Published in final edited form as:

Diabetes Educ. 2013 ; 39(4): 454–463. doi:10.1177/0145721713486199.

Characteristics of American Young Adults With Increased Risk for Type 2 Diabetes:

A Pilot Study

EunSeok Cha, PhD, MPH, MSN, RN, Guillermo Umpierrez, MD, Kevin H. Kim, PhD, Morenike K. Bello, MPH(c), and Sandra B. Dunbar, RN, DSN, FAAN, FAHA

Emory University, Atlanta, Georgia (Drs Cha, Umpierrez, Dunbar, Ms Bello), University of Pittsburgh, Pittsburgh, Pennsylvania (Dr Kim).

Abstract

Purpose—The purpose of the study was to examine the characteristics of American young adults with increased risk for type 2 diabetes (T2D).

Methods—Participants ages 18 to 29, overweight/obese, and sedentary were recruited from the metro Atlanta area in the United States. Variables included demographics, anthropometric and clinical variables, and physical activity. Of 107 participants, 3 participants had undiagnosed diabetes and 1 participant did not complete the modifiable activity questionnaire. Thus, 103 young adults remained for the final data analysis.

Results—Most participants were females and African Americans. About 30% of participants had prediabetes, either impaired fasting glucose, an A1C of 5.7% to 6.4%, or both. Overall, prediabetes young adults were heavier and did less physical activity than Diabetes Prevention Program (DPP) trial participants. In addition, these young adults had a higher prevalence of parental T2D history and lower level of physical activity compared to young adults with normoglycemia.

Conclusions—Physical activity and parent T2D history are key risk factors for identifying young adults with prediabetes. Multilevel strategies are necessary to raise awareness of diabetes risk and to prevent T2D in young adults.

Diabetes is the leading cause of nontraumatic lower extremity amputation, adult blindness, and end-stage of renal failure.¹ Since all type 2 diabetes (T2D) patients go through a prediabetes phase, which can be reversed or delay the progression of T2D, this is an important period for raising awareness of diabetes risk in order to reduce the risk of future diabetes complications.^{1,2} A randomized clinical trial on Diabetes Prevention Program (DPP), which was conducted in 27 centers in the United States (n = 3234), showed that moderate weight loss (5%–7% decrease in body weight) through improving physical activity and dietary quality is effective in the delay or prevention of T2D progression in adults ages 25 years old or over with prediabetes.^{3–5}

There is significant public concern with the growing epidemic of early onset T2D in younger populations due to increased obesity prevalence, reduced physical activity, and poor nutrition behaviors.⁶ Despite a consensus on the significance and urgent need for a diabetes prevention program for young adults, a diabetes prevention program is difficult to

implement because there is limited information on how to identify and access young adults with prediabetes.⁷⁻⁹

Currently, some researchers conduct community-based diabetes screenings using a glucometer.^{10,11} However, a community-based diabetes screening is not recommended by the American Diabetes Association (ADA) for the following reasons.⁷ Individuals who participate in community-based screenings usually do not take follow-up tests. Even those with positive screening results have poor adherence to treatment recommendations. Additionally, community-based screenings do not reach the people who need it the most. Those with a high risk for T2D often are unaware of their risk, uninsured/ underinsured condition, or have low health literacy that prevents them from participating in community-based screenings. Individuals who often participate in screenings are a low-risk group with high health concerns.^{7,8,10,11}

To overcome these challenges, the International Diabetes Federation (IDF) proposed a 3-step process to access high-risk groups for diabetes care: step 1, identification of high-risk individuals using a self-assessment tool; step 2, performance of diabetes screening test using an invasive tool at a clinic to confirm their prediabetes condition; and step 3, delivery of a diabetes prevention program to appropriate target populations.¹² In response to the IDF's recommendations, many researchers are trying to develop a reliable and valid self-assessment tool to identify high-risk individuals for T2D.^{8,9} This 3-step approach has been successful in European populations (eg, Finnish), but has not been developed for the US population yet.¹³

