

Smoking Status and Body Mass Index in the United States: 1996-2000

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Introduction



- **Worldwide, cigarette smoking causes four million deaths annually, with 440,000 occurring in the USA**
- **In the USA, overweight and obesity cause 300,000 deaths annually, incurring \$90 billion in direct medical costs**
- **Elevated BMI is epidemic in the USA. In the past 4 decades:**
 - **104% increase in overweight → 2 in 3 adults are overweight**
 - **131% increase in obesity → 1 in 3 adults is obese**
- **Quitting smoking often leads to weight gain**

Materials & Methods



- **Data used: 1996, 1998, and 2000 waves of the U.S. Behavioral Risk Factor Surveillance System**
- **Sample size: 438,304 participants, ages 18+ years**
- **Response rates: 63.2% in 1996, 59.1% in 1998, 48.9% in 2000**
- **Questionnaires assessed:**
 - **Height & weight (self-report) – used to calculate BMI**
 - **Smoking history – never, current, former (with duration of abstinence)**
 - **Physical activity**
 - **Fruit and vegetable intake**
 - **Demographic information: age, sex, education attainment, race/ethnicity, and income**

Materials & Methods

(Con't)



- **Dependent variables:**
 - **Overweight or obese: BMI \geq 25**
 - **Obesity: BMI \geq 30**
- **Independent variables:**
 - **Smoking status: 7 categories**
 - **Physical activity: 3 categories**
 - **Fruit and vegetable intake: 2 categories**
- **Covariates: age, sex, education attainment, race and ethnicity, and income**

Materials & Methods

(Con't)



- **Physical activity (in the past 30 days):**
 - **Low: none**
 - **Medium: some but not regular, sustained physical activity**
 - **High: regular, sustained physical activity (i.e., respondent engages in any type of physical activity at any intensity at least 5 times per week and for at least 30 minutes per session)**
- **Statistical analysis:**
 - **Logistic regression (univariate and multivariate) analyses**
 - **Odds ratios and 95% confidence intervals were calculated**
 - **Physical activity and fruit and vegetable intake were used to perform stratified analyses**
 - **SAS and SUDAAN software were used in data analyses**

Results

Table 1. Prevalence of Elevated Body Mass Index by Selected Demographics and Behavioral Factors

Demographics	BMI \geq 25		BMI \geq 30	
	%	95% CI	%	95% CI
Sex				
Male (n=179,778)	63.4	63.0-63.8	18.4	18.1-18.7
Female (n=258,526)	46.3	46.0-46.6	18.4	18.2-18.7
Age				
18-24 (n=39,207)	35.9	35.1-36.7	10.4	9.9-10.9
25-44 (n=181,680)	53.8	53.4-54.2	18.0	17.7-18.3
45-64 (n=133,295)	63.7	63.2-64.1	23.5	23.2-23.9
³ 65 (n=84,122)	55.7	55.2-56.3	16.7	16.3-17.1
Education				
Less than high school (n=53,508)	61.2	60.5-61.9	24.6	23.9-25.2
High school (n=141,889)	57.0	56.6-57.4	20.0	19.6-20.3
Some college (n=121,083)	53.8	53.4-54.3	18.3	17.9-18.6
College and above (n=120,858)	49.9	49.5-50.4	13.8	13.4-14.1
Race/Ethnicity				
Non-Hispanic whites (n=352,953)	53.3	53.1-53.6	17.1	16.9-17.3
Non-Hispanic blacks (n=36,235)	65.0	64.2-65.8	27.4	26.7-28.1
Hispanics (n=27,667)	60.6	59.7-61.6	21.8	20.9-22.6
Others (n=21,449)	43.7	42.4-45.1	12.6	11.8-13.4
Income				
< \$10,000 (n=24,439)	55.2	54.0-56.4	24.0	23.1-25.0
\$10,000-24,999 (n=103,519)	56.1	55.6-56.7	21.7	21.3-22.2
\$25,000-49,999 (n=139,724)	56.1	55.7-56.5	18.8	18.4-19.1
\$50,000-74,999 (n=58,783)	55.9	55.3-56.6	17.1	16.7-17.6
³ 75,000 (n=50,140)	52.1	51.4-52.8	13.9	13.4-14.3
DK/not sure/refused (n=61,699)	50.4	49.7-51.0	15.7	15.2-16.1

