Published OnlineFirst August 21, 2013; DOI: 10.1158/1055-9965.EPI-13-0518

Cancer Epidemiology, Biomarkers & Prevention

Short Communication

Family History of Diabetes and Pancreatic Cancer as Risk Factors for Pancreatic Cancer: The PACIFIC Study

Melissa A. Austin[1], Elena Kuo[3], Stephen K. Van Den Eeden[5], Margaret T. Mandelson[1], Teresa A. Brentnall[2], Aruna Kamineni[3], and John D. Potter[1,4,6]

Abstract

Genetic association studies have identified more than a dozen genes associated with risk of pancreatic cancer. Given this genetic heterogeneity, family history can be useful for identifying individuals at high risk for this disease. The goal of this analysis was to evaluate associations of family history of diabetes and family history of pancreatic cancer with risk of pancreatic cancer. PACIFIC is a case–control study based on two large health plans. Cases were diagnosed with pancreatic ductal adenocarcinoma (PDA) and controls were selected from the health plan enrollment databases and frequency matched to cases. Family history data were collected using an interviewer-administered questionnaire and were available on 654 cases and 697 controls. Logistic regression was used for the association analyses. First-degree relative history of diabetes was statistically significantly associated with increased risk of PDA [OR, 1.37; 95% confidence interval (CI), 1.10–1.71]. The highest risk of PDA was observed for an offspring with diabetes (OR, 1.95; 95% CI, 1.23–3.09). In addition, history of pancreatic cancer increased risk for PDA with an OR of 2.79 (95% CI, 1.44–4.08) for any first-degree relative history of pancreatic cancer. This population-based analysis showed that family history of diabetes was associated with increased risk of PDA and confirmed previous studies showing that first-degree family history of pancreatic cancer is associated with PDA. These results support the need for ongoing studies of genetic influences on pancreatic cancer in large samples and investigations of possible pleiotropic genetic effects on diabetes and pancreatic cancer. *Cancer Epidemiol Biomarkers Prev; 22(10); 1913–7. ©2013 AACR.*

Introduction

Pancreatic cancer is the fourth leading cause of cancer mortality in the United States for both men and women (1). Most tumors are pancreatic ductal adenocarcinoma (PDA) and patients have a median survival of only 4 months (2). The estimated annual death toll in the United States is 37,390 and 5-year survival is only 6%. Although smoking is the best established risk factor for PDA (3), diabetes mellitus has also been consistently associated with PDA (4). An analysis from the Pancreatic Cancer Cohort (PanScan) Consortium (5) reported that 2 to 8 years duration of diabetes was associated with an 80% increased risk of the disease, but longer duration (>9 years) was not. The inaccessibility of the pancreas, the nonspecific symptoms of pancreatic cancer, the advanced stages of disease at diagnosis, and a lack of effective therapy continue to make etiologic studies of pancreatic cancer challenging.

It has been estimated that 5% to 10% of pancreatic cancer is genetically influenced (6). Family-based studies and genome-wide association studies (GWAS) have reported that more than a dozen candidate genes or genomic regions are associated with risk of pancreatic cancer, including *BRCA2*, *STK11*, *p16/CDKN2*, *PALB2*, and the *ABO* blood group locus (7). These range from rare genetic variants conferring high risk ("high penetrance genes") to common genetic variants with relatively small risk ("low penetrance genes"; ref. 7).

Given this genetic heterogeneity, family history can be a useful disease-prediction tool, and the PancPRO model was developed to identify high-risk individuals based on their affected family members with pancreatic cancer (8). A meta-analysis of 9 studies reported an 80% increased risk of pancreatic cancer associated with having an affected relative (9). More recently, Jacobs and colleagues (10) used data from seven PanScan studies and found an essentially identical overall OR of 1.76 for the association between having a family history of pancreatic cancer in a first-degree relative and risk of pancreatic cancer. Similar results were also seen in the Cancer Prevention Study II (CPS-II), based on approximately 1.1 million men and women, in which family history of pancreatic cancer in a parent or sibling was associated with 66% increased risk of pancreatic cancer mortality (11). Few of these studies have

Authors' Affiliations: Departments of [1]Epidemiology and [2]Gastroenterology, University of Washington; [3]Group Health Research Institute and [4]Division of Public Health Sciences, Fred Hutchinson Cancer Research Center, Seattle, Washington; [5]Division of Research, Kaiser Permanente Northern California, Oakland, California; and [6]Centre for Public Health Research, Massey University, Wellington, New Zealand

Corresponding Author: Melissa A. Austin, University of Washington, 1959 NE Pacific Street, Health Sciences Bldg, Box 357236, Seattle, WA 98195-7236. Phone: 206-543-0709; Fax: 206-543-8525; E-mail: maustin@uw.edu

doi: 10.1158/1055-9965.EPI-13-0518

Published OnlineFirst August 21, 2013; DOI: 10.1158/1055-9965.EPI-13-0518

considered whether any specificity exists across subtypes of first-degree relatives: mothers, fathers, sisters, brothers, and offspring.

