Routledge
Taylor & Francis Group

Archives of Environmental & Occupational Health

ISSN: 1933-8244 (Print) 2154-4700 (Online) Journal homepage: http://www.tandfonline.com/loi/vaeh20

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

**Camille O. Napier MD, MPH, Ositadinma Mbadugha MD, Laura A. Bienenfeld MD, MPH, John T. Doucette PhD, Roberto Lucchini MD, Shirley Luna-Sánchez MD & Rafael E. de la Hoz MD, MPH, MSc**

**To cite this article:** Camille O. Napier MD, MPH, Ositadinma Mbadugha MD, Laura A. Bienenfeld MD, MPH, John T. Doucette PhD, Roberto Lucchini MD, Shirley Luna-Sánchez MD & Rafael E. de la Hoz MD, MPH, MSc (2016): Obesity and weight gain among former World Trade Center workers and volunteers, Archives of Environmental & Occupational Health, DOI: 10.1080/19338244.2016.1197174

**To link to this article:** http://dx.doi.org/10.1080/19338244.2016.1197174

Accepted author version posted online: 07 Jun 2016.
Published online: 07 Jun 2016.

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

Camille O. Napier, MD, MPH[1,2], Ositadinma Mbadugha, MD[1], Laura A. Bienenfeld, MD, MPH[1,2,3], John T. Doucette, PhD[1], Roberto Lucchini, MD[1,2], Shirley Luna-Sánchez, MD[1], and Rafael E. de la Hoz, MD, MPH, MSc[1,2]

[1]Department of Preventive Medicine, [2]and Medicine, Icahn School of Medicine at Mount Sinai, New York, NY, USA.

[3]Department of Medicine, New York University School of Medicine, New York, NY, USA

Corresponding author: Rafael E. de la Hoz, MD, MPH, MSc, FACP, FCCP,WTC HP CCE Box 1059, One Gustave L. Levy Place, New York, NY 10029, U. S. A., tel. 212-241-7996, facsimile 212-241-5516, electronic address: Rafael.delaHoz@mssm.edu.

FUNDING: None.

DISCLOSURE: The authors declare no conflict of interest, and no source of funding for this project. We acknowledge the collaboration of the staff at the WTC Health Program Clinical Center of Excellence at Mount Sinai Medical Center.



## ABSTRACT

**Objective:** 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.

**Methods:** We surveyed 220 subjects at the [INST] WTC Clinical Center to assess their obesity and current employment and disability status, WTC occupational exposure level, medical comorbidities, dietary and exercise habits. Bivariate and logistic regression multivariate analyses

 

were used to explore associated risk factors.

**Results:** 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.

**Conclusions:** The association of obesity with active employment suggests that interventions that favor healthy habits among actively employed individuals are warranted.



 

## INTRODUCTION

Despite an 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] (e.g., asthma and gastroesophageal 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 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 those by 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 Clinical Center, to identify both lifestyle and occupational factors associated with obesity in this patient population.

## METHODS

### Subjects 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 participate in longitudinal health monitoring at the WTCHP of the [INST] 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 clean-up 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 [INST] 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 [INST] WTC Treatment Program were sequentially invited and 223 agreed to participate in the survey. Due to their small number, 3 subjects of non-Latino Asian race/ethnicity were excluded, leaving a study sample of 220 subjects. Study participants were recruited for a period of four 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 $kg/m^2$. Subjects 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 with 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/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 d, 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/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 (e.g. 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 $\alpha=0.05$. 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 0.10, 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 which, 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 subjects were analyzed. Mean age was 53.4 years (SD 9.3) for the normal and overweight 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=0.05 and p=0.02). Individuals with obesity were more likely to report less active dieting (p=0.0002), less weekly exercise (p=0.03), drinking more glasses of soda (p=0.03) and less glasses of juices daily (p=0.04) than normal/overweight subjects.

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/week (OR 0.39, 95% 0.18, 0.81), active dieting (OR 3.13, 95% CI 1.56, 6.28) and tended 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.



