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# Association between triclosan and obesity using NHANES 2007-2016: Overall and stratified population

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**Abstract.** Studies have shown that triclosan is able to exert estrogenic activity and may affect energy metabolism through multiple mechanisms, which in turn is associated with obesity and overweight. However, insufficient research has been done to confirm its connection to obesity in the general population. This study's aim was to explore the relationship between triclosan and obesity in American adults (aged ≥ 20). The association was further explored in populations stratified by sex, age, race, education level, and socioeconomic status. In the general population, there was a connection between triclosan and obesity that was detrimental. (OR: 0.97, 95% CI: 0.95-0.99, p value: 0.017).In the other race group, triclosan and obesity were found to be dramatically negatively correlated (including multi-racial) when stratified by race (OR: 0.89, 95% CI: 0.8-0.98, p value: 0.019). When stratified by socioeconomic class, there was a substantial relationship between triclosan and obesity in the above poverty group. (OR: 0.97, 95% CI: 0.94-1, p value: 0.023). Finally, when dividing the population according to education level, we had a more novel finding in the graduate or above group: it was discovered that triclosan lowers the likelihood of obesity (OR: 0.92, 95% CI: 0.88-0.98, p value: 0.005) while increasing odds of overweight (OR: 1.06, 95% CI: 1.01-1.11, p value: 0.027).

**Keywords:** Obesity, Triclosan, US Adult, NHANES.

## 1. Introduction

The sixth-ranking risk factor for disease that affects the global burden of illness is having an excessive amount of body weight [1]. A significant public health issue is the obesity epidemic. A number of disorders, including diabetes, hypertension [2], cardiovascular disease, and stroke, as well as life expectancy and mental health, have been demonstrated to be highly correlated with obesity, according to studies. Factors that contribute to obesity are complex, with a large body of research evidence linking obesity to dietary patterns, frequency of exercise, and other studies showing that an individual's propensity for weight gain and obesity is heavily influenced by genetic factors [3]. But new research has revealed that a number of environmental factors are also linked to obesity [4]. By disrupting the body's endocrine system, environmental pollutants that cause obesity include bisphenol A, phthalates, and mentals [5-7]. It was discovered in the late 1930s and early 1940s that substituting chlorine for hydrogen atoms on aromatic rings produced a unique chemistry of antimicrobials [8]. Triclocarban (TCC) and Trilosan (TCS) came into being. TCS, a bacteriostatic agent, is used in the manufacture of clothing, food packaging supplies, toys, food processing surfaces, healthcare supplies, and particularly personal care products (PCP) like soap, toothpaste, and shampoo [9]. Unsettlingly, TCS can be strongly found in

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samples of human urine and serum [10]. The ability of triclosan and triclocarban to have estrogenic effects was demonstrated by a number of in vitro tests [11]. And it was discovered that estrogens contributed to the emergence of fat [12]. Therefore, in this paper, we will explore how Triclocarban (TCC), an environmental factor, will affect obesity in US adults (age≥20). Additionally, contrast the relationship between TCC and obesity in relation to different age groups, genders, races, socioeconomic statuses, and education level.

## 2. Methods

### *2.1. Data resource*

CDC (The Centers for Disease Control and Prevention) conducts NHANES (The National Health and Nutrition study), a regular study, to assess the population's dietary intake and overall health in the US [13]. Each year, they conduct a survey on 5,000 or so randomly selected participants from across the country. NHANES includes both interviews and physical testing. In the interview, questions on demographics, socioeconomics, diet, and health are asked, and in the examination, highly qualified medical staff take measures of the patient's body and do medical, dental, and physiological tests. Epidemiological studies and health sciences research will both use the survey's data. All NHANES participants supplied written informed consent. The US Army Research Institute of Environmental Medicine Human Use Review Committee and the Research Ethics Review Board of the National Center for Health Statistics concurred with the study's methodology [14]. The NHANES website's official page [15-16] provides more information about survey design, procedures, and data protocols.

The initial sample for this study was made up of 13711 individuals who had valid NHANES data from 2007 to 2016. 7685 people were included in our final analysis after those under the age of 20 and those missing information on triclosan, BMI, PIR, Cotinine, and creatinine were not included (Figure 1).