Previous studies have also suggested an association between family history of diabetes and risk of pancreatic cancer, although the results have not been consistent (12, 13). Genes involved in diabetes may be associated with pancreas cancer as well. For example, the Pro12Ala variant of the *PPAR*-γ diabetes susceptibility gene was associated with risk of pancreatic cancer in a small cohort of smokers (14), although this finding was not replicated in a larger case–control study (15). Taken together, these data support the existence of genetic predisposition to pancreatic cancer and the possible role of family history in identifying high-risk individuals.

The goal of this analysis was to evaluate associations of family history of diabetes and family history of pancreatic cancer with risk of PDA using a case–control sample from 2 large health plans in the Western United States.

Materials and Methods

Data collection

The pancreatic cancer: investigation into finding causes (PACIFIC) study is a case–control study of pancreatic cancer based on the defined populations of 2 large health plans [Group Health Cooperative (GHC; Seattle, WA) and Kaiser Permanente Northern California (KPNC; Oakland, CA)]. Case subjects were newly diagnosed pancreatic cancer cases recruited from either July 2005 (GHC) or August 2005 (KPNC) through December 2009, using an ultrarapid identification procedure with physician consent. A total of 1,209 eligible cases (1,031 at KPNC and 178 at GHC) were identified during the study period, all of whom were at least 21 years of age and enrolled in their health plan at the time of diagnosis. Controls were randomly sampled from enrollment files at each health plan and frequency matched to cases on age (5-year intervals) and sex. A total of 1,670 controls were identified as eligible. They were recruited using identical methods to that of cases, except no physician consent was obtained. Sex and age data were available from administrative records, whereas race, ethnicity, diabetes, and smoking histories up to 1 year before diagnosis for cases and reference date for controls were obtained at interview.

Family history data were collected using an interviewer-administered questionnaire that queried history of cancer, diabetes, and other chronic diseases among parents, siblings, and offspring of study subjects as well as vital status and age (or age at death) of each relative. Interviewers recorded the type of cancer verbatim; subsequently, ICD-9 codes were applied. Specific information on type I versus type II diabetes was not obtained.

Of the 1,209 eligible cases, 531 (44%) died before the interview. Of the remaining 678 cases and after excluding 3 adopted cases, family history data were available on 654 (96%) cases. Of the 1,620 eligible controls, 874 (54%) were successfully enrolled in the study. After excluding 18 adopted controls, family history data were available on 697 of the enrolled controls (80%).

Statistical analysis

All analyses were conducted using SPSS 19.0. Logistic regression was used to evaluate the associations between family history of diabetes and family history of pancreatic cancer with case/control status (16), with adjustment for sex, age (continuous), race, and ethnicity. ORs and 95% confidence intervals (CI) were calculated for the following subsets of family history: maternal, paternal, parental, brother, sister, sibling, parent and/or sibling, offspring, and all first-degree relatives. For family history of diabetes, we also calculated risk of PDA for 2 or more first-degree relatives with diabetes. This estimate was not possible for family history of pancreatic cancer because only one case had 2 relatives with pancreatic cancer, a brother and a sister.

Results

As shown in Table 1, distributions of age, sex, and Caucasian race were similar for cases and controls. The proportion of ever smokers was higher among cases than controls (54% vs. 49%), with smoking among controls similar to the prevalence of ever smoking among whites in this age group based on National Health Interview Survey Data (ref. 17; prevalence of current smokers was 15.9% and 8.9% among cases and controls, respectively). The proportion of individuals with a

Table 1. Characteristics of pancreatic cancer cases and controls

	Cases		Controls	
	n = 654	%	*n* = 697	%
Sex				
Female	331	50.6	358	51.4
Male	323	49.4	339	48.6
Age (y), mean ± SD	68.1 ± 11.2		67.8 ± 11.1	
Race				
White/Caucasian	488	74.6	545	78.2
Black	57	8.7	36	5.2
Asian/Pacific Islander	57	8.7	53	7.6
Other	52	8.0	63	9.0
Hispanic ethnicity[a]				
Hispanic	57	8.9	65	9.4
Not Hispanic	582	91.1	625	90.6
Smoking[a]				
Ever	354	54.3	343	49.4
Never	298	45.7	352	50.6
Personal history of diabetes[a]				
Yes	134	20.6	105	15.1
No	518	79.4	592	84.9

[a]Sample sizes vary due to missing data.

