Obesity and Type II Diabetes Risk; A Multinational Study

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Introduction

Many studies have shown that obesity is associated with risk of type II diabetes. However there are inconsistencies in many areas that need to be resolved. Areas of particular interest include further analyses of effect modification by race, gender, smoking and exercise.

Study Aim

To examine the association between obesity and risk of type II diabetes.

Methods

Overview of the Study

▪ **The Global Epidemiology Study:** The Global Epidemiology Study (GES) is a multinational study to assess disease risk factors. Subjects were recruited to the GES from countries including the United States, Tunisia, Poland and India. The GES is linked to the Global Repository that houses biomaterial. For diabetes, subjects provided informed consent and were asked about diet and health behaviors during in-person interviews using the same translated survey instrument.

▪ **Participants:** We examined the association between obesity and type II diabetes risk among 11,455 type II diabetes cases and 12,837 disease-free controls in the Global Epidemiology Study (GES).

Design of Current Project

▪ **Participants:** 11,455 diabetes cases and 12,837 controls (total=24,292)

Inclusion criteria:
- Body Mass Index (BMI) data available
- Race of Caucasian-Americans, African-Americans, Hispanic-Americans, Tunisian-Arabs, Polish-Caucasians or Asian Indians

Covariate data:

Data from the baseline questionnaire and medical assessment included data on age, gender, race, diet, physical activity, and smoking and alcohol consumption.

Statistical Analyses:

- Body Cross tabulations with Chi square tests and t-tests were conducted to determine the association between diabetes status and potential confounders
- Unconditional logistic regression was used to compute odds ratios (ORs) and 95% confidence intervals (CIs). The variables used in the multivariate analyses were age, pack-years of smoking and BMI as continuous variables and race as a categorical variable.
- Potential confounding of the association between obesity and diabetes risk was explored using Spearman rank correlation analyses and multivariate logistic regression models, including stepwise regression models. If the potential confounder caused a >20% change in the β coefficient, it was kept in the model for further analyses.
- All p-values shown are 2-sided.
- All statistical analyses were performed using the software package STATA (STATA Corporation, College Station, TX).