Table 1. Prevalence of Elevated Body Mass Index by Selected Demographics and Behavioral Factors (con't)

Behavioral Factors	BMI \geq 25		BMI \geq 30	
	%	95% CI	%	95% CI
Physical Activity (PA)				
No PA past month (n=124,616)	59.5	59.1-60.0	24.2	23.8-24.6
Some, not regular, sustained (n=217,935)	54.2	53.8-54.5	17.1	16.8-17.4
Regular, sustained PA (n=90,708)	49.6	49.1-50.2	13.8	13.4-14.1
Fruit & Vegetable Consumption				
< 1 serving per day or never (n=14,931)	55.3	53.9-56.6	22.3	21.0-23.5
1-2 servings per day (n=134,192)	57.2	56.7-57.6	20.1	19.7-20.4
3-4 servings per day (n=166,155)	54.8	54.5-55.2	18.0	17.7-18.3
³ 5 servings per day (n=100,897)	51.1	50.6-51.7	16.2	15.9-16.6
Smoking Status				
Current smokers (n=101,078)	49.3	48.8-49.9	15.2	14.8-15.6
Former smokers (n=107,159)	61.7	61.2-62.1	21.1	20.7-21.5
Former smk, quit < 6 months (n=7,144)	53.1	51.1-55.0	17.4	16.0-18.9
Former smk, quit 6-12 months (n=4,654)	57.0	54.6-59.3	20.6	18.7-22.4
Former smk, quit 1-5 years (n=19,214)	60.2	59.1-61.4	21.4	20.4-22.4
Former smk, quit 5-15 years (n=30,245)	62.9	62.0-63.8	22.5	21.7-23.2
Former smk, quit ³ 15 years (n=43,362)	63.9	63.2-64.6	20.8	20.2-21.4
Never smokers (n=228,949)	54.0	53.6-54.3	18.6	18.3-18.8

Table 2. Prevalence of Regular, Sustained Physical Activity and 5 or More Servings of Fruit and Vegetable Intake Per Day by Smoking Status

Smoking Status	Regular, Sustained Physical Activity		= 5 Servings of Fruit and Vegetable Intake Per Day	
	%	95% CI	%	95% CI
Current smokers (n=99,923)	17.0	16.6-17.4	17.6	17.2-17.9
Former smokers	22.9	22.5-23.3	26.0	25.5-26.4
Former smk, quit < 6 months (n=7,062)	21.0	19.4-22.6	22.3	20.7-23.9
Former smk, quit 6-12 months (n=4,594)	20.4	18.5-22.2	21.9	20.0-23.9
Former smk, quit 1-5 years (n=18,985)	21.7	20.7-22.6	23.3	22.3-24.3
Former smk, quit 5-15 years (n=29,879)	23.0	22.3-23.8	26.1	25.3-26.9
Former smk, quit ³ 15 years (n=42,876)	24.1	23.5-24.8	28.4	27.8-29.1
Never smokers (n=226,338)	21.3	21.0-21.5	26.4	26.1-26.7

Table 3. Multivariate* Logistic Regression Analysis of Elevated Body Mass Index by Smoking Status, Physical Activity and Fruit and Vegetable Intake

Variables	BMI \geq 25		BMI \geq 30	
	OR	95% CI	OR	95% CI
Current smokers (n=98,077)	1.00	Referent	1.00	Referent
Former smokers (n=103,303)	1.63	1.57-1.68	1.75	1.67-1.82
Former smk, quit < 6 months (n=6,909)	1.30	1.20-1.42	1.33	1.19-1.48
Former smk, quit 6-12 months (n=4,456)	1.52	1.37-1.69	1.62	1.43-1.84
Former smk, quit 1-5 years (n=18,449)	1.64	1.56-1.74	1.72	1.60-1.84
Former smk, quit 5-15 years (n=29,043)	1.70	1.62-1.78	1.83	1.73-1.93
Former smk, quit ³ 15 years (n=41,989)	1.69	1.62-1.76	1.77	1.68-1.86
Never smokers (n=218,644)	1.48	1.44-1.53	1.57	1.51-1.63
Physical Activity				
Low	1.00	Referent	1.00	Referent
Medium	0.88	0.85-0.90	0.74	0.72-0.76
High	0.73	0.71-0.76	0.59	0.56-0.61
Fruit and Vegetable Intake				
< 3 servings per day	1.00	Referent	1.00	Referent
=3 servings per day	0.92	0.90-0.94	0.89	0.86-0.91