The Finnish Diabetes Risk Score (FINDRISC), including age, body mass index (BMI), gender, exercise, eating habits, high blood pressure history or medication taking history, past hyperglycemic history, and family diabetes history, is a well-known patient assessment tool with appropriate psychometric properties.^{13,14} However, there are some concerns in utilizing this tool with young adults in the United States. First, their target population is relatively homogenous (Finnish), unlike the US population ("melting pot" population). There is a significant difference in the prevalence of T2D among race/ethnicity.¹⁵ Second, the obesity prevalence in Finland is much lower (1 in 5) than in the United States (1 in 3).^{16,17} Thus, FINDRISC may not correctly identify high-risk individuals in the United States. Third, eating habits and food availability are different between the populations, which may affect the psychometric properties of the food items (ie, everyday eating for vegetables, fruit, or berries). Lastly, age as a major risk factor is inapplicable to young adults who are at high risk for early onset T2D.

As an alternative, a patient assessment score algorithm was proposed for the US population using age, sex, family diabetes history, hypertension history, obesity, and physical activity.⁸ However, like FINDRISC, the researchers missed the genetic risk based on race/ethnicity and disproportionately weighed age.⁸ Consequently, this approach is also inappropriate for identifying American young adults at risk for T2D. A systemic review study revisited our concern. Of 43 articles assessing diabetes risk published in 1993 to 2011, the risk factors frequently addressed in diabetes screening tools were blood pressure history (n = 33), age (n = 30), family history of diabetes (n = 29), BMI (n = 28), past fasting glucose level (n = 19), waist circumference (n = 16), physical activity (n = 6), eating habits (n = 3), and gestational diabetes history (n = 1).⁹

In sum, existing approaches place too much emphasis on age, hypertension, and past fasting glucose histories, which most young adults rarely perceive until they have reached very high abnormal values. Lifestyle factors are also rarely considered even though physical inactivity leads to increased insulin resistance, which is a major cause of early onset diabetes as

opposed to modulating β -cell function (a cause of late onset T2D).¹⁸ A new self-assessment tool specifically targeted for American young adults needs to be developed. As an initial step, this descriptive study aims to identify risk factors that increase diabetes risk in American young adults.

Purpose and Research Questions

The purpose of the study was to examine the characteristics of American young adults with increased risk for type 2 diabetes. Specifically, the research questions were:

Research Question 1: Is there any significant difference in demographic and clinical characteristics between young adults aged 18 to 29 and those reported in the DPP trial?⁵

Research Question 2: Is there a significant difference in T2D risk from factors related to obesity between young adults with and without prediabetes?

Methods

Study Design

A cross-sectional, correlational design was used to collect data that can be used to inform the design of an age-specific diabetes prevention program in the future.

Sample and Setting

Diabetes Prevention Program for Young Adults (DPP-Y study) is a 2-phased project including mixed method formative and pilot intervention studies. In this study, phase 1 project data, a descriptive study, were used. Young adults who were ages 18 to 29, overweight/ obese (BMI ≥ 25 kg/m²), and sedentary (leisure time physical activity < 90 minutes per week during the past month) were recruited from the metro Atlanta area. Individuals diagnosed with diabetes, cardiovascular diseases, serious illness requiring physician-supervised dietary and exercise regimens, conditions affecting erythrocyte turnover (eg, hemolysis, blood loss), or who were pregnant were excluded.

Data Collection Procedures

Between July 2011 and May 2012, participants were recruited using: (1) recruitment flyers posted on campus bulletin boards (8 colleges and universities), (2) e-mail invitations via student mailing list (1 state university), (3) flyers posted at a diabetes clinic and 4 universities' student health centers, and (4) peers and self-referral. A total of 234 potential participants were contacted to participate in the screening test. Of these potential participants, 110 persons were ineligible. There were 17 young adults who dropped out of the study. Thus, data from 107 participants were collected for phase 1 study.