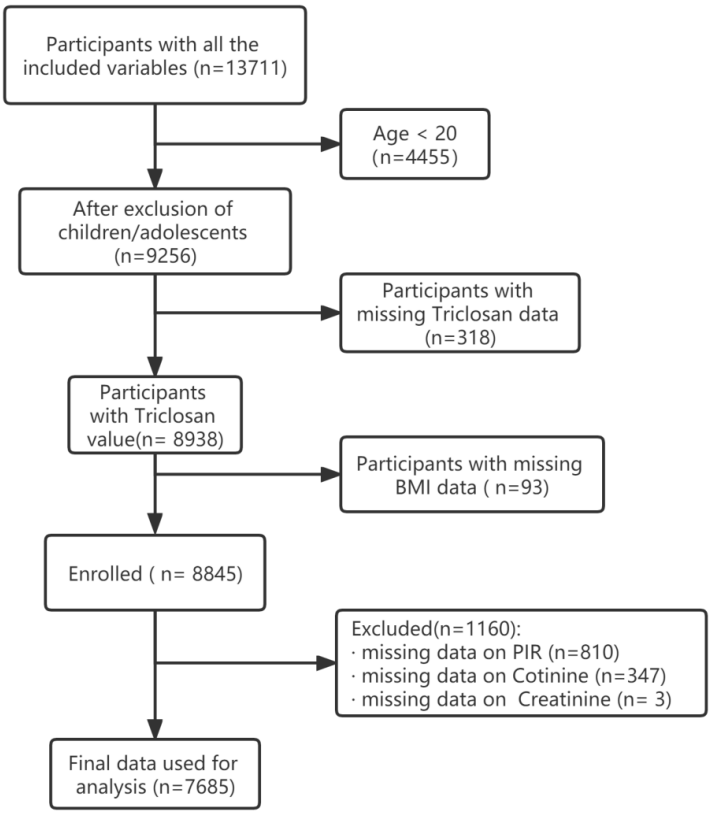


**Figure 1.** Flowchart illustrating the selection of the study's participants.

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### *2.2. Triclosan*

Urinary triclosan was the exposure variable for this investigation. It has been utilized in soap and other personal care products as bactericides. In the mobile examination center (MEC), a urine sample was collected. The MEC required participants to use a specimen cup to provide a complete void of urine. After that, the samples are prepared, kept, and dispatched. Using HPLC-MS/MS in conjunction with isotope dilution on-line solid-phase extraction (SPE), nine environmental phenolic chemicals, including triclosan, were detected in urine [17]. The conjugated phenol species in 100 mL of urine are hydrolyzed with -glucuronidase/sulfatase. Following hydrolysis, samples are neutralized with 0.1 M formic acid before the phenols are preconcentrated online using SPE, separated using reversed-phase HPLC, and detected using APCI-MS/MS. Detailed laboratory procedure manual, including the clinical relevance, test principles, safety precautions, and so on could be found at NHANES laboratory methods [18-19].

### *2.3. Obesity*

BMI, which is calculated by dividing a person's weight in kilograms by their height in square meters, was used to measure obesity [20]. The Mobile Examination Centers (MECs) measured people's weight and height according to a set protocol. Afterward, based on the size of their BMI, the study participants were divided into three categories: underweight/normal, overweight, and obese. BMI at or above 30 kg/m2 was considered obese [21], while the underweight/normal and overweight groups have BMI measures of less than 25 and midway between 25 and 30.

### *2.4. Covariates*

Several possible complicating factors, including age, gender, race, smoking status, socioeconomic status, education level, smoking status, and some chemical substances such as creatinine and bisphenol A were set as covariates to be considered. Using a standardized questionnaire, the demographic data—including age, sex, education level, race, and socioeconomic status—was collected during the family interview. Sex categories included male and female. Age was broken down into three categories: 20–39, 40–59, and 60 and order. Three categories of educational level were established: graduate or above, college, and high school or below. Following are categories for race and ethnicity: Other Hispanics, Mexican Americans, non-Hispanic White, non-Hispanic Black, and other racial groups (including multiracial). The poverty income ratio (PIR), which is used to assess poverty and determine socioeconomic status, is created by dividing the family's income by a poverty threshold. PIR less than or equal to 1 is regarded as at or below poverty, whereas PIR greater than 1 is regarded as above poverty. Smoking and bisphenol A were included in the model since they have been linked to obesity [22]. To determine the level of bisphenol A (ng/mL) in the urine, a tandem mass spectrometry method, high performance liquid chromatography, and an online SPE methodology were used. The serum level of cotinine(ng/mL) served as a proxy for smoking status. Creatinine levels(mg/dL) were also included in the model to account for urine dilution.

### *2.5. Statistical analysis*

R version 4.2.2 was used to perform statistical analysis. To correct for skewness, the concentrations of bisphenol A and triclosan in the urine were log-transformed. After accounting for all potentially confounding factors such sex, age, race, smoking status, socioeconomic status, level of education, bisphenol A and creatinine, logistic regression was performed to acertain the relationship between urine triclosan concentrations and obesity. The link between obesity and triclosan was then assessed in people of various ages, genders, races, educational levels, and socioeconomic statuses.

