



Risk factors for pre-diabetes and diabetes in adolescence and their variability by race and ethnicity



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ABSTRACT

Adolescent risk factors for pre-diabetes and diabetes in young adulthood were examined in three minority groups and compared to those in non-Hispanic Whites.

Retrospective cohort study with data on 8337 adolescent respondents from Add Health (1994–2008). Participants included 5131 non-Hispanic Whites, 1651 non-Hispanic Blacks, 1223 Hispanics, and 332 American Indians/Alaska Natives. Diabetes was defined as: hemoglobin A1C $\geq 6.5\%$, glucose > 125 mg/dl, self-reported diabetes, or self-reported diabetes medication use, in Wave 4 data. Pre-diabetes was defined as hemoglobin A1C $\geq 5.7\%$. Relative risk regression models were used to evaluate the association between risk factors and risk of diabetes and pre-diabetes, controlling for body mass index, sedentary and physical activity habits, fast food consumption, and parental education, parental diabetes status, and financial stability. 484 participants developed diabetes; 2878 developed pre-diabetes between 1994 and 2008. Pre-diabetes and diabetes were more prevalent in non-Hispanic Blacks (55% and 12%, respectively) than in American Indians/Alaska Natives (43% and 11%), Hispanics (37% and 6%), and non-Hispanic Whites (27% and 3%). In all races, higher body mass index and parental diabetes were associated with higher risk of pre-diabetes and diabetes, while female sex was associated with lower risk of pre-diabetes. Efforts to reduce the risk of pre-diabetes and diabetes in adolescents should emphasize parental diabetes and BMI in all races, independent of physical activity, sedentary behaviors, or fast food consumption. Future interventions might be interested in targeting households, rather than individuals, to prevent pre-diabetes and diabetes in adolescents and young adults.

1. Introduction

Diabetes is a risk factor for cardiovascular disease, kidney disease, stroke, amputations, blindness, and depression (Zhang et al., 2010; Pinhas-Hamiel and Zeitler, 2007; Copeland et al., 2013; Springer et al., 2013). In adolescence, diabetes complications develop at an accelerated pace (Tryggstad and Willi, 2015), and the incidence of diabetes in racial and ethnic minority youth has increased in recent years (Mayer-Davis et al., 2017). Current projections estimate that the prevalence of diabetes will quadruple among adolescents of all races in the next 30 years (Dabelea et al., 2014). Recent research indicates that American Indian and Alaska Native (AI/AN) adolescents have the highest prevalence of diabetes in the US, at 1.20 per 1000, followed by non-Hispanic Blacks (1.06), Hispanics (0.79), Asians (0.34), and non-Hispanic

Whites (0.17) (Dabelea et al., 2014).

Previous studies have explained disparities in diabetes as the result of genetic, metabolic, behavioral, and socioeconomic risk factors (Fagot-Campagna et al., 2000; Fretts et al., 2014; Marley and Metzger, 2015; Jernigan et al., 2010). However, recent studies suggest that diabetes risk factors might lead to differential outcomes depending on race and ethnicity (Chernausek et al., 2016; Rhee et al., 2015; Ma et al., 2012). One study found that maternal diabetes (either gestational or type 2 diabetes mellitus) was more strongly associated with low glycemic control among Hispanics and non-Hispanic Blacks (NHBs) than among NHWs (Chernausek et al., 2016). Another investigation developed a risk reduction score for diabetes based on dietary intake in the Nurses' Health Study (1980–2009), finding that minority respondents, achieved a larger reduction in absolute diabetes risk than did NHWs

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(Rhee et al., 2015). If the impact of risk factors on prevalent diabetes truly varies by race and ethnicity, as this body of research suggests, it is a public health imperative to determine the associations between risk factors and diabetes outcomes in people of all backgrounds, especially youth.

Although no study to date has examined risk factors for pre-diabetes and diabetes in a multi-racial sample of adolescents and young adults, the National Longitudinal Study of Adolescent to Adult Health (Add Health) offers data to fill this gap. Add Health assembled a nationally representative cohort of adolescents and followed them for four waves of data collection (1994–2008). The study cohort includes the largest sample of adolescent and young adult AI/ANs with longitudinal health data. The Add Health dataset enables an examination of the risk factors for diabetes in adolescence, as well as an estimate of the extent to which these factors vary by race. The objective of the present study was to measure the associations between known risk factors for pre-diabetes and diabetes among adolescents and the prevalence of these conditions among young adults in four racial and ethnic groups: NHWs, NHBs, AI/ANs, and Hispanics. Although Add Health also collected data on Asians and Native Hawaiians/Other Pacific Islanders, these data were aggregated in a single category (“Asian or Pacific Islander”), forestalling an extension of the analysis to additional races.

2. Methods

2.1. Data

Add Health is a nationally representative survey conducted by the Carolina Population Center at the University of North Carolina–Chapel Hill. Details of Add Health have been previously published (Harris and Udry, 2014). Respondents were 11–20 years old (mean age: 16 years) at baseline in 1994 and were followed for additional waves of data collection in 1996, 2002, and 2008. In 2008 (Wave 4; mean follow-up time: 14 years; mean age: 30 years), respondents completed a questionnaire and a biomarker assessment that measured hemoglobin A1C and fasting glucose, enabling assessment of prevalent pre-diabetes and diabetes. Add Health retention rates over all waves ranged from 72% to 79%, similar to those in the National Health and Nutrition Examination Survey (Pierce and Hartford, 2004). Because the present study used anonymized survey data, it was exempt from ethical review by the authors' Institutional Review Board.