* Odds Ratios are adjusted for other variables in the table, as well as age, sex, race/ethnicity, race, and income.

Table 4. Multivariate Logistic Regression Analysis of Elevated Body Mass Index by Smoking Status, Physical Activity and Fruit and Vegetable Intake (controlled for demographics)

Smoking Status by Physical Activity and Fruit and Vegetable Intake	BMI \geq 25				BMI \geq 30			
	%	95% CI	OR	95% CI	%	95% CI	OR	95% CI
Low PA, low FV								
Current smokers (n=18,960) (reference)	52.2	51.0-53.4	1.00	Referent	19.4	18.4-20.5	1.00	Referent
Former smokers, quit < 12 months (n=1,478)	57.6	53.3-61.9	1.31	1.08-1.59	23.9	20.3-27.5	1.41	1.14-1.74
Former smokers, quit 1-5 years (n=2,221)	65.7	62.4-69.1	1.74	1.47-2.07	28.4	24.8-32.0	1.70	1.40-2.05
Former smokers, quit 5-15 years (n=3,042)	73.3	70.9-75.8	2.27	1.98-2.61	32.7	30.0-35.5	2.03	1.75-2.35
Former smokers, quit ³ 15 years (n=3,836)	73.2	71.0-75.4	2.12	1.86-2.42	32.5	30.1-34.9	2.11	1.85-2.41
Never smokers (n=23,115)	61.7	60.7-62.8	1.77	1.65-1.90	27.1	26.2-28.1	1.71	1.58-1.86
Low PA, high FV								
Current smokers (n=15,579)	51.7	50.4-53.0	1.03	0.95-1.11	17.7	16.7-18.7	0.91	0.83-1.00
Former smokers, quit < 12 months (n=1,664)	58.2	54.0-62.3	1.41	1.16-1.70	22.4	19.2-25.6	1.29	1.05-1.59
Former smokers, quit 1-5 years (n=2,596)	62.5	59.5-65.4	1.62	1.40-1.86	27.4	24.6-30.1	1.71	1.46-2.00
Former smokers, quit 5-15 years (n=4,323)	68.8	66.6-71.0	2.06	1.83-2.31	31.8	29.6-34.0	2.14	1.89-2.43
Former smokers, quit ³ 15 years (n=6,860)	68.6	66.6-71.0	1.99	1.80-2.19	26.7	25.1-28.3	1.82	1.63-2.03
Never smokers (n=33,378)	59.2	58.4-60.1	1.69	1.58-1.80	23.9	23.1-24.6	1.52	1.40-1.65
Medium PA, low FV								
Current smokers (n=20,136)	49.7	48.6-50.8	1.02	0.96-1.10	14.1	13.3-14.8	0.79	0.72-0.86
Former smokers, quit < 12 months (n=2,210)	57.4	54.1-60.7	1.49	1.28-1.72	19.6	16.8-22.4	1.23	1.01-1.49
Former smokers, quit 1-5 years (n=3,304)	64.0	61.4-66.7	1.81	1.60-2.05	22.5	20.1-25.0	1.44	1.23-1.69
Former smokers, quit 5-15 years (n=4,705)	65.1	62.8-67.3	1.66	1.48-1.86	23.1	21.2-25.0	1.41	1.24-1.60
Former smokers, quit ³ 15 years (n=5,290)	69.2	67.3-71.0	1.82	1.64-2.02	23.0	21.2-24.8	1.43	1.26-1.62
Never smokers (n=37,598)	55.5	54.6-56.3	1.50	1.41-1.59	18.9	18.3-19.6	1.28	1.19-1.39