Variables and Measures

Variables and measures included demographics (questionnaire), anthropometric variables (weight, height, BMI, waist circumference), clinical variables (blood pressure, fasting insulin, 8-hour fasting blood glucose, hemoglobin A1C, 8-hour fasting insulin, and serum lipids), and physical activity (modifiable activity questionnaire [MAQ]).¹⁹ Trained research nurses measured the anthropometric variables and blood pressure and administered the MAQs. After the blood draws by a qualified staff, lipids tests were performed by an enzymatic method at the Emory Lipid Research Laboratory on the Beckman AU480. This laboratory has been a participant in the CDC lipid standardization program since 1991. Glucose, insulin, and A1C were determined using Beckman reagent and calibrator on the Beckman AU480 chemistry analyzer. Based on the results of 8-hour plasma fasting glucose

and insulin values, beta cell function (%B), insulin sensitivity (%S), and insulin resistance were calculated with HOMA 2 calculator.²⁰

Data Analysis

Of 107 participants, 3 participants who had undiagnosed diabetes (A1C ≥ 6.5 or fasting plasma glucose ≥ 126 mg/dL) and 1 participant who did not complete the MAQ were excluded. Thus, a total of 103 young adults remained for the final data analysis: young adults with normoglycemia ($n = 73$), impaired fasting glucose only ($n = 5$), an A1C of 5.7% to 6.4% only ($n = 24$), and both ($n = 1$).

To address research questions 1 and 2, young adults were divided into 2 groups (prediabetes group vs normoglycemic group). Young adults with impaired fasting glucose (≥ 100 mg/dL and <126 mg/dL) or a high A1C (5.7%–6.4%) were assigned to the prediabetes group. All other young adults were classified as the normoglycemic group. To obtain anthropometric and clinical data from the DPP sample, several publications were reviewed.^{5,21,22} To answer research question 1, a series of 1-sample *t* tests were performed. To answer research question 2, independent-sample *t* tests, Mann-Whitney U tests, and 2-way chi-square tests were performed. Effect sizes (ie, Cohen's *d*—a mean difference between groups in standard units; small, .20; medium, .50; large, .80) were examined due to a large power (ie, large sample size of DPP).²³ SPSS 20.0 version (IBM SPSS Inc) was used for examining test differences.

Results

Sample Characteristics

In the DPP trial, the average age of the participants was 50.6 ± 10.7 years (range, 25.5–85.2) and average BMI was 34.0 (SD = 6.7).³ The majority of the participants were Caucasian (54.7%), female (67.7%), and middle-aged or older adults 40 or older (89.2% for men, 82.1% for women).^{3,5} In the study (DPP-Y phase 1 study), the average age was 24.0 ± 3.2 years old (range, 18.69–29.92; median = 23.18), and average BMI was 36.6 (SD = 8.1). The majority of DPP-Y participants were female (77.7%) and African Americans (67.0%). Smoking prevalence was much lower in DPP-Y participants compared to DPP participants. About three-quarters of young adults (72.8%, $n = 75$) reported no smoking history (see Table 1).

Comparisons of Participant Characteristics With Prediabetes in DPP Trials and DPP-Y

Overall, young adults with prediabetes in the DPP-Y were heavier ($P = .006$) and did less physical activity than DPP trial participants ($P = .017$). However, there was no significant difference between 2 groups with regard to waist circumference ($P = .086$, Cohen's *d* = 0.34). Young adults with prediabetes showed significantly lower fasting glucose in the DPP trial (Cohen's *d* = 1.46), but A1C differences between the 2 groups were relatively small (Cohen's *d* = 0.37). The reported systolic and diastolic blood pressures in young adults with prediabetes were also lower than the DPP participants (Cohen's *d* = 0.42). The prevalence of hypertension (blood pressure $\geq 140/90$ mmHg) was significantly lower in the young adults with prediabetes. Only 10% of the prediabetes young adults had hypertension (see Table 2).

Comparisons of Young Adults With and Without Prediabetes

Young adults with prediabetes were 1 year older and had higher BMI and larger waist circumference than those in the young adults without prediabetes. However, there were no statistically significant differences between the 2 groups on those variables. Aside from fasting glucose and A1C test results, there were no significant differences in the clinical

variables (ie, blood pressure, lipids) between the 2 groups either. As expected, there were no significant group differences in β -cell function, but lower insulin sensitivity ($P = .004$) and higher insulin resistance ($P = .005$) were identified in young adults with prediabetes. These young adults also had a higher prevalence of parental history of T2D ($P = .01$). Their levels of physical activity were also significantly lower than the normoglycemic group ($P = .007$) (see Table 3).

