Obesity and weight gain among former World Trade Center workers and volunteers

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Abstract

A high prevalence of obesity has been observed among former World Trade Center (WTC) workers and volunteers. We hypothesized that unemployment and disability status would predict obesity. We surveyed 220 participants at the Mount Sinai WTC Clinical Center to assess their obesity and current employment and disability status, WTC occupational exposure level, medical comorbidities, and dietary and exercise habits. Bivariate and logistic regression multivariate analyses were used to explore associated risk factors. Obesity was associated with active employment status. Other significant covariates included non-Latino African American race, having a high number of comorbid chronic diseases, low exercise frequency, and not drinking any glass of juice daily. The association of obesity with active employment suggests that interventions that favor healthy habits among actively employed individuals are warranted.

Keywords

Employment status; obesity; World Trade Center attack, 2001

Despite increased awareness, obesity continues to rise in prevalence in most developed countries, including the United States.[1,2] Studies among former World Trade Center (WTC) workers and volunteers described a relatively high prevalence of overweight and obesity[3,4] and identified weight gain[5] and obesity markers[6] as risk factors for accelerated expiratory flow decline on longitudinal follow-up. Since obesity is associated with some of the adverse health effects highly prevalent after WTC- related occupational exposures[7] (eg, asthma and gastro- esophageal reflux disease), it is important to understand the characteristics of the obesity problem in this population, which would in turn help guide interventions to prevent increased disability. Given the number of potentially disabling medical conditions observed in this population, we hypothesized that obesity would be associated with nonworking status (from disability, unemployment, and/or retirement). Previous studies have been conflicting regarding employment status and obesity. Recent work by Monsivais et al[8] and Gueorguieva

et al[9] suggested that obesity is related to job loss and retirement while Au et al.[10,11] suggest more weight gain among full- time employed individuals.

In this study, we conducted a survey among former WTC workers and volunteers followed longitudinally at the WTC Health Program (WTCHP) Clinical Center to identify both lifestyle and occupational factors associated with obesity in this patient population.

Methods

Participants and data collection

The target population was represented by the workers and volunteers who participated in the rescue, recovery, and restoration of services at the WTC disaster site after September 11, 2001, and who participate in longitudinal health monitoring at the WTCHP of the Mount Sinai Clinical Center of Excellence, according to previously described eligibility criteria.[12] The WTCHP offers no-cost longitudinal surveillance and individualized treatment to eligible WTC workers and volunteers for both physical and mental health conditions related to their WTC occupational exposures. Eligible workers include those who have been involved with rescue, recovery, and cleanup efforts in the aftermath of the 2001 WTC disaster.

To be included in the study, each participant needed to be a patient currently enrolled in the Treatment Program clinic and not have an acute condition requiring urgent medical attention. Potential participants were approached at regularly scheduled outpatient treatment clinic appointments. Those agreeing to participate provided verbal consent. All investigative procedures were approved by the Mount Sinai Institutional Review Board.

An interviewer administered a 10-minute survey to gather demographic, current employment status, WTC occupational exposure, diet, exercise, and morbidity information (see Table 1). The survey was administered in English, using trained medical interpreters (in person or by telephone) for patients who were not comfortable responding in English. Those surveys were conducted in Spanish, Polish, Russian, Serbian, and Italian. A total of 257 patients from the Mount Sinai WTC Treatment Program were sequentially invited, and 223 agreed to participate in the survey. Due to their small number, three patients of non-Latino Asian race/ ethnicity were excluded, leaving a study sample of 220 participants. Study participants were recruited for a period of 4 months, from May 15 to September 15, 2011.

Age was determined at the time of the interview. Height and weight were measured during the interview and served to determine the body mass index (BMI), expressed in kg/m^2. Participants were categorized as with overweight if their BMI equaled or exceeded 25 kg/m^2 and with obesity if their BMI equaled or exceeded 30 kg/m^2. Obesity was the outcome of interest, compared to subjects with normal or overweight.

Race/ethnicity was categorized into three groups: Latino, non-Latino Caucasian, and non-Latino African American. Language was categorized into three groups: English, Spanish, and Polish/other. The level of education was assigned in relation to high school diploma (less than high school, high school, beyond high school).

