73	1.13	0.15	4.47	0.45	5.88	0.46		
Diabetes									<.0001	26.07
No	87.38	0.81	9.28	0.48	32.80	0.87	45.29	1.09		
Yes	12.62	0.81	0.78	0.14	3.70	0.37	8.14	0.56		
Other chronic diseases									0.86	0.30
No	37.67	1.04	3.93	0.34	13.77	0.64	19.97	0.82		
Yes	62.33	1.04	6.13	0.40	22.74	0.86	33.46	0.86		
Cancer									0.97	0.07
No	18.28	0.84	1.80	0.20	6.73	0.45	9.75	0.62		
Yes	81.72	0.84	8.29	0.45	29.78	0.89	43.65	0.99		

Abbreviations: CVD: cardiovascular disease; SE: standard error; BMI: body mass index.

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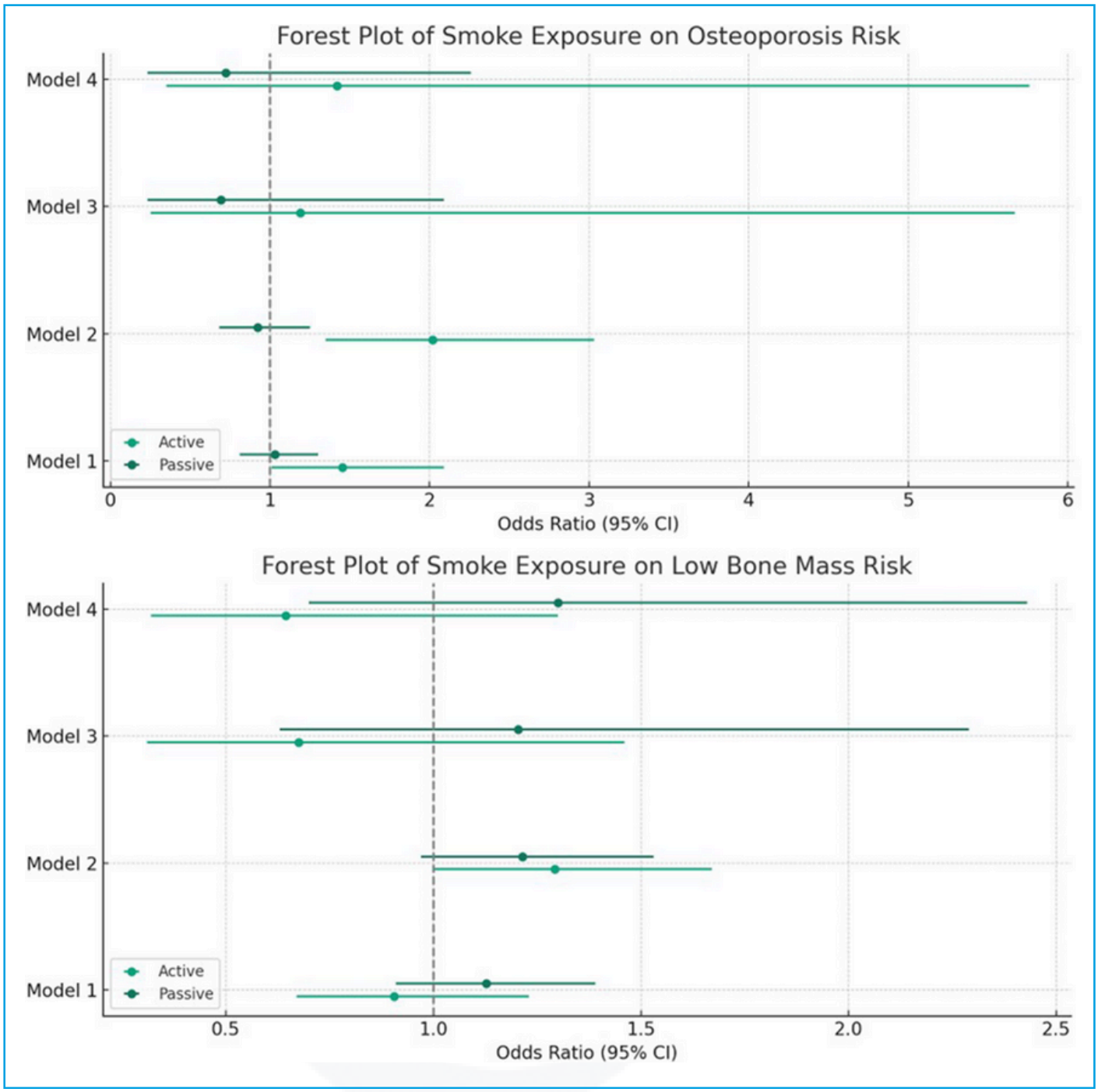