Discussion

There is strong scientific evidence for preventing diabetes through lifestyle modifications, and young adults are the prioritized age group for implementing a diabetes prevention program,^{3,24} but it is challenging to do so in a real-life setting since the best way to access high-risk American young adults is unknown. This current study may begin to fulfill this current scientific gap.

All young adult participants scored more than 10 (of 27) on a self-assessment diabetes risk test tool used by the National Diabetes Education Program, which supposedly put them at risk for developing T2D and refers them to see a doctor.²⁵ However, only 30% of the participants have since developed prediabetes, yielding a false positive rate of 70%. Likewise, the prediabetes group scored only 3 of 9, which did not meet the cutoff point of 5 or higher for undiagnosed diabetes or high T2D risk according to a patient assessment score algorithm for Americans proposed by Bang and colleagues.⁸ Sensitivity and specificity would be a big issue in using existing patient assessment tools.

A few suggestions can be made based on these findings on how to identify high-risk American young adults. First, the level of physical activity needs to be carefully assessed in addition to overweight and obese condition and race/ethnicity. To do this, this study suggests using a valid and reliable physical activity measure, which actually measures the amount (or level) of physical activity (eg, METs-hour per week) rather than a single item (physically active vs physically inactive, or exercising more than 30 minutes or not). For example, the modifiable activity questionnaire (MAQ) would be a considerably good measure. During the survey administration, neither participants nor research staff expressed difficulty in completing the MAQ, and actual administration time was less than 5 minutes. Second, family history should be clearly defined to avoid any confusion (ie, blood relative parent T2D history) in the survey instrument, especially when targeted to a younger population. Due to the young adults' age, their siblings may not have developed T2D yet. Also, family diabetes history may include family T1D history rather than a focus on T2D history. Another possible misinterpretation concern is the definition of family based on the diverse cultures or family dynamics. Some young people may respond to this item based on who actually serves the role of parents (eg, stepparents). Thus, a survey item asking biological parent T2D history rather than family diabetes history would be better for a self-assessment tool. Finally, it is suggested that blood pressure history is used cautiously to predict early onset T2D despite the accumulating evidence of the hypertension as a contributing factor for developing T2D.⁷ As this study shows, those 2 health conditions (elevated blood pressure and prediabetes) seem to develop independently in this age group rather than as a comorbidity condition. When a condition reaches at a serious level, a worse health condition is synergistically made, though.²⁶ Given this, detection of elevated blood pressure in an earlier developmental phase is still beneficial and significant to decrease early onset T2D; however, a different approach to examine blood pressure history needs to be considered.

Like diabetes, hypertension has no signs or symptoms until serious complications develop. Young adults rarely participate in an annual check-up, thus elevated blood pressure, like

hyperglycemic condition, usually goes unnoticed. Consequently, many young adults reported no hypertension history or hypertension medication history although they actually do have high blood pressure. As this study showed, about 10% of young adults had hypertension (140/90 mmHg) and 20% of them had elevated blood pressure (130/85 mmHg). Only 3 young adults (2.8%), however, actually reported their elevated blood pressure history on the screening phone calls. Since measurement of blood pressure is relatively simple and noninvasive, it is suggested that measuring actual blood pressure instead of a survey item reporting blood pressure history should be the noninvasive diabetes risk screening tool for young adults.

Despite significant findings, several limitations exist. The small sample size provided a limitation to accurately interpret or compare the findings between groups. Also, there was difficulty obtaining the actual averages of lipids in the baseline overall DPP samples for comparison (eg, lipids). Despite many available publications using the DPP trial, the publications described these variables by ethnicity, gender, or intervention arms only.³⁻⁵ Thus, accurate comparisons of certain variables between DPP and DPP-Y were unable to be achieved in this study. Finally, unlike DPP, the sample used in this study was female and African American dominant, which potentially affected the study findings (eg, A1C values). These differences may stem from recruitment method and site differences (27 centers in the United States vs metro Atlanta area). A larger clinical trial is required to provide more in-depth information to develop a successful diabetes self-assessment tool for American young adults.