**DISCUSSION**

The results of the study revealed a significant trend amongst the actively working population subgroup, in that these workers were over twice as likely to be obese as their nonworking(disabled, retired, un-or underemployed) counterparts. This finding seems to replicate Au et al.'s ~~recently~~ reported positive associations between employment status and weight gain[10, 14] as well as previous studies on employment hours and weight[8-9,14-16]. Lifestyle choices associated with working longer hours, such as poor diet and non-adherence to physical exercise, may explain these results. Our study population consisted of many first responders,

including firefighters, emergency medical technicians, 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 United States 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]. Exposure to PAHs has been associated with obesity[19]. 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 non-working 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 which 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[18]. Although we assessed the effect of comorbid conditions, we did not directly assess the impact 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 which can impact positively 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 (compared to at least 3-time) weekly exercise, 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.

**REFERENCES**

1. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity in the United States, 2009–2010. *NCHS data brief, no 82*. National Center for Health Statistics. Hyattsville, MD: 2012.

2. The NHS Information Centre. *Statistics on Obesity, Physical Activity and Diet: England, 2012.* The Health and Social Care Information Centre: London, 2012.

3. Skloot GS, Schechter CB, Herbert R, Moline JM, Levin SM, Crowley LE, et al. Longitudinal assessment of spirometry in the World Trade Center Medical Monitoring Program. *Chest* 2009; 135:492-498.

4. Aldrich TK, Gustave J, Hall CB, Cohen HW, Webber, MP, Zeig-Owens R, et al. Lung Function in Rescue Workers at the World Trade Center after 7 Years. *New England Journal of Medicine* 2010; 362:1263-1267**.**

5. Webber MP, Lee R, Soo J, Gustave J, Hall CB, Kelly K, 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.

6. Naveed B, Weiden MD, Kwon S, Gracely EJ, Comfort AL, Ferrier N, et al. Metabolic syndrome biomarkers predict lung function impairment: a nested case-control study. *Am J Respir Crit Care Med* 2011; 185:392-399.

7. de la Hoz RE, Shohet MR, Chasan R, Bienenfeld LA, Afilaka AA, Levin SM, et al. Occupational toxicant inhalation injury: the World Trade Center (WTC) experience. *Int Arch Occup Environ Health* 2008, 81:479-485.

8. Monsivais P, Martin A, Suhrcke M, Forouhi N, and Warehama N. Job-loss and weight gain in

British adults: Evidence from two longitudinal studies. *Soc Sci Med.* 2015 Oct; 143: 223–231.

9. Gueorguieva R, Sindelar JL, Wu R, and Gallo WT. Differential changes in body mass index after retirement by occupation: hierarchical models. *Int J Public Health.* 2011 Feb;56(1):111-6.

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 and Hollingsworth B. Employment patterns and changes in body weight among young women. *Prev Med.* 2011 May;52(5):310-6.

12. Herbert R, Moline J, Skloot G, Metzger K, Barron, S, Luft B,
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.

13. Wisnivesky JP, Teitelbaum S, Todd AC, Boffetta P, Crane M, Crowley L, et al. Persistence of multiple illnesses in September 11 rescue workers. *Lancet* 2011; 378:888-897.

14. Shields M. Long working hours and health. *Health Rep* 1999; 11:33-48.

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(5): 557-567.

17. Landrigan PJ, Lioy PJ, Thurston G, Berkowitz G, Chen LC, Chillrud SN, et al. Health and Environmental Consequences of the World Trade Center Disaster. Environ Health Perspect 2004; 112: 731- 739.

18. Buchvold HV, Pallesen S, Oyane NF, Bjorvatn. Associations between night work and BMI, alcohol, smoking, caffeine and exercise - a cross- sectional study. *BMC Public health* 2015;

15:1112.

19. Ranjbar M, Rotondi MA, Ardern CI, and Kuk JL. Urinary Biomarkers of Polycyclic Aromatic Hydrocarbons Are Associated with Cardiometabolic Health Risk. *PLoS One.* 2015; 10(9): 1- 10.