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Table 2. (A) Odds Ratios for bone mass according to risk factors in stratified populations by gender, age, race, education, poverty-income ratio (PIR), and marital status.

	Osteoporosis			
Variables	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
Smoke exposure				
Normal	Ref	Ref	Ref	Ref
Actively	1.453 (1.01–2.09)*	2.020 (1.35–3.03)*	1.188 (0.25–5.67)	1.420 (0.35–5.76)
SHS	1.029 (0.81–1.30)	0.922 (0.68–1.25)	0.690 (0.23–2.09)	0.721 (0.23–2.26)
Age				
18–45	Ref	Ref	Ref	Ref
45–65	2.892 (0.94–8.94)	3.467 (1.03–11.66)	–	–
65–75	5.881 (1.71–20.22)	7.144 (1.91–26.74)	1.451 (0.48–4.44)	1.760 (0.56–5.52)
≥75	12.347 (3.96–38.47)	14.560 (4.23–50.11)	1.479 (0.33–6.54)	2.462 (0.48–12.74)
Race				
Non-Hispanic white	Ref	Ref	Ref	Ref
Non-Hispanic black	1.008 (0.75–1.36)	0.914 (0.68–1.24)	0.234 (0.06–0.96)	0.244 (0.05–1.17)
Non-Hispanic Asian	0.617 (0.34–1.13)	0.486 (0.26–0.91)	2.533 (0.63–10.13)	3.081 (0.72–13.11)
Mexican American, other Hispanics	5.221 (3.25–8.39)	6.237 (3.60–10.82)	2.496 (1.00–6.22)	2.496 (0.96–6.53)
Multi-Racial	2.015 (1.46–2.78)	2.173 (1.52–3.11)	0.209 (0.02–2.56)	0.174 (0.01–2.96)
Other	0.237 (0.05–1.16)	0.202 (0.04–1.10)	–	–
Education				
High school or less	Ref	Ref	Ref	Ref
Some college	0.533 (0.38–0.75)	0.700 (0.49–1.00)	0.408 (0.13–1.24)	0.409 (0.14–1.16)
College graduates	0.617 (0.43–0.88)	0.969 (0.62–1.53)	1.029 (0.23–4.52)	0.881 (0.20–3.82)
Family income-to-poverty ratio				
< 130%	Ref	Ref	Ref	Ref
130 to < 350%	0.788 (0.58–1.07)	0.800 (0.58–1.11)	1.515 (0.58–3.98)	1.395 (0.46–4.28)
> 350%	0.356 (0.26–0.48)	0.497 (0.31–0.79)	0.628 (0.15–2.55)	0.563 (0.15–2.11)
Marital status				
Married	Ref	Ref	Ref	Ref
Widowed	2.515 (1.81–3.50)	1.211 (0.80–1.83)	1.955 (0.40–9.64)	2.045 (0.40–10.39)
Divorced	1.424 (0.97–2.09)	1.249 (0.82–1.90)	0.735 (0.20–2.64)	0.717 (0.19–2.70)
Separated	0.896 (0.46–1.73)	0.658 (0.35–1.26)	1.541 (0.25–9.67)	1.476 (0.22–9.76)
Never married	1.088 (0.62–1.91)	1.169 (0.64–2.14)	0.459 (0.07–2.86)	0.526 (0.08–3.34)
Living with partner	1.322 (0.55–3.20)	1.300 (0.53–3.20)	0.341 (0.03–4.45)	0.496 (0.03–7.67)

