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Serum cotinine and urinary 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanonol levels among non-Hispanic Asian American smokers and nonsmokers as compared to other race/ethnicities: Data from NHANES 2011–2012 ☆

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HIGHLIGHTS

- Non-Hispanic Asians and Hispanics smokers had the lowest serum cotinine levels.
- Non-Hispanic Asians smokers had the lowest urinary NNAL levels.
- Nonsmokers with SHS exposure had substantially higher cotinine and NNAL levels.
- Serum nicotine/cotinine and NNAL have different elimination kinetics.

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ABSTRACT

The objective of this study was to evaluate serum cotinine and total urinary 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanonol (NNAL) levels from a nationally representative sample of non-Hispanic Asian Americans as compared with other racial/ethnic groups. Data from the latest National Health and Nutrition Examination Survey for the years 2011–2012 were used for this purpose. The total sample size used was 4580. Regression models were fitted to estimate serum cotinine and urinary NNAL levels for smokers and nonsmokers aged 20 years and older adjusted for other factors that affect these levels. For nonsmokers, exposure to second hand smoke at home was associated with about 30 times higher serum cotinine levels when compared to those without such exposure (0.717 ng mL^{-1} vs. 0.024 ng mL^{-1}, $p < 0.01$). NNAL levels among nonsmokers with second hand smoke exposure at home were about twenty times what they were in those without such exposure (9 pg mL^{-1} vs. 109 pg mL^{-1}, $p < 0.01$). As compared to other racial/ethnic groups, the lowest adjusted serum cotinine levels occurred in non-Hispanic Asian smokers (92.6 ng mL^{-1}) and Hispanics (84.5 ng mL^{-1}) as compared to non-Hispanic whites (143.8 ng mL^{-1}) and non-Hispanic blacks (158.4 ng mL^{-1}). Urinary NNAL levels for smokers were in the order: non-Hispanic Asian (0.121 ng mL^{-1}) < non-Hispanic blacks (0.139 ng mL^{-1}) < Hispanics (0.201 ng mL^{-1}) < non-Hispanic whites (0.234 ng mL^{-1}). Compared to non-Hispanic whites, non-Hispanic blacks had substantially higher levels of serum cotinine but substantially lower levels of urinary NNAL irrespective of smoking status thus pointing towards differences in elimination kinetics of nicotine/cotinine and NNAL.

1. Introduction

More than half of the growth in the United States population between 2000 and 2010 was due to 43% increase in population of the Hispanics from 35.3 million in 2000 to 50.5 million in 2010 (http://www.census.gov/2010census/news/releases/operations/cb11-cn125.html). During the same period, the population of Asians grew by 43% from 10.2 million in 2000 to 14.7 million in 2010. Any national survey that intends to remain representative

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of all segments of the population should track the relevant changes in the respective population composition. In other words, every continuous, ongoing national survey needs to make necessary design changes on an ongoing basis to remain representative of all segments of the corresponding population. Consequently, not only the weighted sum of each segment of the population it represents should be reflective of the actual composition of the population but also, the un-weighted sample size from each segment of the population should be large enough to provides estimates, for example of the means or other location parameters with acceptable sampling error. This is usually done by oversampling those segments of the population that form relatively smaller proportion of the sampled population.

To remain representative of various segments of the U.S. population by race/ethnicity, National Health and Nutrition Examination Survey (NHANES) conducted by the United States Centers for Disease Control and Prevention (CDC) (www.cdc.gov/nchs/nhanes.htm) oversampled Mexican Americans and blacks during 1999–2006 (Johnson et al., 2013). Starting with survey cycle 2007–2008 and for the survey years 2007–2010, all Hispanics (HISP) and non-Hispanic blacks (NHB) were oversampled (Johnson et al., 2013). Starting with 2011–2012 cycle of NHANES, additional design changes were made (CDC, 2013) and non-Hispanic Asians also started being oversampled in NHANES cycle 2011–2012. This will allow reliable and precise estimates of health status indicators for non-Hispanic Asians in addition to all HISP and NHB.

Consistent with the design of NHANES for the years 1999–2006, almost all publication that used NHANES data reported on, for example, for serum cotinine concentrations (Jain and Bernert, 2010; Jain, 2014) for four racial/ethnic groups, namely, non-Hispanic whites (NHW), non-Hispanic blacks (NHB), Mexican Americans (MA), and other (OTH1) unclassified racial/ethnic groups like Asians and Pacific Islanders, American Indian, Alaskan Natives, Hispanics like those from Cuba and other South American countries. Design changes in NHANES during 2007–2010 did allow creation of new racial/ethnic categories, namely, NHW, NHB, all Hispanics (HISP), and other (OTH2) unclassified racial/ethnic groups like Asians and Pacific Islanders, American Indian, and Alaskan Natives. Though many of the publications using data from NHANES beyond 2005–2006 continued using the racial/ethnic categories NHW, NHB, MA, and OTH1 (Harrington et al., 2013; Tian et al., 2013; Jain, 2014), one publication (Jain, 2013) using data from NHANES 2007–2008 did use racial/ethnic categories NHW, NHB, HISP, and OTH2. NHANES data for 2011–2012 and beyond will allow creation of racial/ethnic categories NHW, NHB, HISP, non-Hispanic Asians (NHAS), and others (OTH3) which will include such racial/ethnic groups as American Indians, Alaskan Natives and others. The differences between other categories OTH1, OTH2, and OTH3 should be noted when interpreting the results. The sample sizes, depending upon a specific study may not be large enough to derive valid estimates for OTH1, OTH2, or OTH3.