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## 3. Results

### *3.1. Baseline characteristics*

**Table 1.** Participants' baseline characteristics according to their obese level.

| characteristic | level | Overall | Obesity measured by BMI | | |
|---|---|---|---|---|---|
| | | | Underweight /Normal | Overweight | Obese |
| n | | 7685 | 2265 | 2515 | 2905 |
| Gender (%) | male | 3735 (48.6) | 1033 (45.6) | 1406 (55.9) | 1296 (44.6) |
| | female | 3950 (51.4) | 1232 (54.4) | 1109 (44.1) | 1609 (55.4) |
| Race (%) | mexican American | 1127 (14.7) | 196 ( 8.7) | 430 (17.1) | 501 (17.2) |
| | other Hispanic | 787 (10.2) | 183 ( 8.1) | 295 (11.7) | 309 (10.6) |
| | non-Hispanic White | 3309 (43.1) | 1051 (46.4) | 1101 (43.8) | 1157 (39.8) |
| | non-Hispanic Black | 1605 (20.9) | 377 (16.6) | 440 (17.5) | 788 (27.1) |
| Race (%) | other Race - Including Multi-Racial | 857 (11.2) | 458 (20.2) | 249 (9.9) | 150 (5.2) |
| Education (%) | college | 2244 (29.2) | 613 (27.1) | 673 (26.8) | 958 (33.0) |
| | graduate or above | 1821 (23.7) | 696 (30.8) | 624 (24.8) | 501 (17.2) |
| | highschool or below | 3613 (47.1) | 950 (42.1) | 1217 (48.4) | 1446 (49.8) |
| PIR (%) | above poverty | 5964 (77.6) | 1759 (77.7) | 1991 (79.2) | 2214 (76.2) |
| | at/below poverty | 1721 (22.4) | 506 (22.3) | 524 (20.8) | 691 (23.8) |
| Cotinine (mean (SD)) | | 58.2 (129.0) | 70.2 (137.4) | 56.9 (128.1) | 49.9 (122.3) |
| Creatinine (mean (SD)) | | 124.4 (80.0) | 110.8 (79.1) | 122.4 (77.0) | 136.7 (81.3) |
| Triclosan (mean (SD)) | | 91.5 (281.4) | 96.2 (275.0) | 94.0 (271.4) | 85.6 (294.4) |
| Bisphenol_A (mean (SD)) | | 3.4 (18.7) | 3.3 (19.1) | 3.4 (21.6) | 3.6 (15.4) |
| Age (mean (SD)) | general | 48.9 (17.6) | 46.2 (18.8) | 50.8 (17.5) | 49.3 (16.4) |
| | 20-39 | 29.5 (5.8) | 28.3 (5.8) | 30.2 (5.7) | 30.1 (5.8) |
| | 40-59 | 49.2 (5.6) | 48.7 (5.7) | 49.1 (5.7) | 49.5 (5.6) |
| | 60 and older | 69.9 (6.9) | 71.4 (7.2) | 70.1 (6.9) | 68.6 (6.4) |

The characteristics of the test population were shown in Table 1. In all, 7685 people were included in the study, with a balanced gender distribution of 48.6% men and 51.4% women. The population's 48.9-year-old median age was the total figure. There were 2905 obese people in total, which is more than one-third of the overall population, 2515 individuals were overweight, and the number of people with low or normal weight was 2265. Those above the poverty line accounted for the vast majority of the

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total (77.6%).The Non-Hispanic White group, which made up 43.1% of the overall population, had the most members in terms of ethnic dispersion. The mean triclosan level in urine was 91.5 ng/mL.

### *3.2. Association between triclosan and obesity*

By using logistic regression analysis, Table 2 displayed the relationships between triclosan in urine and obesity. Using logistic regression with age, gender, race, smoking status, education level, socioeconomic status, creatinine, and bisphenol A in urine set as covariates, associations between triclosan exposure and overweight and obesity were studied individually. According to the results, exposure to triclosan was associated with a decreased incidence of obesity (OR: 0.97, 95% CI: 0.95-0.99, p value: 0.017). The exposure to triclosan, however, was not significantly linked to being overweight.