Conclusion

Due to a close association between obesity and early onset T2D epidemic,⁷ researchers often propose a weight reduction program (ie, a program focused on the BMI) as an approach to prevent T2D.^{27,28} However, mechanisms causing obesity and early onset T2D are different, and careful considerations need to be made. Obesity is caused by chronic imbalance of energy intake and energy expenditure.²⁹ Individuals therefore need to reduce energy intake and/or increase energy expenditure in order to maintain or reduce their weights. In particular, young adults should be aware of nutritional needs that shift from growth (adolescence) to maintenance (young adults) of a healthy body.^{30,31} On the contrary, the main cause of early onset T2D is related to insulin insensitivity and insulin resistance.¹⁸ When young adults become overweight and obese, their increased adipose tissue can impair appropriate response of insulin-sensitive tissues, especially liver, muscle, and adipose tissues.^{27,32} Physical activity, especially accumulated physical activity, is a way to rapidly increase insulin sensitivity.^{27,32}

In the United States, nearly 50% of people with type 2 diabetes have already developed diabetes complications, such as cardiovascular disease, at the time of diagnosis.⁷ Early detection and appropriate intervention to reduce diabetes risk and complications are imperative. Multilevel (individual, social, environmental, and policy level) strategies are necessary to raise awareness of diabetes risk and to prevent T2D in young adults.³³ Findings from this study may contribute to the development of noninvasive diabetes screening tool as well as an age-specific diabetes prevention program in young adults.

Acknowledgments

This study was supported by: Development of a Diabetes Prevention Program for Young Adults With Increased Risk for Type 2 Diabetes (K01NR012779-01) from the National Institute of Nursing Research, NIH 07/15/2011-06/30/2014, PI: E. S. Cha; University Research Committee and Atlanta Clinical & Translational Science Institute (ACTSI) collaborative grant; and Atlanta Clinical and Translational Science Institute/National

Institutes of Health grant UL1 RR025008 National Institutes of Health. Also, the authors thank Dr Venkat Narayan, and KM for his mentoring of Dr Cha's early career development training supported by the K01 award.

References

1. Kasper, DL.; Braunwald, E.; Fauci, AS.; Hauser, SL.; Longo, DL.; Jameson, JL. Chapter 338. Diabetes Mellitus. 17th ed.. New York: McGraw-Hill Medical; 2008.
2. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care*. 2010; 33(suppl 1):S62–S69. [PubMed: 20042775]
3. Knowler WC, Barrett-Connor E, Fowler SE, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med*. 2002; 346(6):393–403. [PubMed: 11832527]
4. Orchard TJ, Temprosa M, Barrett-Connor E, et al. Long-term effects of the Diabetes Prevention Program interventions on cardiovascular risk factors: a report from the DPP Outcomes Study. *Diabet Med*. 2013; 30(1):46–55. [PubMed: 22812594]
5. The Diabetes Prevention Program Research Group. The Diabetes Prevention Program: baseline characteristics of the randomized cohort. *Diabetes Care*. 2000; 23(11):1619–1629. [PubMed: 11092283]
6. Center for Disease Control and Prevention. Youth Risk Behavior Surveillance—United States, 2007. *Morbidity and Mortality Weekly Report*. 2007; 57(SS-4):1–131.
7. American Diabetes Association. Standards of medical care in diabetes—2012. *Diabetes Care*. 2012; 35(suppl 1):S11–S63. [PubMed: 22187469]
8. Bang H, Edwards AM, Bombardier AS, et al. Development and validation of a patient self-assessment score for diabetes risk. *Ann Intern Med*. 2009; 151(11):775–783. [PubMed: 19949143]
9. Noble D, Mathur R, Dent T, Meads C, Greenhalgh T. Risk models and scores for type 2 diabetes: systematic review. *BMJ*. 2011; 343:d7163. [PubMed: 22123912]
10. Tabaei BP, Burke R, Constance A, et al. Community-based screening for diabetes in Michigan. *Diabetes Care*. 2003; 26(3):668–670. [PubMed: 12610019]
11. American Diabetes Association. Screening for type 2 diabetes. *Diabetes Care*. 2004; 27(suppl 1):S11–S14. [PubMed: 14693922]
12. Alberti KG, Zimmet P, Shaw J. International Diabetes Federation: a consensus on type 2 diabetes prevention. *Diabet Med*. 2007; 24:451–463. [PubMed: 17470191]
13. Schwarz PE, Li J, Reimann M, et al. The Finnish Diabetes Risk Score is associated with insulin resistance and progression towards type 2 diabetes. *J Clin Endocrinol Metab*. 2009; 94(3):920–926. [PubMed: 19106274]
14. Saaristo T, Peltonen M, Lindstrom J, et al. Cross-sectional evaluation of the Finnish Diabetes Risk Score: a tool to identify undetected type 2 diabetes, abnormal glucose tolerance and metabolic syndrome. *Diab Vasc Dis Res*. 2005; 2(2):67–72. [PubMed: 16305061]
15. Kandula NR, Kersey M, Lurie N. Assuring the health of immigrants: what the leading health indicators tell us. *Annu Rev Public Health*. 2004; 25:357–376. [PubMed: 15015925]
16. Saaristo TE, Barengo NC, Korpi-Hyövalti E, et al. High prevalence of obesity, central obesity and abnormal glucose tolerance in the middle-aged Finnish population. *BMC Public Health*. 2008; 8:423. [PubMed: 19113993]
17. Center for Disease Control and Prevention. [Accessed April 4, 2009] Overweight and obesity. <http://www.cdc.gov/nccdphp/dnpa/obesity/>
18. McCance, K.; Huether, SE.; Brrashers, V.; Rote, NS. Pathophysiology: The Biologic Basis for Disease in Adults and Children. 6th ed.. St. Louis, MO: Mosby; 2010.
19. Kriska AM, Edelstein SL, Hamman RF, et al. Physical activity in individuals at risk for diabetes: Diabetes Prevention Program. *Med Sci Sports Exerc*. 2006; 38(5):826–832. [PubMed: 16672833]
20. Diabetes Trials Units. [Accessed October 23, 2012] HOMA calculator. <http://www.dtu.ox.ac.uk/homacalculator/index.php>
21. Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med*. 2002; 346(6):393–403. [PubMed: 11832527]
22. Perreault L, Pan Q, Mather KJ, Watson KE, Hamman RF, Kahn SE. Effect of regression from prediabetes to normal glucose regulation on long-term reduction in diabetes risk: results from the