 

**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) | 0.66 |
| **Ethnicity** | | | | 0.21 |
| 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** | | | | 0.04 |
| 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** | | | | 0.56 |
| 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** | | | | 0.04 |
| 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** | | | | 0.05 |
| Non-working | 70(61.9) | 52(48.6) | 122(55.5) | |
| Working | 43(38.1) | 55(51.4) | 98(44.6) | |
| **WTC Occupational exposure** | | | | 0.02 |
| Arrival $\leq$ 48 hr and exposure $\geq$ 60 d | 39(34.5) | 51(47.7) | 90(40.9) | |
| Arrival $\leq$ 48 hr or exposure $\geq$ 60 d | 60(53.1) | 50(46.7) | 110(50) | |
| Arrival > 48 hr and exposure < 60 d | 14(12.4) | 6(5.6) | 20(9.1) | |
| **Comorbid chronic diseases** | | | | 0.0004 |
| 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** | | | | 0.68 |
| Yes | 41(36.3) | 36(33.6) | 77(35) | |
| No | 72(63.7) | 71(66.4) | 143(65) | |
| **Exercise** | | | | 0.45 |
| 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** | | | | 0.03 |
| 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** | | | | 0.0002 |
| No | 83(73.5) | 52(48.6) | 135(61.4) | |
| Yes | 30(26.6) | 55(51.4) | 85(38.6) | |
| **Daily meals** | | | | 0.08 |
| 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** | | | | 0.03 |
| 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** | | | | 0.04 |
| 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) | |
| **Weekly fast food** | | | | 0.53 |
| 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** | | | | 0.80 |
| < 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 | Adjusted odds ratio | | |
|---|---|---|---|
| | **Estimate** | **95% C.I.** | **p** |
| **Gender** | | | 0.951 |
| Male | 1.00 | | |
| Female | 1.02 | 0.51, 2.07 | |
| **Age** | 0.99 | 0.96, 1.03 | 0.771 |
| **Ethnicity** | | | 0.038 |
| Latino | 1.00 | | |
| Non-Latino Caucasian | 1.69 | 0.79, 3.58 | |
| Non-Latino African-American | 4.37 | 1.36, 14.05 | |
| **Work status** | | | 0.043 |
| Not-Working | 1.00 | | |
| Working | 2.14 | 1.02, 4.46 | |
| **WTC exposure** | | | 0.12 |
| Arrival > 48 hr and exposure < 60 d | 1.00 | | |
| Arrival $\leq$ 48 hr or exposure $\geq$ 60 d | 1.54 | 0.47, 5.01 | |
| Arrival $\leq$ 48 hr and exposure $\geq$ 60 d | 2.81 | 0.84, 9.37 | |
| **Comorbid chronic diseases** | | | 0.001 |
| 1-2 | 1.00 | | |
| 3-5 | 2.10 | 0.76, 5.85 | |
| 6-10 | 7.22 | 2.21, 23.59 | |
| **Exercise frequency** | | | 0.006 |
| None | 1.00 | | |
| 1-2 times/week | 1.56 | 0.54, 4.49 | |
| $\geq$ 3 times/week | 0.39 | 0.18, 0.81 | |
| **Dieting** | | | 0.001 |
| No | 1.00 | | |
| Yes | 3.13 | 1.56, 6.28 | |
| **Daily glasses of juice** | | | 0.001 |
| 0 | 1.00 | | |
| 1 | 0.21 | 0.09, 0.49 | |
| $\geq$ 2 | 0.58 | 0.21, 1.56 | |
| **Weekly fast food** | | | 0.125 |
| None | 1 | | |
| 1-5 | 2.15 | 1.03, 4.49 | |
| > 5 | 2.17 | 0.43, 10.88 | |
| **Weekly home meals** | | | 0.199 |
| < 5 | 1 | | |

| | | | |
|---|---|---|---|
| 5-10 | 0.69 | 0.18, 2.64 | |
| > 10 | 1.54 | 0.41, 5.81 | |



 