At baseline, Add Health administered separate questionnaires to 20,745 adolescents and 17,669 of their parents. Adolescent and parental questionnaires provided complementary information on risk factors for diabetes. For this study, analyses were limited to respondents who self-identified at baseline as NHW, NHB, AI/AN, or Hispanic; whose parents completed the parental questionnaire at baseline; and who participated in the biomarker assessment at Wave 4.

2.2. Exclusions and missing data

Of the original sample of 20,745 adolescents, only 10,684 had data from the parental questionnaire at baseline and participated in Waves 1, 2, and 4. From this subsample, 2374 were excluded for the following reasons: 1) racial identification as “Asian or Pacific Islander” (N = 540); 2) age 20 years or older at baseline (N = 16); 3) prevalent diabetes at baseline (N = 44); and 4) missing data for at least one variable of interest (N = 1747). We conducted a complete case analysis with a final sample of 8337 respondents, including 5131 NHWs, 1651 NHBs, 332 AI/ANs, and 1223 Hispanics.

2.3. Measures

Outcomes of interest were prevalent pre-diabetes and diabetes (either type 1 or 2) at Wave 4. Participants were defined as pre-diabetic if they had hemoglobin A1C $\geq 5.7\%$ or fasting glucose 100–125 mg/dl

and did not meet any criteria for diabetes: hemoglobin A1C $\geq 6.5\%$, fasting glucose > 125 mg/dl, self-reported history of diabetes (yes/no), or self-reported diabetes medication use (yes/no). Previous research has confirmed the reliability of diabetes indicators in Add Health (Nguyen et al., 2014).

The adolescent questionnaire at baseline (Wave 1) provided variables to measure respondents' BMI in kg/m², measured with self-reported height and weight; weekly frequency of playing an active sport, such as baseball, softball, basketball, soccer, swimming, or football (not at all, 1 to 2 times, 3 to 4 times, and 5 or more times); hours of watching TV per week (< 14 , 14 to 27, and 28 or more); and weekly frequency of fast food consumption (none, 1 to 2 days per week, and 3 days per week or more). BMI was transformed into a percentile based on age- (months) and sex-matched CDC referent values (Ogden et al., 2002) and measured in 5-percentile intervals.

The parental questionnaire at Wave 1 included self-reported diabetes status for both parents and for the adolescent respondent (yes/no) and two indicators to measure adolescents' socioeconomic status: a) parental education (less than a high school degree, high school graduate or more), and b) self-reported ability to pay monthly bills (yes/no).

If participants selected more than one race and ethnicity, they were assigned to a single racial/ethnic category in the following order of preference: AI/AN, Hispanic, NHB, and NHW. This approach, which is endorsed in the literature, maximizes the representation of racial and ethnic minorities (Lin and Kelsey, 2000; Mays et al., 2003).

2.4. Analyses

Sample characteristics were summarized by using means, standard deviations, and proportions by race and ethnicity. The statistical analysis of the data used relative risk regression models with a binomial distribution assumption, stratified by race and adjusted for age and sex, to model the association between adolescent risk factors at Wave 1 and prevalent pre-diabetes and diabetes at Wave 4. Relative risks (RR) and 95% confidence intervals (CI) are presented as results. All analyses were conducted with R, version 3.2.5.20. All data were analyzed in 2017.

3. Results

Table 1 provides descriptive statistics for the study sample. At baseline, the average age was 15.7 years (standard deviation [SD] 1.6) and 52.9% were female. Relative to NHWs, Hispanics were older by an average of 0.35 years, and NHBs and AI/ANs had a higher proportion of female participants (by 3.8% and 4.9%, respectively). Among all races and ethnicities, NHWs reported the healthiest BMI and the highest frequency of physical activity. The average BMI among NHWs was 21.9 kg/m² (SD 4.2 kg/m²), while the average was higher by 1.2 kg/m² (95% CI 0.95, 1.34) among AI/ANs, NHBs, and Hispanics. Obesity was present in 17% of AI/ANs, 14% of NHBs, and 13% of Hispanics, but only 9% of NHWs. NHWs were the least likely to report not playing sports at all (24%) and the most likely to play sports at least five times per week (28%), while Hispanics were the most likely to report not playing sports (33%) and the least likely to play at least five times per week (22%). NHWs had the lowest frequency of weekly TV viewing, with 64% reporting 14 h or fewer per week, while NHBs had the highest prevalence, with 25% reporting 28 h or more per week. AI/ANs had the lowest frequency of fast food consumption, with 17% reporting no fast food consumption at all, compared to 16% of NHWs, 15% of NHBs, and 13% of Hispanics, while 39% of NHBs reported eating fast food at least three times per week, closely followed by Hispanics at 38%.

NHW parents also reported the best metabolic health, the highest prevalence of college degrees, and the lowest prevalence of financial instability. While 15% of AI/AN parents were diabetic, diabetes prevalence was 11% in NHB and Hispanic parents and only 6% in NHW parents. Among NHW parents, 38% had a college degree, compared to

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