- Diabetes Prevention Program Outcomes Study. *Lancet*. 2012; 379(9833):2243–2251. [PubMed: 22683134]
23. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed.. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
 24. Kaufman FR. Type 2 diabetes in children and young adults: a “new epidemic.”. *Clin Diabetes*. 2002; 20(4):217–218.
 25. National Diabetes Education Program. [Accessed October 16, 2012] Diabetes risk test. <http://ndep.nih.gov/resources/ResourceDetail.aspx?ResId=252&redirect=true>
 26. Cha E, Clark PC, Reilly CM, et al. Educational needs for improving self-care in heart failure patients with diabetes. *Diabetes Educ*. 2012; 38(5):673–684. [PubMed: 22722611]
 27. Balkau B, Mhamdi L, Oppert JM, et al. Physical activity and insulin sensitivity: the RISC study. *Diabetes*. 2008; 57(10):2613–2618. [PubMed: 18591396]
 28. Burke LE, Wang J. Treatment strategies for overweight and obesity. *J Nurs Scholarsh*. 2011; 43(4):368–375. [PubMed: 22018175]
 29. Pate RR, Pratt M, Blair SN, Physical activity, public health, et al. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA*. 1995; 273(5):402–407. [PubMed: 7823386]
 30. Owen KR, Shepherd M, Stride A, Ellard S, Hattersley AT. Heterogeneity in young adult onset diabetes: aetiology alters clinical characteristics. *Diabet Med*. 2002; 19(9):758–761. [PubMed: 12207813]
 31. Plowman, SA.; Smith, DL. *Exercise Physiology for Health, Fitness and Performance*. 2nd ed.. New York: Lippincott Williams & Wilkins; 2008.
 32. Shaibi GQ, Cruz ML, Ball GD, et al. Effects of resistance training on insulin sensitivity in overweight Latino adolescent males. *Med Sci Sports Exerc*. 2006; 38(7):1208–1215. [PubMed: 16826016]
 33. Kahn R, Alperin P, Eddy D, et al. Age at initiation and frequency of screening to detect type 2 diabetes: a cost-effectiveness analysis. *Lancet*. 2010; 375(9723):1365–1374. [PubMed: 20356621]
 34. Nelson ME, Rejeski WJ, Blair SN, et al. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. *Circulation*. 2007; 116(9):1094–1105. [PubMed: 17671236]
 35. Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc*. 2000; 32(suppl 9):S498–S504. [PubMed: 10993420]