Results

Table 1. Crosstabs of Demographics and Health Behavior Indicators

Characteristic	All Controls	All Cases	P-Value	Caucasian American Controls	Caucasian American Cases	P-Value	African American Controls	African American cases	P-Value	Hispanic American Controls	Hispanic American Cases	P-Value
Age (Years)*	52.39 (12.52)	57.93 (12.78)	<0.0001	56.35 (13.11)	61.26 (13.32)	<0.0001	47.34 (11.0)	58.51 (13.3)	<0.0001	51.34 (15.1)	52.78 (13.1)	0.04
Gender												
Male	6718 (52.33%)	6002 (52.40%)		2312 (49.01%)	1971 (50.71%)		794 (66.2%)	300 (45.7%)		713 (39.6%)	319 (51.7%)	
Female	6119 (47.67%)	5453 (47.60%)	<0.08	2405 (50.99%)	1916 (49.29%)	<0.12	406 (33.8%)	357 (54.3%)	<0.0001	1087 (60.4%)	298 (48.3%)	<0.0001
Smoking												
No	7167 (55.83%)	6534 (56.95%)		2391 (50.60%)	1699 (43.60%)		371 (31.0%)	351 (53.4%)		1330 (73.9)	369 (59.9)	
Yes	5671 (44.17%)	4939 (43.05%)	<0.0001	2325 (49.40%)	2197 (56.40%)	<0.0001	825 (68.98%)	306 (46.58%)	<0.0001	469 (26.1)	247 (40.1)	<0.0001
Alcohol												
No	8546 (66.94%)	9462 (82.76%)		2640 (56.27%)	2962 (76.36%)		553 (46.3%)	544 (83.2%)		1299 (72.7)	519 (84.4)	
Yes	4219 (33.06%)	1971 (17.24%)	<0.0001	2052 (43.73%)	917 (23.64%)	<0.0001	641 (53.7%)	110 (16.8%)	<0.0001	487 (27.3)	96 (15.6)	<0.0001
Vegetables (servings/day)*	2.62 (2.16)	2.73 (2.51)	<0.0004	2.10 (1.27)	2.20 (1.30)	<0.0004	2.22 (1.3)	1.96 (1.4)	<0.001	1.62 (1.02)	1.65 (1.00)	<0.54
Fruits (servings/day)*	1.51 (1.18)	1.54 (1.26)	<0.02	1.74 (1.17)	1.85 (1.30)	<0.0001	1.89 (1.5)	1.79 (1.7)	<0.19	1.68 (1.05)	1.56 (1.09)	<0.02
Wholegrains (servings/day)*	4.06 (5.37)	4.65 (5.56)	<0.0001	1.74 (1.26)	1.93 (1.43)	<0.0001	1.84 (1.3)	1.57 (1.3)	<0.0001	1.59 (1.10)	2.83 (2.50)	<0.0001
Dairy prod. (servings/day)*	2.01 (1.66)	1.99 (1.82)	<0.38	1.77 (1.29)	1.74 (1.21)	<0.24	1.93 (1.3)	1.31 (1.0)	<0.0001	1.62 (1.15)	1.41 (1.00)	<0.0002
Red meat (Times/week)*	2.55 (2.26)	2.27 (2.13)	<0.0001	3.09 (2.39)	3.32 (2.48)	<0.0001	3.76 (2.9)	2.44 (2.3)	<0.0001	2.62 (2.13)	2.45 (1.95)	<0.07
Fish (Times/week)*	1.18 (1.21)*	1.14 (1.33)	<0.01	1.41 (1.22)	1.27 (1.16)	<0.0001	1.90 (1.7)	1.88 (1.9)	<0.78	1.23 (1.25)	1.33 (1.36)	<0.13
Exercise (Minutes/week)*	180.37 (340.02)	137.71 (309.18)	<0.0001	210.79 (359.57)	138.29 (322.13)	<0.0001	265.34 (412.2)	124 (265.2)	<0.0001	150.39 (315.11)	169.90 (275.16)	<0.18
BMI, Kg/m²*	26.48 (5.46)	29.07 (6.57)	<0.0001	27.63 (5.55)	32.30 (7.25)	<0.0001	28.25 (6.7)	32.56 (7.1)	<0.0001	28.40 (6.12)	31.05 (6.06)	<0.0001