The WTC occupation was categorized in groups, including volunteers (see Table 1). Employment status was categorized so that patients who were not working at least 20 hours per week (due to under- or unemployment, disability, or retirement) were deemed unemployed.

WTC occupational exposures were categorized in terms of early or late arrival (less or more than 48 hours, respectively) at the WTC disaster site and exposure duration (categorized into less or more than 60 days). We derived a composite variable based on both arrival before 48 hours and exposure duration > 60 days, either, or neither.[13]

Comorbidities (including anxiety and depression) were assessed by self-report and by medical chart review and verification. The number of comorbid conditions was categorized in three levels: 1 to 2, 3 to 5, and 6 to 10, respectively.

Individuals were asked about alcohol consumption and whether they were exercising (with categorization into times per week and type of exercise), actively dieting or not, number of daily meals, daily glasses of sodas and juices, and weekly home meals and fast food meals (all categorical variables, see Table 1).

Finally, participants were asked whether they identified any specific life event (eg, accident, pregnancy, and WTC occupational experience) as related to their weight gain.

Data analyses

Statistical analyses were conducted with SAS software (version 9.4). All significance tests were conducted with a two-sided significance level of $\alpha = .05$. Standard descriptive statistics were produced for all variables. Bivariate analyses were used to explore the association of obesity with potential risk factors, using the chi-square test for trend for ordinal variables or Pearson chi-square for nominal ones. These risk factors were then analyzed in multiple logistic regression models using a modified stepwise approach to determine which variables to include. In the first step, a traditional stepwise selection procedure was performed, using a nominal significance level of .10, to create the "base model." Then, models were fit using the base model plus, one at a time, each of the variables not chosen for the base model. The variable that, when added, produced the greatest absolute change in the parameter estimate (ß) for the primary risk factor of interest (work status) was kept if it altered that estimate by at least 10%. This added variable would define a new base model, and the process was repeated, adding one variable at a time, until no remaining candidates would, when added, alter the parameter estimate by at least 10%. All models were adjusted for age and sex regardless of significance levels.

Results

Survey data from 220 participants were analyzed. Mean age was 53.4 years (*SD* 9.3) for the normal and over- weight group, and 53.2 years (*SD* 8.8) for the group with obesity. Unadjusted analyses (shown on Table 1) demonstrated that employed and highly WTC-exposed individuals were more likely to be obese (respectively, $p = .05$ and $p = .02$). Individuals with obesity were more likely to report less active dieting ($p = .0002$), less

weekly exercise ($p = .03$), and drinking more glasses of soda ($p = .03$) and fewer glasses of juices daily ($p = .04$) than normal/overweight participants.

In logistic regression, the following factors were associated with obesity (see Table 2): ethnicity (higher risk for non-Latino African Americans, OR 4.37, 95% CI, 1.36–14.05), being actively employed (OR 2.14, 95% CI, 1.02–4.46), having a high number (6–10) of comorbid chronic diseases (OR 7.22, 95%, CI 2.21–23.59), low exercise frequency: none vs. at least 3 times per week (OR 0.39, 95%, 0.18–0.81), active dieting (OR 3.13, 95%, CI 1.56–6.28) and tending to drink no juice daily (OR 0.21 and 0.58, respectively, for drinking 1 or at least 2 glasses daily, relative to none). Only 55 of the patients seemed to identify some specific life event (accident, pregnancy, etc.) as related to their weight gain, and of those, only 17 pointed to their WTC occupational experience. There was no association between obesity and self-reported depression/anxiety.

Comment

The results of the study revealed a significant trend among the actively working population subgroup in that these workers were more than twice as likely as their nonworking (disabled, retired, un- or underemployed) counterparts to be obese. This finding seems to replicate the positive associations between employment status and weight gain reported by Au et al[10,14] as well as previous studies on employment hours and weight.[8–9,14–16] Life-style choices associated with working longer hours, such as poor diet and nonadherence to physical exercise, may explain these results. Our study population consisted of many first responders, including firefighters, emergency medical technicians, and police officers as well as construction workers and laborers who generally work long hours and variable or irregular shifts, all of which may be contributing factors to our findings.