(B)

	Low bone mass			
Variables	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
Smoke exposure				
Normal	Ref	Ref	Ref	Ref
Actively	0.906 (0.67–1.23)	1.292 (1.00–1.67)	0.676 (0.31–1.46)	0.645 (0.32–1.30)
Passively	1.127 (0.91–1.39)	1.214 (0.97–1.53)	1.204 (0.63–2.29)	1.301 (0.70–2.43)
Age				
18–45	Ref	Ref	Ref	Ref
45–65	3.255 (1.92–5.53)	3.435 (2.05–5.74)	–	–
65–75	3.783 (2.24–6.40)	4.109 (2.51–6.74)	1.470 (0.73–2.97)	1.462 (0.77–2.77)
≥75	5.215 (2.93–9.29)	5.956 (3.50–10.15)	1.052 (0.47–2.38)	1.191 (0.49–2.92)
Race				
Non-Hispanic white	Ref	Ref	Ref	Ref
Non-Hispanic black	1.015 (0.84–1.23)	0.955 (0.79–1.15)	0.968 (0.61–1.54)	1.020 (0.62–1.68)
Non-Hispanic Asian	0.639 (0.49–0.84)	0.562 (0.43–0.73)	2.166 (0.67–7.05)	2.187 (0.73–6.58)
Mexican American, other Hispanic	2.757 (1.93–3.94)	2.696 (1.86–3.90)	1.834 (0.73–4.59)	1.814 (0.67–4.94)
Multi-Racial	1.733 (1.21–2.49)	1.720 (1.17–2.53)	0.581 (0.14–2.43)	0.663 (0.16–2.83)
Other	0.411 (0.13–1.29)	0.375 (0.11–1.25)	–	–
Education				
High school or less	Ref	Ref	Ref	Ref
Some college	0.836 (0.70–1.00)	0.917 (0.75–1.13)	0.467 (0.28–0.79)	0.452 (0.27–0.76)
College graduates	1.005 (0.81–1.26)	1.133 (0.86–1.49)	0.950 (0.49–1.86)	0.977 (0.49–1.94)
Family income-to-poverty ratio				
< 130%	Ref	Ref	Ref	Ref
130 to < 350%	0.984 (0.83–1.16)	0.967 (0.80–1.17)	1.779 (1.02–3.10)	1.719 (0.86–3.44)
> 350%	0.808 (0.68–0.96)	0.837 (0.67–1.05)	1.134 (0.63–2.05)	1.050 (0.59–1.86)
Marital status				
Married	Ref	Ref	Ref	Ref
Widowed	1.171 (0.91–1.50)	0.895 (0.68–1.17)	1.019 (0.47–2.20)	0.818 (0.43–1.57)
Divorced	1.176 (0.89–1.55)	1.135 (0.85–1.51)	1.409 (0.68–2.94)	1.442 (0.69–3.01)
Separated	1.258 (0.85–1.85)	1.254 (0.82–1.93)	1.114 (0.49–2.56)	1.142 (0.47–2.80)
Never married	0.909 (0.60–1.38)	1.007 (0.63–1.60)	0.756 (0.26–2.21)	0.772 (0.21–2.92)
Living with partner	0.760 (0.39–1.49)	0.807 (0.39–1.67)	0.506 (0.14–1.86)	0.549 (0.17–1.79)

Abbreviations: OR: odds ratio.
Model 1: Unadjusted.
Model 2: Adjusted for age, race, education, family poverty-income ratio, and marital status.
Model 3: Model 2 plus adjustments for body mass index (BMI), smoking status, and drinking status.
Model 4: Model 3 plus adjustments for hypertension, cardiovascular disease (CVD), cancer, and other chronic diseases.

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