Characteristic	Tunisian Arab Controls	Tunisian Arab Cases	P-Value	Polish Caucasian Controls	Polish Caucasian Cases	P-Value	South Indian Controls	South Indian Cases	P-Value	North Indian Controls	North Indian Cases	P-Value
Age (Years)*	44.74 (9.3)	50.93 (10.4)	<0.0001	56.12 (6.26)	58.34 (13.09)	<0.0001	50.22 (9.80)	57.11 (11.0)	<0.0001	48.67 (9.8)	58.21 (11.4)	<0.0001
Gender												
Male	739 (73.5%)	585 (49.5%)		485 (41.07%)	639 (59.09%)		1447 (57.5%)	1903 (62.7%)		111 (64.5%)	195 (58.2%)	
Female	266 (26.5%)	597 (50.5%)	<0.0001	696 (58.93%)	923 (40.91%)	<0.934	1068 (42.5%)	1131 (37.3%)	<0.0001	61 (35.5%)	140 (41.8%)	<0.17
Smoking												
No	744 (74.18%)	865 (73.24%)		694 (58.76%)	964 (61.56%)		1385 (55.0%)	1943 (63.9%)		110 (64.0%)	232 (69.3%)	
Yes	259 (25.82%)	316 (26.76%)	<0.62	487 (41.24%)	602 (38.44%)	<0.14	1135 (45.0%)	1097 (36.1%)	<0.0001	62 (36.0%)	103 (30.75%)	<0.23
Alcohol												
No	894 (91.0%)	1058 (89.7%)		710 (60.12%)	1261 (80.83%)		2153 (85.8%)	2692 (88.8%)	<0.001	133 (77.8%)	286 (85.9%)	
Yes	89 (9.0%)	122 (10.3%)	<0.316	471 (39.88%)	299 (19.17%)	<0.0001	357 (14.2%)	338 (11.2%)		38 (22.2%)	47 (14.1%)	<0.3
Vegetables (servings/day)*	1.89 (0.3)	1.89 (0.3)	<0.68	1.33 (0.66)	1.23 (0.65)	<0.0001	5.31 (2.8)	4.68 (3.5)	<0.0001	5.17 (2.8)	4.59 (3.4)	<0.06
Fruits (servings/day)*	1.88 (0.3)	1.91 (0.3)	<0.04	1.30 (0.79)	1.18 (0.67)	<0.0001	0.73 (1.1)	1.12 (1.4)	<0.0001	1.09 (1.3)	1.59 (1.6)	<0.0005
Wholegrains (servings/day)*	0.99 (0.3)	0.95 (0.4)	<0.009	0.73 (0.76)	1.59 (0.86)	<0.0001	13.51 (4.3)	11.48 (5.8)	<0.0001	13.31 (4.6)	11.01 (5.5)	<0.0001
Dairy prod. (servings/day)*	1.09 (0.4)	1.15 (1.2)	<0.0006	1.49 (0.99)	1.57 (0.73)	<0.02	3.36 (2.3)	2.98 (2.6)	<0.0001	3.48 (2.5)	3.2 (2.8)	<0.30
Red meat (Times/week)*	1.80 (0.7)	1.97 (0.7)	<0.0001	3.37 (1.70)	2.03 (1.39)	<0.0001	0.92 (1.13)	1.28 (1.73)	<0.0001	1.01 (1.4)	0.95 (1.5)	<0.67
Fish (Times/week)*	1.17 (0.4)	1.10 (0.4)	<0.0001	1.15 (0.83)	1.18 (0.67)	<0.23	0.44 (0.8)	0.82 (1.7)	<0.0001	0.50 (0.8)	0.55 (1.3)	<0.6
Exercise (Minutes/week)*	157.48 (466.6)	104.42 (333.3)	<0.002	203.07 (304.09)	113.15 (313.72)	<0.0001	105.20 (189.3)	152.71 (263.5)	<0.0001	134.22 (192.6)	91.30 (126.0)	<0.003
BMI, Kg/m²*	25.01 (2.1)	27.23 (4.0)	<0.0001	25.95 (3.53)	28.92 (5.15)	<0.0001	23.29 (4.2)	24.87 (4.1)	<0.0001	24.45 (4.4)	25.98 (4.1)	<0.0001

* Mean [Standard Deviation]

Conclusions

We observed a consistent increase in diabetes risk with increased Body Mass Index (BMI). The increase in diabetes risk was observed in all race groups including Caucasian-Americans, Polish-Caucasians, African-Americans, Hispanics, Tunisian-Arabs, South-Indians and North-Indians. An association between BMI and risk of type II diabetes was also found among current smokers, former smokers, and in the male versus female subcategories in our study population. In all the subgroups, the p-value for trend that assessed the strength and dose response association between BMI and diabetes risk was statistically significant. In table 3 we show that diabetes risk can be potentially reduced in healthy-weight, over-weight and obese individuals with increased physical activity among Caucasians but not Indians. We postulate that Indians primarily develop insulin resistant type II diabetes due to over consumption of carbohydrates. Among Caucasian individuals, we observed an over 40% reduction in diabetes risk among those that reported exercising more than 150 minutes per week after adjusting for age, race, gender and smoking. Obese individuals also benefited from exercising more than 150 minutes per week. In summary, our study shows that obesity is strong risk factor for type II diabetes and that exercise may reduce risk in everyone except Indians.