Table 4. Multivariate Logistic Regression Analysis of Overweight and Obesity by Smoking Status, Physical Activity and Fruit and Vegetable Intake (controlled for demographics)

Smoking Status by Physical Activity and Fruit and Vegetable Intake	BMI \geq 25				BMI \geq 30			
	%	95% CI	OR	95% CI	%	95% CI	OR	95% CI
Medium PA, high FV								
Current smokers (n=25,752)	48.0	47.0-49.0	0.99	0.93-1.06	13.5	12.8-14.2	0.76	0.69-0.83
Former smokers, quit < 12 months (n=3,499)	54.3	51.7-56.9	1.41	1.24-1.59	16.4	14.6-18.3	1.03	0.88-1.20
Former smokers, quit 1-5 years (n=6,008)	58.3	56.3-60.4	1.58	1.43-1.74	19.0	17.4-20.5	1.21	1.07-1.37
Former smokers, quit 5-15 years (n=10,008)	60.0	58.5-61.6	1.52	1.40-1.65	19.5	18.2-20.7	1.23	1.11-1.37
Former smokers, quit ³ 15 years (n=15,227)	61.6	60.4-62.8	1.53	1.42-1.65	18.1	17.1-19.0	1.17	1.07-1.29
Never smokers (n=74,362)	52.0	51.5-52.6	1.37	1.29-1.45	16.5	16.1-16.9	1.10	1.02-1.19
High PA, low FV								
Current smokers (n=5,559)	47.6	45.5-49.8	0.98	0.88-1.08	13.0	11.5-14.4	0.74	0.63-0.85
Former smokers, quit < 12 months (n=691)	48.8	42.7-54.8	1.12	0.87-1.45	15.9	11.0-20.7	1.05	0.73-1.52
Former smokers, quit 1-5 years (n=1,030)	59.7	55.0-64.3	1.50	1.21-1.85	18.5	14.7-22.3	1.14	0.88-1.49
Former smokers, quit 5-15 years (n=1,429)	64.4	60.5-68.3	1.61	1.35-1.92	19.2	16.0-22.4	1.14	0.92-1.42
Former smokers, quit ³ 15 years (n=1,838)	64.8	61.5-68.1	1.46	1.25-1.71	21.0	17.7-24.2	1.29	1.05-1.59
Never smokers (n=11,405)	53.4	51.8-54.9	1.38	1.27-1.50	15.7	14.6-16.7	1.05	0.94-1.17
High PA, high FV								
Current smokers (n=10,911)	44.1	42.6-45.7	0.87	0.80-0.95	11.6	10.6-12.6	0.65	0.57-0.73
Former smokers, quit < 12 months (n=1,685)	47.8	43.9-51.7	1.10	0.93-1.30	13.7	11.3-16.2	0.87	0.70-1.10
Former smokers, quit 1-5 years (n=3,058)	53.5	50.5-56.4	1.27	1.12-1.45	15.4	13.2-17.6	0.96	0.80-1.15
Former smokers, quit 5-15 years (n=5,181)	55.3	53.1-57.5	1.26	1.14-1.40	15.1	13.5-16.7	0.93	0.81-1.07
Former smokers, quit ³ 15 years (n=8,448)	56.2	54.5-57.8	1.23	1.13-1.34	14.4	13.2-15.6	0.93	0.83-1.05
Never smokers (n=36,201)	46.3	45.4-47.2	1.09	1.03-1.16	12.8	12.2-13.4	0.84	0.77-0.92

Table 5. Multivariate Logistic Regression Analysis of Obesity by Smoking Status, Physical Activity and Fruit and Vegetable Intake in Males and Females, 18+ Yrs