Overweight and obesity prevalences have both been noted to be higher in the WTC cohorts than in the general US population.[3,5] Since there could be some potential explanations for an association between obesity and WTC occupational exposures, we explored that in this study. A mix of various chemical substances with potential endocrine disrupting properties such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organochlorine pesticides, and polychlorinated furans and dioxins were detected in analyses of the WTC dust.[14,17] Exposure to PAHs has been associated with obesity.[18] Thus, by direct exposure to the toxic dust, obesity-related hormones may have been affected. The unadjusted association was not confirmed by multivariate analysis, but further investigation into a potential association may be warranted.

Although we hypothesized that disability and nonworking status could be associated with excessive weight, our findings were actually the opposite in that we found that those individuals did not have significant weight gain and seemed to be less overweight and obese than their actively working counterparts.

There were limitations to our study. Its cross-sectional design limits the ability to establish the direction of the associations. We classified WTC-related exposure using a composite variable with a qualitative approach similar to previous classifications of WTC exposures,[13]

which may be relevant to some but not all of potentially related adverse health effects. There is no complete quantitative inventory of all the occupational and environmental exposures that may have been relevant to the adverse health effects resulting from work at the WTC disaster site. We also lacked information on work shift, another suggested risk factor for weight gain.[19] Although we assessed the effect of comorbid conditions, we did not directly assess the effect of treatment modalities that can be associated with weight gain. It is possible differential effects of comorbidity type, as well as level of activity and fitness requirements associated with different types of work, are related to WTC exposure. Another limitation is that disability, retirement, and unemployment status were grouped into a single category, which may mask the true association of one of those working status subcategories with the outcome of interest.

These associations deserve further exploration and may guide future interventions to prevent obesity-related comorbidities, including accelerated lung function decline in this patient cohort. Besides promotion of exercise for fitness in this occupationally physically active population (mostly construction workers), formal nutritional counseling may be an important therapeutic intervention that can positively affect the long-term health and well-being of this patient population.

Conclusions

Obesity is highly prevalent among former WTC workers and volunteers,[3,4] and we detected associations of obesity with active employment status, race/ethnicity, number of comorbidities, active dieting, no weekly exercise (compared to at least 3 times per week), and not drinking any glass of juice daily. The association of obesity with active employment suggests that interventions that favor healthy habits among actively employed individuals are warranted.

Acknowledgment

References

1. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity in the United States, 2009–2010. NCHS Data Brief. 1 2012:1–8.

2. The NHS Information Centre. Statistics on Obesity, Physi- cal Activity and Diet: England, 2012. London, England: The Health and Social Care Information Centre; 2012.

3. Skloot GS, Schechter CB, Herbert R, et al. Longitudinal assessment of spirometry in the World Trade Center Medical Monitoring Program. Chest. 2009;135:492–498. [PubMed: 19141527]

4. Aldrich TK, Gustave J, Hall CB, et al. Lung function in rescue workers at the World Trade Center after 7 years. N Engl J Med. 2010;362:1263–1267. [PubMed: 20375403]

5. Webber MP, Lee R, Soo J, et al. Prevalence and incidence of high risk for obstructive sleep apnea in World Trade Center-exposed rescue/recovery workers. Sleep Breath. 2011;15:283–294. [PubMed: 20593281]

6. Naveed B, Weiden MD, Kwon S, et al. Metabolic syndrome biomarkers predict lung function impairment: a nested case-control study. Am J Respir Crit Care Med. 2011;185:392–399. [PubMed: 22095549]

7. de la Hoz RE, Shohet MR, Chasan R, et al. Occupational toxicant inhalation injury: the World Trade Center (WTC) experience. Int Arch Occup Environ Health. 2008;81:479–485. [PubMed: 17786467]

8. Monsivais P, Martin A, Suhrcke M, Forouhi N, Warehama N. Job-loss and weight gain in British adults: evidence from two longitudinal studies. Soc Sci Med. 2015;143:223–231. [PubMed: 26364009]

9. Gueorguieva R, Sindelar JL, Wu R,Gallo WT. Differential changes in body mass index after retirement by occupation: hierarchical models. Int J Public Health. 2011;56:111–116. [PubMed: 20625792]

10. Au N, Hauck K, Hollingsworth B. Employment, work hours and weight gain among middle-aged women. Int J Obes. 2013;37:718–724.