Table 2. Obesity and Diabetes Risk

Body Mass Index	Overall OR (95% CI) [Cases/Controls]	Caucasian-American OR (95% CI) [Cases/Controls]	African-American OR (95% CI) [Cases/Controls]
18.5 to 24.9 [Healthy weight]	1.0 (ref) [2780/5092]	1.0 (ref) [412/1581]	1.0 (ref) [77/388]
25.0 to 29.9 [Overweight]	1.71 (1.60-1.83) [3860/4774]	2.19 (1.90-2.53) [1022/1808]	1.83 (1.30-2.59) [163/412]
30 or higher [Obese]	4.84 (4.46-5.25) [4090/2579]	8.04 (6.99-9.25) [2142/1279]	5.21(3.73-7.29) [377/375]
	p-trend<0.001	p-trend<0.001	p-trend<0.001
	Hispanic-American OR (95% CI) [Cases/Controls]	**Tunisian-Arab OR (95% CI) [Cases/Controls]**	**Polish-Caucasian OR (95% CI) [Cases/Controls]**
18.5 to 24.9 [Healthy weight]	1.0 (ref) [72/549]	1.0 (ref) [297/398]	1.0 (ref) [223/464]
25.0 to 29.9 [Overweight]	2.41(1.79-3.24) [207/644]	1.23 (1.00-1.52) [643/604]	2.02 (1.64-2.49) [566/570]
30 or higher [Obese]	4.06(3.05-5.42) [306/589]	37.09 (14.96-91.99) [237/5]	9.35(7.22-112.10) [569/140]
	p-trend<0.001	p-trend<0.001	p-trend<0.001
	South Indian OR (95% CI) [Cases/Controls]	**North Indian OR (95% CI) [Cases/Controls]**	**All Males OR (95% CI) [Cases/Controls]**
18.5 to 24.9 [Healthy weight]	1.0 (ref) [1528/1468]	1.0 (ref) [122/93]	1.0 (ref) [1726/2527]
25.0 to 29.9 [Overweight]	1.66 (1.46-1.90) [1025/603]	2.55 (1.59-4.08) [155/47]	1.41 (1.28-1.54) [2167/2833]
30 or higher [Obese]	2.10 (1.68-2.63) [358/144]	2.00 (1.02-3.90) [50/19]	3.77 (3.35-4.24) [1726/1184]
	p-trend<0.001	p-trend<0.001	p-trend<0.001
	All Female OR (95% CI) [Cases/Controls]	**Never smokers OR (95% CI) [Cases/Controls]**	**Current smokers OR (95% CI) [Cases/Controls]**
18.5 to 24.9 [Healthy weight]	1.0 (ref) [1048/2555]	1.0 (ref) [1600/2823]	1.0 (ref) [620/1572]
25.0 to 29.9 [Overweight]	2.19 (1.97-2.43) [1680/1939]	1.72 (1.57-1.88) [2248/2662]	1.72 (1.49-1.98) [696/1199]
30 or higher [Obese]	6.18 (5.51-6.92) [2359/1393]	4.49 (4.03-5.01) [2124/1423]	4.30 (3.60-5.14) [567/581]
	p-trend<0.001	p-trend<0.001	p-trend<0.001

p-value for trend estimated from logistic regression models.
Odds Ratios adjusted for age, gender, and smoking pack-years. The overall model was also adjusted for race.

Table 3. Obesity, Exercise and Diabetes Risk

Caucasian-American	Healthy-Weight OR (95% CI) [Cases/Controls]	Over-Weight OR (95% CI) [Cases/Controls]	Obese OR (95% CI) [Cases/Controls]
Exerise (Minutes/week)			
Tertile 1: 0	1.0 (ref) [121/269]	1.0 (ref) [287/345]	1.0 (ref) [892/371]
Tertile 2: 0-150	0.61 (0.44-0.84) [135/524]	0.75 (0.60-0.94) [358/630]	0.72 (0.60-0.85) [695/428]
Tertile3: >150	0.43 (0.32-0.59) [142/772]	0.55 (0.44-0.69) [334/817]	0.46 (0.38-0.55) [478/462]
	p-trend<0.0001	p-trend<0.0001	p-trend<0.0001

Dravidian South Indian	Healthy-Weight OR (95% CI) [Cases/Controls]	Over-Weight OR (95% CI) [Cases/Controls]	Obese OR (95% CI) [Cases/Controls]
Exercise (Minutes/week)			
Tertile 1: 0	1.0 (ref) [700/916]	1.0 (ref) [436/364]	1.0 (ref) [202/100]
Tertile 2: 0-150	2.39 (1.87-3.06) [239/134]	2.51 (1.75-3.59) [163/58]	2.29 (1.22-4.31) [63/18]
Tertile3: >150	1.93 (1.63-2.30) [589/418]	2.16 (1.68-2.76) [425/180]	2.57 (1.47-4.49) [92/26]
	p-trend<0.0001	p-trend<0.0001	p-trend<0.0001

Adjusted for age, gender and smoking packyears.