Smoking Status by Physical Activity and Fruit and Vegetable Intake	Obesity in Males				Obesity in Females			
	%	95% CI	OR	95% CI	%	95% CI	OR	95% CI
Low PA, low FV								
Current smokers (n=18,960) (reference)	18.3	16.7-20.0	1.00	Referent	20.7	19.4-21.9	1.00	Referent
Former smokers, quit < 12 months (n=1,478)	21.1	16.4-25.8	1.26	0.93-1.71	27.4	22.0-32.8	1.56	1.15-2.10
Former smokers, quit 1-5 years (n=2,221)	26.8	22.4-31.2	1.66	1.30-2.13	30.6	24.6-36.5	1.76	1.31-2.37
Former smokers, quit 5-15 years (n=3,042)	32.4	28.6-36.2	2.09	1.70-2.57	33.3	29.4-37.1	2.06	1.69-2.52
Former smokers, quit ³ 15 years (n=3,836)	30.2	27.2-33.2	2.08	1.74-2.49	37.1	33.2-41.0	2.41	2.00-2.90
Never smokers (n=23,115)	25.5	24.0-27.0	1.65	1.45-1.89	28.4	27.2-29.5	1.66	1.50-1.83
Low PA, high FV								
Current smokers (n=15,579)	16.9	15.4-18.4	0.91	0.78-1.06	18.4	17.2-19.7	0.89	0.80-1.01
Former smokers, quit < 12 months (n=1,664)	22.0	16.9-27.1	1.30	0.93-1.80	22.7	18.8-26.6	1.29	1.01-1.65
Former smokers, quit 1-5 years (n=2,596)	26.6	22.6-30.5	1.70	1.35-2.14	28.1	24.3-31.9	1.72	1.40-2.11
Former smokers, quit 5-15 years (n=4,323)	29.9	26.7-33.2	2.03	1.67-2.47	33.8	30.8-36.8	2.31	1.97-2.69
Former smokers, quit ³ 15 years (n=6,860)	24.5	22.4-26.7	1.69	1.44-1.98	29.6	27.2-29.6	2.07	1.79-2.39
Never smokers (n=33,378)	21.7	20.3-23.1	1.39	1.22-1.60	25.0	24.1-25.8	1.50	1.36-1.64
Medium PA, low FV								
Current smokers (n=20,136)	14.7	13.6-15.8	0.85	0.74-0.97	13.2	12.2-14.2	0.69	0.61-0.78
Former smokers, quit < 12 months (n=2,210)	21.4	17.5-25.3	1.38	1.07-1.79	16.7	12.9-20.4	0.99	0.74-1.32
Former smokers, quit 1-5 years (n=3,304)	23.4	20.0-26.7	1.50	1.21-1.86	21.1	17.7-24.5	1.36	1.09-1.69
Former smokers, quit 5-15 years (n=4,705)	24.1	21.5-26.7	1.49	1.24-1.78	21.3	18.6-24.0	1.26	1.05-1.52
Former smokers, quit ³ 15 years (n=5,290)	23.1	20.9-25.3	1.46	1.24-1.73	22.7	19.6-25.8	1.40	1.15-1.69
Never smokers (n=37,598)	19.4	18.4-20.3	1.32	1.16-1.49	18.4	17.5-19.2	1.19	1.08-1.31

Table 5. Multivariate Logistic Regression Analysis of Obesity by Smoking Status, Physical Activity and Fruit and Vegetable Intake in Males and Females, 18+ Yrs (continued)