Published OnlineFirst August 21, 2013; DOI: 10.1158/1055-9965.EPI-13-0518

Table 2. Association between family history of diabetes in first-degree relatives and risk of pancreatic cancer

Family history of diabetes[a]	Cases (%)	Controls (%)	Adjusted[b] OR (95% CI)
Father	77/579 (13.3)	76/640 (11.9)	1.30 (0.97–1.74)
Mother	123/614 (20.0)	109/665 (16.4)	1.15 (0.91–1.64)
Parents	187/578 (32.4)	167/634 (26.3)	1.32 (1.03–1.69)
Brothers	81/400 (20.3)	81/444 (18.2)	1.18 (0.85–1.66)
Sisters	89/417 (21.3)	67/446 (15.0)	1.60 (1.14–2.26)
Siblings	141/332 (42.5)	126/354 (35.6)	1.39 (1.05–1.82)
Offspring	53/319 (16.6)	32/340 (9.4)	1.95 (1.23–3.09)
Parents and/or siblings	256/392 (65.3)	236/413 (57.1)	1.34 (1.07–1.68)
Any first-degree relative	278/341 (81.5)	255/340 (75.0)	1.37 (1.10–1.71)
Two or more first-degree relatives	140/341 (41.1)	111/340 (32.6)	1.41 (1.06–1.88)

[a]Sample sizes vary due to missing data and exclusion of cases and controls with no brothers, sisters, siblings, or offspring as appropriate.
[b]Adjusted for sex (male/female), age (continuous), race (Black, Asian/Pacific Islander, White, other), and Hispanic ethnicity (Hispanic/non-Hispanic).

personal history of diabetes diagnosed at least 1 year before reference date was also higher in cases than in controls (21% vs. 15%).

We observed a statistically significant association between history of diabetes in parents, sisters, and siblings and risk of PDA, with ORs of 1.32, 1.60, and 1.39, respectively (Table 2). The highest risk was observed for having an offspring with diabetes (OR, 1.95; 95% CI, 1.23–3.09). As expected from these results, history of diabetes in any first-degree relative was also statistically significantly associated with risk of PDA (OR, 1.37; 95% CI, 1.10–1.71). The risk of PDA associated with having 2 or more relatives with diabetes was slightly higher (OR, 1.41; 95% CI, 1.06–1.88).

We observed a more than 2-fold increase in risk of PDA associated with a paternal or maternal history of pancreatic cancer, although these associations were not statistically significant (Table 3). However, for mothers and fathers combined, the observed elevation in risk was statistically significant (OR, 2.57; 95% CI, 1.29–5.12). We observed only a modest increase in risk with having a brother with pancreatic cancer (OR = 1.49), but a more than 2-fold increase in risk associated with a sister with a similar history (OR = 2.47). As with parental history, the

Table 3. Association between family history of pancreatic cancer in first-degree relatives and risk of pancreatic cancer

Family history of pancreatic cancer[a]	Cases (%)	Controls (%)	Adjusted[b] OR (95% CI)
Father	15/577 (2.6)	7/650 (1.1)	2.25 (0.90–5.62)
Mother	13/609 (2.1)	6/678 (0.9)	2.45 (0.92–6.52)
Parent	28/562 (5.0)	12/637 (1.9)	2.57 (1.29–5.12)
Brother	8/434 (1.8)	6/460 (1.3)	1.49 (0.52–4.36)
Sister	11/431 (2.6)	5/453 (1.1)	2.47 (0.85–7.19)
Sibling(s)[c]	18/532 (3.4)	9/562 (1.6)	2.28 (1.01–5.13)
Offspring	1/541 (0.2)	2/588 (0.3)	0.55 (0.05–6.20)
Parent and/or sibling	46/550 (8.4)	20/597 (3.4)	2.63 (1.54–4.52)
Any first-degree relative	47/538 (8.7)	22/580 (3.8)	2.79 (1.44–4.08)

[a]Sample sizes vary due to missing data and exclusion of cases and controls with no brothers, sisters, siblings, or offspring as appropriate.
[b]Adjusted for sex (male/female), age (continuous), race (Black, Asian/Pacific Islander, White, other), and Hispanic ethnicity (Hispanic/non-Hispanic)
[c]One case had both a brother and sister with pancreatic cancer.