Table 1Demographic characteristics between DPP and DPP-Y^a

	DPP (n = 3,234)³⁻⁵	DPP-Y (n = 103)	
Gender	Male: 32.3% (n = 1043) Female: 67.1% (n = 2191)	Male: 22.3% (n = 23) Female: 77.7% (n = 80)	
Ethnicity	Caucasian: 54.7% (n = 1,768) African American: 19.9% (n = 645) Hispanic: 15.7% (n = 508) Asian: 4.4% (n = 142)	Caucasian: 18.4% (n = 19) African American: 67.0% (n = 69) Hispanic: 7.8% (n = 8) Asian: 6.8% (n = 7)	
Age (years)	DPP (n = 3234) 50.6 ± 10.7	Prediabetes (n = 30) 24.7 ± 3.4	Nomoglycemia (n = 73) 23.7 ± 3.1
Body mass index	34.0 ± 6.7	38.6 ± 9.1	35.67 ± 7.8
Family type 2 diabetes history	Male: 66.2% (n = 690) Female: 70.9% (n = 1553)	40.0% (n = 12)	16.4% (n = 12)
Smoking	Never: 58.7% (n = 1897) Former: 34.4% (n = 1111) Current: 7.0% (226)	Never: 63.3% (n = 19) Former: 26.7% (n = 8) Current: 10.0% (n = 3)	Never: 76.7% (n = 56) Former: 12.3% (n = 9) Current: 11.1% (n = 8)

^aDPP indicates the Diabetes Prevention Program trial (DPP trial), and DPP-Y refers to our study, Diabetes Prevention Program for young adults, ages 18 to 29.

Table 2Comparisons of DPP and DPP-Y participant with prediabetes^a

	DPP	DPP-Y	<i>P</i> value (2-tailed)	Cohen's <i>d</i>
	Baseline sample (<i>n</i> = 3234)	Prediabetes (<i>n</i> = 30)		
Age (years) ***	50.6 ± 10.7	24.7 ± 3.4	<.001	7.62
Body mass index (kg/m ²) **	34.0 ± 6.7	38.6 ± 9.1	.006	0.51
Family type 2 diabetes history	Male: 66.2% (<i>n</i> = 690) Female: 70.9% (<i>n</i> = 1553)	40.0% (<i>n</i> = 12)	N/A	N/A
Waist circumference (cm)	105.1	111.2 ± 18.2	.084	0.34
Fasting insulin (pmol/l)	Male: 158.3 ± 98.6 Female: 158.1 ± 86.1	146.40 ± 62.9	NA	NA
Fasting glucose (mg/dL) ***	106.5 ± 14.5	90.7 ± 10.8	.001	1.46
A1C (%)	5.91 ± 0.50	5.8 ± 0.3	.10	0.37
Systolic blood pressure (mmHg) *	123.7 ± 14.7	116.8 ± 16.6	.016	0.42
Diastolic blood pressure (mmHg) **	78.3 ± 9.3	72.5 ± 13.8	.001	0.42
Hypertension (140/90 mmHg)	29.0%	10.0%	NA	NA
Elevated blood pressure (130/85 mmHg)	Not reported anywhere	20.0%	NA	NA
Triglyceride (mmol/l)	Male: 2.0 ± 1.1 Female: 1.7 ± 0.9	1.2 ± 0.9	NA	NA
LDL-C (mmol/l)	Male: 3.3 ± 0.8 Female: 3.2 ± 0.9	2.8 ± 0.7	NA	NA
HDL-C (mmol/l)	Male: 1.0 ± 0.2 Female: 1.2 ± 0.3	1.1 ± 0.2	NA	NA
Physical activity (MET-hr/week) ^{b*}	Mean ± SD: 16.3 ± 25.8 Median: N/A	Mean ± SD: 9.1 ± 15.5 Median: 2.2	.017	0.47

^aDPP indicates the Diabetes Prevention Program (DPP),⁵ and DPP-Y refers to our study, Diabetes Prevention Program for young adults ages 18 to 29.