Smoking Status by Physical Activity and Fruit and Vegetable Intake	Obesity in Males				Obesity in Females			
	%	95% CI	OR	95% CI	%	95% CI	OR	95% CI
Medium PA, high FV								
Current smokers (n=25,752)	13.3	12.4-14.3	0.76	0.66-0.87	13.6	12.8-14.5	0.74	0.67-0.83
Former smokers, quit < 12 months (n=3,499)	17.0	14.2-19.8	1.06	0.85-1.34	15.9	13.4-18.3	0.97	0.79-1.19
Former smokers, quit 1-5 years (n=6,008)	19.0	16.7-21.3	1.21	1.01-1.46	18.9	16.8-18.9	1.17	0.99-1.38
Former smokers, quit 5-15 years (n=10,008)	20.5	18.6-22.3	1.27	1.09-1.49	18.4	16.7-20.0	1.19	1.04-1.37
Former smokers, quit ³ 15 years (n=15,227)	18.2	16.9-19.5	1.19	1.04-1.37	17.9	16.5-19.3	1.17	1.03-1.32
Never smokers (n=74,362)	16.6	15.8-17.3	1.11	0.98-1.25	16.5	16.0-17.0	1.07	0.98-1.17
High PA, low FV								
Current smokers (n=5,559)	13.4	11.3-15.6	0.79	0.64-0.98	12.2	10.4-14.1	0.65	0.54-0.79
Former smokers, quit < 12 months (n=691)	19.4	12.4-26.5	1.36	0.86-2.14	10.1	5.2-15.0	0.64	0.37-1.12
Former smokers, quit 1-5 years (n=1,030)	19.7	14.6-24.9	1.25	0.89-1.75	16.0	10.8-16.0	0.95	0.65-1.39
Former smokers, quit 5-15 years (n=1,429)	22.8	18.5-27.1	1.43	1.10-1.87	12.3	7.9-16.7	0.68	0.44-1.03
Former smokers, quit ³ 15 years (n=1,838)	23.0	19.0-27.1	1.52	1.19-1.95	15.2	10.4-15.2	0.84	0.57-1.24
Never smokers (n=11,405)	15.6	14.1-17.1	1.06	0.91-1.24	15.7	14.1-17.3	1.00	0.86-1.15
High PA, high FV								
Current smokers (n=10,911)	11.9	10.4-13.4	0.69	0.58-0.83	11.3	10.0-12.5	0.60	0.52-0.70
Former smokers, quit < 12 months (n=1,685)	14.0	10.4-17.6	0.91	0.65-1.26	13.5	10.1-16.8	0.84	0.62-1.15
Former smokers, quit 1-5 years (n=3,058)	17.7	14.2-21.2	1.13	0.87-1.46	12.6	10.1-15.2	0.77	0.60-0.98
Former smokers, quit 5-15 years (n=5,181)	17.4	14.9-19.8	1.08	0.88-1.33	12.8	10.8-14.7	0.78	0.64-0.95
Former smokers, quit ³ 15 years (n=8,448)	15.5	13.8-17.2	1.03	0.87-1.22	12.8	11.0-14.5	0.83	0.69-0.99
Never smokers (n=36,201)	14.2	13.2-15.2	0.97	0.84-1.11	11.7	11.0-12.4	0.73	0.66-0.82

Key Findings



- **From 1996 to 2000, 54.8% of Americans were overweight/obese and 18.4% were obese (lower than NHANES – probably due to self-report in BRFSS).**
- **More men were overweight than women, but obesity was equally prevalent across sex.**
- **Groups with elevated BMI:**
 - **45 to 64 year olds**
 - **Lower education attainment (< high school)**
 - **Lower income**
 - **African Americans**
 - **Physically inactive**
 - **Less intake of fruits and vegetables**

Key Findings



- **Former smokers, especially those abstinent ≥ 5 years, had the highest BMIs, followed by never smokers and current smokers.**
- **In multivariate analyses, former smokers of ≥ 5 years were also more likely to report exercising regularly and eating 3+ servings of fruits & vegetables per day**
- **Compared to current smokers, BMI was elevated even in former smokers off < 6 months.**

Key Findings



- **At the same duration of abstinence, former smokers who were physically active and who consumed 3+ daily servings of fruits & vegetables were less likely to have elevated BMIs than former smokers who were less active and/or who consumed fewer fruits & vegetables**

Discussion



- **The health benefit from quitting smoking exceeds any decrement from elevated BMI (e.g., lean smokers are at elevated risk of lung cancer).**
- **Increased physical activity and fruit & vegetable consumption by former smokers will reduce BMI and risk of coronary heart disease, cancer, and other diseases.**
- **Physical activity and energy dense foods may serve as alternative reinforcers, stimulating neurotransmitters such as dopamine and endorphins.**

Discussion (con't)



- **Restricting energy intake alone has been proven ineffective in preventing weight gain and maintaining smoking abstinence. Fruits & vegetables in adequate amounts can facilitate achievement of satiety.**
- **Smokers should continue to prioritize cessation.**
- **Former smokers should consider spending the money they've saved by not smoking on various exercise options (e.g., equipment, health club membership) and for fruits & vegetables.**

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