Published OnlineFirst August 21, 2013; DOI: 10.1158/1055-9965.EPI-13-0518

combined sibling association was statistically significant (OR, 2.28; 95% CI, 1.01–5.13). As expected from the age distribution of study participants, the number of offspring with pancreatic cancer was small, limiting the precision of our estimates for this association (OR, 0.55; 95% CI, 0.05–6.20). Combining all first-degree relatives resulted in the largest magnitude of risk in this analysis (OR, 2.79; 95% CI, 1.44–4.0).

Discussion

In this study, history of diabetes in any first-degree relative was statistically significantly associated with risk of PDA (OR, 1.37; 95% CI, 1.10–1.71). Statistically significant associations between history of diabetes in parents, siblings, and offspring and risk of PDA were also observed. The risk of PDA associated with having 2 or more relatives with diabetes was slightly higher (OR = 1.41) and was also statistically significant. We also confirmed results from previous studies showing that family history of pancreatic cancer in first-degree relatives was associated with increased risk of PDA.

To our knowledge, this study is the first to examine risk of pancreatic cancer associated with family history of diabetes among subsets of first-degree relatives. An early population-based case–control study did not find any association with diabetes in first-degree relatives, whereas a clinic-based study found a moderate association (12, 13). We found that the strongest relationship was for history of diabetes in offspring (OR = 1.95) with lower, but still statistically significant associations for history of diabetes among parents (OR = 1.32) and siblings (OR = 1.39). This difference could be due to recall bias if cases have poorer knowledge of the health status of their siblings and parents than of their offspring. Family history of diabetes did not distinguish between type I and type II diabetes, also potentially biasing the results.

Despite these limitations, these results, if confirmed, imply that there could be common, underlying genetic susceptibility to both diabetes and pancreatic cancer, diseases that involve the same organ. On the basis of case–control data from the Cancer Genetic Markers of Susceptibility PanScan-I GWAS, we recently examined 37 common type II diabetes susceptibility variants for association with risk of pancreatic cancer (18). Although the results did not provide strong evidence for association of these variants with risk of PDA, nominally significant associations were found for 2 genes, *FTO* and *MTNR1B*. In addition, familial aggregation of lifestyle factors such as obesity and cigarette smoking, both established risk factors for diabetes, could explain the familial associations reported here.

These results confirm previous studies showing familial aggregation of pancreatic cancer. The largest study to date, the CPS-II study, based on approximately than 1.1 million men and women and 7,306 pancreatic cancer deaths, reported a relative risk of 1.66 (95% CI, 1.43–1.94) for the association between pancreatic cancer in a parent or sibling and pancreatic cancer mortality (11). Similarly, recent findings from the PanScan Consortium that included 1,183 cases and 1,205 controls found a nearly 80% increase in risk associated with a family history of pancreatic cancer in a first-degree relative (OR, 1.76; 95% CI, 1.19–2.61; ref. 10). Data from the nationwide Swedish Family-Cancer Database, created by linking the Swedish Cancer Registry with an administrative register of all Swedish families, calculated standardized incidence rations (SIRs) for offspring of parents with pancreatic tumors. The resulting SIR for pancreatic cancer in offspring was 1.73 (95% CI, 1.13–2.54) for pancreatic adenocarcinoma in a parent (19). The magnitude of the association for a first-degree family history of pancreatic cancer in the present study was higher (OR = 2.79) than estimates from these previous studies. This may be due to potential biases in the present study, including differential interview rates among eligible cases and controls. That is, only 80% of the study controls completed the family history questionnaire, due primarily to failure to complete the study interview, compared with 97% of the living cases. Despite the ultrarapid case ascertainment, 44% of cases died before interview, also possibly introducing bias in the estimation of familial risk. Finally, due to the modest size of this study, the CI is relatively wide (1.44–4.08) and includes the point estimates from the previous studies. Nonetheless, the accumulating evidence shows that history of pancreatic cancer in a first-degree relative confers an approximately 2-fold increased risk of pancreatic cancer.