11. Au N, Hollingsworth B. Employment patterns and changes in body weight among young women. Prev Med. 2011;52:310–16. [PubMed: 21397631]

12. Herbert R, Moline J, Skloot G, et al. The World Trade Center disaster and the health of workers: five-year assessment of a unique medical screening program. Environ Health Perspect. 2006;114:1853–1858. [PubMed: 17185275]

13. Wisnivesky JP, Teitelbaum S, Todd AC, et al. Persistence of multiple illnesses in September 11 rescue workers. Lan- cet. 2011;378:888–897.

14. Shields M Long working hours and health. Health Rep. 1999;11:33–48. [PubMed: 10618741]

15. Courtemanche C Longer hours and larger waistlines? The relationship between work hours and obesity. Forum Health Econ Policy. 2009;12:1–31.

16. Mercan MA. A research note on the relationship between long working hours and weight gain for older workers in the United States. Research on Aging. 2014;36:557–567. [PubMed: 25651510]

17. Landrigan PJ, Lioy PJ, Thurston G, et al. Health and environmental consequences of the World Trade Center disaster. Environ Health Perspect. 2004;112:731–739. [PubMed: 15121517]

18. Ranjbar M, Rotondi MA, Ardern CI, Kuk JL. Urinary biomarkers of polycyclic aromatic hydrocarbons are associated with cardiometabolic health risk. PLoS One. 2015;10:1–10.

19. Buchvold HV, Pallesen S, yane NF, Bjorvatn B. Associations between night work and; BMI, alcohol, smoking, caffeine and exercise—a cross-sectional study. BMC Public Health. 2015;15:1112. [PubMed: 26558686]

Table 1.

Characteristics of the study population (*n* = 220) and unadjusted comparisons between subjects with and without obesity.

Characteristic	Without obesity *n* (%)	Obesity *N* (%)	Total *n* (%)	*P*
Male sex	75 (66.4)	74 (69.2)	149(67.7)	.66
Ethnicity				.21
Latino	66 (58.4)	50 (46.7)	116 (52.7)	
Non-Latino Caucasian	36 (31.9)	45 (42.1)	81 (36.8)	
Non-Latino African American	11 (9.7)	12 (11.2)	23 (10.5)	
Language				.04
English	45 (39.8)	51 (47.7)	96 (43.6)	
Spanish	62 (54.9)	43 (40.2)	105 (47.7)	
Polish/other	6 (5.3)	13 (12.2)	19 (8.6)	
Highest level of education				.56
Less than high school	33 (29.2)	26 (24.3)	59 (26.8)	
High school	29 (25.7)	31 (28.9)	60 (27.3)	
Beyond high school	51 (45.2)	50 (46.7)	101 (45.9)	
WTC occupation				.04
Law enforcement	13 (11.5)	21 (19.6)	34 (15.5)	
Laborer	64 (56.6)	49 (45.8)	113 (51.4)	
Construction	10 (8.9)	6 (5.6)	16 (7.3)	
City employee	4 (3.5)	10 (9.4)	14 (6.4)	
Firefighter	4 (3.5)	1 (0.9)	5 (2.3)	
Ironworker	1 (0.9)	4 (3.7)	5 (2.3)	
Other	7 (6.2)	12 (11.2)	19 (8.6)	
Volunteer	10 (8.9)	4 (3.7)	14 (6.4)	
Work status				.05
Nonworking	70 (61.9)	52 (48.6)	122 (55.5)	
Working	43 (38.1)	55 (51.4)	98 (44.6)	
WTC occupational exposure				.02
Arrival 48 hr and exposure 60 d	39 (34.5)	51 (47.7)	90 (40.9)	
Arrival 48 hr or exposure 60 d	60 (53.1)	50 (46.7)	110 (50)	