^bRecommendations of physical activity are: American College of Sports Medicine (ACSM): 7.5 to 12.5 MET-hour/week of aerobic activity with muscle-strengthen activity;³⁴ International Physical Activity Questionnaire group classifies the activity level as: low: <10 MET-hour/week, moderate: 10 MET-hour/week and < 25 MET-hour/week, and high: 25 MET-hour/week;³⁵ American Diabetes Association recommendations are similar to ACSM but emphasize frequency (no more than 2 consecutive days without activity).³⁴

* *P* < .05.

** *P* < .01.

*** *P* < .001.

Table 3Comparisons of young adults with and without prediabetes^a

	DPP-Y (n = 103)		Test differences (<i>t</i> test/ Mann-Whitney test)	Cohen's d
	Prediabetes (n = 30)	Normoglycemia (n = 73)		
Age (years)	24.7 ± 3.4	23.7 ± 3.1	<i>P</i> = .16	.31
BMI (kg/m ²)	38.8 ± 8.9	35.7 ± 7.7	<i>P</i> = .78	.23
Family type 2 diabetes history [*]	40.0% (n = 12)	16.4% (n = 12)	<i>P</i> = .01	
Waist circumference (cm)	111.1 ± 18.2	105.5 ± 16.3	<i>P</i> = .91	.34
Fasting insulin (pmol/l) [*]	146.4 ± 62.9	113.7 ± 58.6	<i>P</i> = .013	.48
Fasting glucose (mg/dL) ^{***}	90.7 ± 10.8	82.6 ± 9.4	<i>P</i> < .001	.81
A1C (%) ^{***}	5.8 ± 0.3	5.2 ± 1.3	<i>P</i> < .001	.55
B-cell function (%B)	192.8 ± 86.8	183.4 ± 71.5	<i>P</i> = .58	.07
Insulin sensitivity (%S) ^{b**}	44.1 ± 17.7	65.1 ± 42.0	<i>Z</i> = -2.88, <i>P</i> = .004	.54
Insulin resistance ^{**}	2.7 ± 1.1	2.0 ± 1.0	<i>P</i> = .005	.56
Systolic blood pressure (mmHg)	116.8 ± 16.6	119.8 ± 15.3	<i>P</i> = .33	.19
Diastolic blood pressure (mmHg)	72.5 ± 13.8	72.9 ± 8.4	<i>P</i> = .42	.04
Hypertension (140/90 mmHg)	10.0%	13.7%	<i>P</i> = .75	NA
Elevated blood pressure (130/85 mmHg)	20.0%	27.4%	<i>P</i> = .47	NA
Triglyceride (mmol/l) ^b	1.2 ± 0.9	1.0 ± .5	<i>Z</i> = -.83, <i>p</i> = .41	.28
LDL-C (mmol/l)	2.8 ± 0.73	2.6 ± .9	<i>P</i> = .47	.21
HDL-C (mmol/l)	1.1 ± 0.2	1.1 ± .2	<i>P</i> = .80	.06
Physical activity (MET-hr/week) ^{b,c**}	9.1 ± 15.5	32.2 ± 73.9	<i>Z</i> = -2.68, <i>p</i> = .007	.37
	Median: 2.2	Median: 7.6		

^aDPP indicates the Diabetes Prevention Program (DPP),⁵ and DPP-Y refers to our study, Diabetes Prevention Program for young adults ages 18 to 29.

^bRefers to the results of Mann-Whitney test.

^cRecommendations of physical activity are: American College of Sports Medicine (ACSM): 7.5 to 12.5 MET-hour/week of aerobic activity with muscle-strengthen activity;³⁴ International Physical Activity Questionnaire group classifies the activity level as: low: <10 MET-hour/week, moderate: 10 MET-hour/week and < 25 MET-hour/week, and high: 25 MET-hour/week;³⁵ American Diabetes Association recommendations are similar to ACSM but emphasize frequency (no more than 2 consecutive days without activity).³⁴

^{*}*P* < .05.

^{**}*P* < .01.

^{***}*P* < .001.