NHB smokers have been reported to have highest serum cotinine levels among NHW, NHB, MA, and OTH1 while MA had the lowest cotinine levels (Caraballo et al., 1998; Signorello et al., 2009; Jain and Bernert, 2010). NHB smokers have higher serum cotinine concentrations than NHW even though they smoke significantly lower number of cigarettes per day (11.4 cigarettes per day vs. 18.6 cigarettes per day, Jain, 2014). It may be that NHB extract more nicotine from each cigarette smoked or there may be a racial/ethnicity difference in the nicotine metabolic pathway which produces the difference in serum cotinine.

Benowitz et al. (2002) reported that intake of nicotine per day by Chinese-Americans was lower (0.73 mg) than it was for whites (1.10 mg) and Latinos (1.05 mg). They also reported nicotine clearance via cotinine pathway to be similar among whites and Latinos but statistically significantly lower among Chinese-Americans. Half-life of cotinine among Chinese-Americans was reported to be 1099 min, compared to 874 min for Latinos, and 965 min for whites. They also reported both Chinese-Americans and Latinos smoking lower number of cigarettes per day (CPD) than whites (11.2 CPD, 12.0 CPD, and 20.2 CPD, respectively). If the nicotine intake and metabolism among other Asians, for example, Indians, is similar to Chinese-Americans, NHAS should have higher levels of serum cotinine as compared to MA and NHW.

The focus of this study was to evaluate serum cotinine and total urinary 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanonol) (NNAL) levels among NHAS using data from NHANES 2011–2012 and to compare these levels with other racial/ethnic groups, namely, NHW, NHB, and HISP. This also provides an opportunity to study any differences in serum cotinine levels of MA as compared to all HISP both among smokers and nonsmokers. Simultaneous impact of exposure to second hand smoke (SHS) at home will also be made. To the best of our knowledge, this is the first time that serum cotinine and urinary NNAL are being reported for a nationally representative sample of Asian-Americans.

2. Materials and methods

NHANES provides data on possible exposure to SHS at home in family smoking questionnaires. The specific question that provided data on SHS exposure at home was "Does anyone who lives here smoke cigarettes, cigars, or pipes anywhere inside this home?" (http://www.cdc.gov/nchs/nhanes/nhanes2011-2012/SMQFAM_G.htm#SMD410). If the answer to this question was yes and there was at least one person who smoked cigarettes at home, the respondent was considered to be exposed to SHS at home.

Data were downloaded from demographic, serum cotinine, urinary NNAL, family smoking questionnaire, and a smoking questionnaire administered at the time of medical examination (http://www.cdc.gov/nchs/nhanes/nhanes2011-2012/SMQRTU_G.htm) from NHANES for the survey years 2011–2012 and match merged. NHANES uses a complex, stratified, multistage, probability sampling designed as representative of the civilian, non-institutionalized U.S. population based on age, gender, and race/ethnicity (http://www.cdc.gov/nchs/nhanes.htm). Sampling weights are created in NHANES to account for the complex survey design, including oversampling, survey non-response, and post-stratification. This study was limited to those who were aged 20 years and older.

A smoker for the purpose of this study was defined as one who reported smoking cigarettes during the five days prior to the examination and who had no other source of nicotine e.g., smoking pipes and cigars or using nicotine patches and additionally had serum cotinine levels $\geqslant 10$ ng mL^{-1}. Number of days the cigarettes were smoked during the last five days (SMK_DAYS) and number of cigarettes smoked during the days they were smoked (CPD) were the two smoking related variables that were used. A nonsmoker for the purpose of this study was defined as the one who reported not using any tobacco product for five days prior to the examination and whose serum cotinine levels were <10 ng mL^{-1}. Number of cigarette smokers at home (SMKR_HOME) and number of cigarettes smoked at home (CPD_HOME) were the two SHS exposure related variables that were used. Total un-weighted sample sizes for the data for smokers was 1028 (males = 647, females = 381, NHW = 459 NHB = 299, HISP = 162, NHAS = 67, OTH3 = 41, SHS exposure at home = 465, no SHS exposure at home = 560). Total un-weighted sample sizes for the data for nonsmokers was 3552 (males = 1620, females = 1932, NHW = 1288, NHB = 888, HISP = 742, NHAS = 536, OTH3 = 98, SHS exposure at home = 160, no SHS exposure at home = 3386). However, actual sample sizes used in computations were smaller because of missing values for other analysis variables, e.g., serum cotinine, urinary NNAL, and CPD.