Characteristic	Without obesity n (%)	Obesity N (%)	Total n (%)	P
Arrival > 48 hr and exposure < 60 d	14 (12.4)	6 (5.6)	20 (9.1)	
Comorbid chronic diseases				.0004
1–2	21 (18.6)	10 (9.4)	31 (14.1)	
3–5	66 (58.4)	48 (44.9)	114 (51.8)	
6–10	26 (23.1)	49 (45.8)	75 (34.1)	
Alcohol consumption				.68
Yes	41 (36.3)	36 (33.6)	77 (35)	
No	72 (63.7)	71 (66.4)	143 (65)	
Exercise				.45
No	36 (31.9)	42 (39.3)	78 (35.5)	
Walking and/or weights only	41 (36.3)	32 (29.9)	73 (33.2)	
Jog/swim/bike/Aerobics (1 or more)	36 (31.9)	33 (30.8)	69 (31.4)	
Exercise frequency				.03
None	36 (31.9)	42 (39.3)	78 (35.5)	
1–2 times/week	10 (8.9)	22 (20.6)	32 (14.6)	
> 3 times/week	67 (59.3)	43 (40.2)	110 (50)	
Dieting				.0002
No	83 (73.5)	52 (48.6)	135 (61.4)	
Yes	30 (26.6)	55 (51.4)	85 (38.6)	
Daily meals				.08
1 or 2	36 (31.9)	42 (39.3)	78 (35.5)	
3	45 (39.8)	46 (42.9)	91 (41.4)	
4	32 (28.3)	19 (17.8)	51 (23.2)	
Daily glasses of soda				.03
0	71 (62.8)	53 (49.5)	124 (56.4)	
1	30 (26.6)	34 (31.8)	64 (29.1)	
> 2	12 (10.6)	20 (18.7)	32 (14.6)	
Daily glasses of juice				.04
0	62 (54.9)	79 (73.8)	141 (64.1)	
1	36 (31.9)	15 (14)	51 (23.2)	
2	15 (13.3)	13 (12.2)	28 (12.7)	

Characteristic	Without obesity *n* (%)	Obesity *N* (%)	Total *n* (%)	*P*
Weekly fast food				.53
None	53 (46.9)	43 (40.2)	96 (43.6)	
1–5	50 (44.3)	56 (52.3)	106 (48.2)	
> 5	10 (8.9)	8 (7.5)	18 (8.2)	
Weekly home meals				.80
< 5	11 (9.7)	12 (11.2)	23 (10.5)	
5–10	26 (23)	19 (17.8)	45 (20.5)	
> 10	76 (67.3)	76 (71)	152 (69.1)	

Table 2.

Obesity-associated risk factors in the WTC population.

Risk factor	Estimate	95% CI	P
	Adjusted odds ratio		
Gender			.951
Male	1.00		
Female	1.02	0.51, 2.07	
Age	0.99	0.96, 1.03	.771
Ethnicity			.038
Latino	1.00		
Non-Latino Caucasian	1.69	0.79,3.58	
Non-Latino African American	4.37	1.36,14.05	
Work status			.043
Not working	1.00		
Working	2.14	1.02, 4.46	
WTC exposure			.12
Arrival > 48 hr and exposure < 60 d	1.00		
Arrival 48 hr or exposure 60 d	1.54	0.47, 5.01	
Arrival 48 hr and exposure 60 d	2.81	0.84, 9.37	
Comorbid chronic diseases			.001
1–2	1.00		
3–5	2.10	0.76, 5.85	
6–10	7.22	2.21, 23.59	
Exercise frequency			.006
None	1.00		
1–2 times/week	1.56	0.54, 4.49	
3 times/week	0.39	0.18, 0.81	
Dieting			.001
No	1.00		
Yes	3.13	1.56, 6.28	
Daily glasses ofjuice			.001
0	1.00		
1	0.21	0.09, 0.49	
2	0.58	0.21, 1.56	
Weekly fast food			.125
None	1		
1–5	2.15	1.03, 4.49	
> 5	2.17	0.43, 10.88	
Weekly home meals			.199
< 5	1		
5–10	0.69	0.18, 2.64	
> 10	1.54	0.41, 5.81	