An important next step in this research will be to determine the extent to which recently discovered genetic susceptibility variants contribute to the familial risk of pancreatic cancer. GWAS and candidate gene studies have implicated several genetic susceptibility variants, including the *ABO* locus on chromosome 9 (20, 21) and chromosomal regions 1q32.1 and 13q22.1 (22). Most recently, the SET binding factor 2 (*SBF2*) on chromosome 11p15.4 has been associated with pancreatic cancer survival (23). Currently available methods can be applied to determine the genetic variance in pancreatic cancer risk attributable to associated single-nucleotide polymorphisms based on GWAS data (24).

In conclusion, this population-based analysis of pancreatic cancer cases and controls showed that family history of diabetes was statistically significantly associated with an approximately 30% increased risk of PDA with the highest risk of PDA seen for an offspring with diabetes (OR = 1.95). In addition, history of pancreatic cancer was a risk factor for PDA for any first-degree relative history of pancreatic cancer. These results support a need for further studies of genetic influences on pancreatic cancer in large samples and investigations of possible pleiotropic genetic effects on diabetes and pancreatic cancer. Such research would advance our understanding of the etiology of pancreatic cancer and contribute to strategies for the early detection and, perhaps, prevention of this devastating disease.

Published OnlineFirst August 21, 2013; DOI: 10.1158/1055-9965.EPI-13-0518

Disclosure of Potential Conflicts of Interest

T.A. Brentnall is a consultant/advisory board member for GlobeImmune. No potential conflicts of interest were disclosed by the other authors.

Authors' Contributions

Conception and design: M.A. Austin, S.K. Van Den Eeden, M.T. Mandelson, T.A. Brentnall, J.D. Potter
Development of methodology: M.A. Austin, E. Kuo, S.K. Van Den Eeden, M.T. Mandelson
Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): M.A. Austin, E. Kuo, S.K. Van Den Eeden, M.T. Mandelson, J.D. Potter
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): M.A. Austin, E. Kuo, S.K. Van Den Eeden, M.T. Mandelson, A. Kamineni
Writing, review, and/or revision of the manuscript: M.A. Austin, E. Kuo, S.K. Van Den Eeden, M.T. Mandelson, T.A. Brentnall, A. Kamineni, J.D. Potter
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): M.A. Austin, E. Kuo, S.K. Van Den Eeden, A. Kamineni
Study supervision: M.A. Austin, S.K. Van Den Eeden, M.T. Mandelson, T. A. Brentnall, J.D. Potter

Grant Support

This work was supported by grants R01 CA102765 and R21CA115878 from the National Cancer Institute.

Received May 20, 2013; revised July 23, 2013; accepted August 5, 2013; published OnlineFirst August 21, 2013.