**Table 2.** Association between Triclosan and Obesity via Logistic Regression.

| | Underweight/ Normal | Overweight (95% CI) | p values | Obese OR (95% CI) | p values |
|---|---|---|---|---|---|
| Overall population | Ref. | 1.01(0.98~1.03) | 0.549 | 0.97(0.95~0.99) | 0.017 |
| Stratification by Gender | | | | | |
| male | Ref. | 1.02(0.98~1.05) | 0.311 | 0.97(0.93~1) | 0.058 |
| female | Ref. | 1(0.96~1.03) | 0.876 | 0.98(0.94~1.01) | 0.205 |
| Racial | | | | | |
| mexican American | Ref. | 0.99(0.94~1.06) | 0.866 | 1(0.94~1.06) | 0.938 |
| other Hispanic | Ref. | 1(0.96~1.04) | 0.980 | 0.97(0.93~1.01) | 0.139 |
| non-Hispanic White | Ref. | 1(0.93~1.07) | 0.997 | 0.93(0.87~1) | 0.051 |
| non-Hispanic Black | Ref. | 1.01(0.95~1.08) | 0.676 | 1(0.95~1.06) | 0.869 |
| other Race - Including multi-Racial | Ref. | 1.05(0.98~1.13) | 0.185 | 0.89(0.8~0.98) | 0.019 |
| Age | | | | | |
| 20-39 | Ref. | 1.03(0.98~1.07) | 0.253 | 0.98(0.94~1.02) | 0.351 |
| 40-59 | Ref. | 1.01(0.97~1.06) | 0.574 | 0.97(0.93~1.01) | 0.136 |
| 60 and older | Ref. | 0.98(0.94~1.03) | 0.430 | 0.97(0.93~1.02) | 0.206 |
| Socioeconomic status | | | | | |
| at/below poverty | Ref. | 0.98(0.93~1.04) | 0.614 | 0.98(0.93~1.04) | 0.575 |
| above poverty | Ref. | 1.01(0.98~1.04) | 0.416 | 0.97(0.94~1) | 0.023 |
| Education level | | | | | |
| High school or below | Ref. | 1(0.97~1.04) | 0.874 | 0.98(0.94~1.01) | 0.207 |
| college | Ref. | 0.97(0.92~1.02) | 0.177 | 1(0.96~1.05) | 0.928 |
| graduate or above | Ref. | 1.06(1.01~1.11) | 0.027 | 0.92(0.88~0.98) | 0.005 |

Stratified analyses were then performed in the hope that further analyses could be postulated for different sexes, ages, races, education levels, and socioeconomic statuses of the population, The correlation between obesity and urine Triclosan concentrations (Table 2).

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In males, triclosan was found to be inversely linked with increased odds of being obese after stratified by gender and age (OR: 0.97, 95% CI: 0.93-1, p value: 0.058). However, the association was not very strong. further gender and age (20-39, 40-59, 60 and older) subgroups did not show any further evidence of a significant relationship between triclosan consumption and obesity.

After racial stratification, participants who were classified as other race, including multiracial, had a negative and significant connection between triclosan and obesity (OR:0.89, 95% CI: 0.8-0.98, p value: 0.019). Notably, triclosan and obesity were found to have a marginally significant connection in the Non-Hispanic Black population (OR:0.93, 95% CI: 0.87-1, p value: 0.051). In the remaining racial subgroups, no association was observed between triclosan exposure and overweight or obesity in the population within that group.

Upon stratification by socioeconomic status, no correlation between overweight and triclosan was observed in both the at or below poverty group and above poverty group. In contrast, triclosan and obesity were significantly associated negatively in the poverty group mentioned above (OR: 0.97, 95% CI: 0.94-1, p = 0.023). This implies that in the wealthier group, there is a higher correlation between triclosan exposure and obesity.

Similar results were reported when triclosan was stratified by educational level. Among those with a doctoral degree or higher, it turns out to lower the risk of obesity (OR:0.92, 95% CI: 0.88-0.98, p value: 0.005) while increasing the odds of overweight (OR:1.06, 95% CI: 1.01-1.11, p value: 0.027).

## 4. Conclusion

In conclusion, the association between urine triclosan concentrations and obesity in US adults is demonstrated. (OR: 0.97, 95% CI: 0.95-.99, p = 0.017). However, triclosan in urine is not associated with overall overweight. The findings are consistent with and different from previous findings. Triclosan and obesity have been correlated in various ways in previous studies, including positively, negatively, and insignificantly. Sample size, the demographic being investigated (children, adults, the elderly, etc.), the choice and handling of variables, and the choice of urine samples can all affect how an analysis turns out differently. Due to the controversial association between triclosan and obesity, we innovatively conducted a stratification study of the population, eager to discover more valuable clues by refining the classification. Additionally, we discovered evidence of racial, socioeconomic, and educational variations in the relationship between triclosan and obesity. A negative and significant association between triclosan and obesity in other race, including multi-racial group (OR:0.89, 95% CI: 0.8-0.98, p value: 0.019), above poverty group (OR:0.97, 95% CI: 0.94-1, p value: 0.023) and the graduate or above group (OR:0.92, 95% CI: 0.88-0.98, p value: 0.005). Furthermore, it demonstrates that triclosan increases the risk of becoming overweight in the group of people with doctoral degrees (OR:1.06, 95% CI: 1.01-1.11, p value: 0.027). In the future, we can further improve our model by conducting more literature research to find more covariates that may affect the results of this experiment. And we will repeat the study by expanding the amount of data to further confirm the results of this study.

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