References

1. Seigel R, Naishadham D, Jemal A. Cancer statistics. CA Cancer J Clin 2012;66:10–29.
2. Fesinmeyer MD, Austin MA, Li CI, De Roos AJ, Bowen DJ. Differences in survival by histologic type of pancreatic cancer. Cancer Epidemiol Biomarkers Prev 2005;14:1766–73.
3. Iodice S, Gandini S, Maisonneuve P, Lowenfels AB. Tobacco and the risk of pancreatic cancer: a review and meta-analysis. Langenbecks Arch Surg 2008;393:535–55.
4. Huxley R, Ansary-Moghaddam A, Berrington de Gonzalez A, Barzi F, Woodward M. Type-II diabetes and pancreatic cancer: a meta-analysis of 36 studies. Br J Cancer 2005;92:2076–83.
5. Elena JW, Steplowski E, Yu K, Hartge P, Tobias GS, Brotzman MJ, et al. Diabetes and risk of pancreatic cancer: a pooled analysis from the Pancreatic Cancer Cohort Consortium. Cancer Causes Control 2013; 24:13–25.
6. Brand RE, Lynch HT. Genotype/phenotype of familial pancreatic cancer. Endocrinol Metab Clin North Am 2006;35:405–15.
7. Klein AP. Genetic susceptibility to pancreatic cancer. Mol Carcinog 2012;51:14–24.
8. Wang W, Chen S, Brune KA, Hruban RH, Parmigiani G, Klein AP. Risk assessment for individuals with a family history of pancreatic cancer. J Clin Oncol 2007;25:1417–22.
9. Permuth-Wey J, Egan KM. Family history is a significant risk factor for pancreatic cancer: results from a systematic review and meta-analysis. Fam Cancer 2009;8:109–17.
10. Jacobs EJ, Chanock SJ, Fuchs CS, LaCroix A, McWilliams RR, Steplowski E, et al. Family history of cancer and risk of pancreatic cancer: a pooled analysis from the Pancreatic Cancer Cohort Consortium. Int J Cancer 2010;127:1421–8.
11. Jacobs EJ, Rodriguez C, Newton CC, Bain EB, Patel AV, Feigelson HS, et al. Family history of various cancer and pancreatic cancer mortality in a large cohort. Cancer Causes Control 2009;20: 1261–9.
12. Pannala R, Leirness JB, Bamlet WR, Basu A, Petersen GM, Chari ST. Prevalence and clinical profile of pancreatic cancer-associated diabetes mellitus. Gastroenterology 2008;134:981–7.
13. Silverman DT, Schiffman M, Everhart J, Goldstein A, Lillemoe KD, Swanson GM, et al. Diabetes mellitus, other medical conditions and familial history of cancer as risk factors for pancreatic cancer. Br J Cancer 1999;80:1830–7.
14. Fesinmeyer MD, Stanford JL, Brentnall TA, Mandelson MT, Farin FM, Srinouanprachanh S, et al. Association between the peroxisome proliferator-activated receptor gamma Pro12Ala variant and haplotype and pancreatic cancer in a high-risk cohort of smokers: a pilot study. Pancreas 2009;38:631–7.
15. Tang H, Dong X, Hassan M, Abbruzzese JL, Li D. Body mass index and obesity- and diabetes-associated genotypes and risk for pancreatic cancer. Cancer Epidemiol Biomarkers Prev 2011;20:779–92.
16. Breslow NE, Day NE. Unconditional logistic regression for matched sets. In: Davis W, editor. Statistical methods in cancer research. Lyon, France: International Agency for Research on Cancer, IARC Scientific Publication No. 32;1980. p. 192–246.
17. Burns DM, Lee L, Shen LZ, Gilpin E, Golley HD, Vaughn J, Shanks TG. Chapter 2. Cigarette smoking behavior in the United States. In: Smoking and Tobacco Control Monograph No. 8. Bethesda, MD: National Cancer Institute: 1997. [accessed 2012 Dec 19]. Available from: http://cancercontrol.cancer.gov/tcrb/monographs/8/m8_2.pdf.
18. Pierce BL, Austin MA, Ahsan H. Association study of type 2 diabetes genetic susceptibility variants and risk of pancreatic cancer: an analysis of PanScan-I data. Cancer Causes Control 2011;22:877–83.
19. Hemminki K, Li X. Familial and second primary pancreatic cancers: a nationwide epidemiologic study from Sweden. Int J Cancer 2003;103: 525–30.
20. Amundadottir L, Kraft P, Stolzenberg-Solomon RZ, Fuchs CS, Petersen GM, Arslan AA, et al. Genome-wide association study identifies variants in the ABO locus associated with susceptibility to pancreatic cancer. Nat Genet 2009;41:986–90.
21. Wolpin BM, Chan AT, Hartge P, Chanock SJ, Draft P, Hunter DJ, et al. ABO blood group and the risk of pancreatic cancer. J Natl Cancer Inst 2009;101:424–31.
22. Petersen GM, Amundadottir L, Fuchs CS, Kraft P, Stolzenberg-Solomon RZ, Jacobs KB, et al. A genome-wide association study identified pancreatic cancer susceptibility loci on chromosomes 13q22.1, 1q32.1, and 5p15.33. Nat Genet 2010;42:244–28.
23. Wu C, Kraft P, Stolzernberg-Solomon R, Steplowski E, Brotzman M, Xu M, et al. Genome-wide association study of survival in patients with pancreatic adenocarcinoma. Gut. 2012 Nov 24. [Epub ahead of print].
24. Yang J, Benyamin B, McEvoy BP, Gordon S, Henders AK, Nyholt DR, et al. Common SNPs explain a large proportion of the heritability for human height. Nat Genet 2010;42:565–9.

Cancer Epidemiology, Biomarkers & Prevention

AACR American Association for Cancer Research

Family History of Diabetes and Pancreatic Cancer as Risk Factors for Pancreatic Cancer: The PACIFIC Study

Melissa A. Austin, Elena Kuo, Stephen K. Van Den Eeden, et al.

Cancer Epidemiol Biomarkers Prev 2013;22:1913-1917. Published OnlineFirst August 21, 2013.