Consequences of Change in Waist Circumference on Cardiometabolic Risk Factors Over 9 Years

Data from an Epidemiological Study on the Insulin Resistance Syndrome (DESIR)

BEVERLEY BALKAU, PHD[1,2]
PASCALINE PICARD, MSC[1,2]
SYLVIANE VOL, MSC[3]
LEOPOLD FEZEU, MD, MSC[1,2]
EVELINE ESCHWÈGE, MD[1,2]
FOR THE DESIR STUDY GROUP*

Obesity and abdominal adiposity have been shown in prospective studies to be risk factors for cardiovascular disease and particularly for diabetes (1–8). In cross-sectional studies, both are related with risk factors for these diseases (9–12), but there are few publications on the effects of changes in abdominal adiposity (13). We characterized men and women who gained and lost abdominal adiposity over 9 years and describe the incidence and the improvement in cardiometabolic risk factors according to changes in waist circumference.

RESEARCH DESIGN AND METHODS — From the Data from an Epidemiological Study on the Insulin Resistance Syndrome (DESIR) cohort (9,14,15), 1,868 men and 1,939 women aged 30–64 years at baseline were followed over 9 years. The 73% of the baseline cohort that we studied were older, less frequently abdominally obese, hypertriglyceridemic, hyperinsulinemic, smokers, and fewer had metabolic syndrome. Cardiometabolic abnormalities and the metabolic syndrome were defined according to the National Cholesterol Education Program (NCEP) criteria (16), except high blood pressure, which included antihypertensive treatment (Table 1); hyperinsulinemia was defined by upper quartiles of fasting insulin ≥57.3 pmol/l for men and ≥52.8 pmol/l. The incidence and improvement of cardiometabolic risk factors were studied by age-adjusted logistic regression, according to waist change: ≤ −3.0 cm, −2.9 to +2.9 cm, 3.0–6.9 cm, and ≥7.0 cm. Statistical significance was defined as $P < 0.05$.

RESULTS — The median increase in waist circumference was 3 cm in men and 4 cm in women; 25 and 34% of men and women, respectively, increased their waist by ≥7 cm, 14% decreased their waist by ≥3 cm, and 29% remained stable (±2.9 cm).

Men whose waist decreased were older and had a larger waist circumference and BMI at baseline. Age was not significantly related to waist change in women; however, women who became slimmer had a larger baseline waist but similar BMI. Men who decreased alcohol intake reduced their waist circumference. Stopping smoking was associated with an increase in waist circumference, but smoking at baseline was associated with a gain in waist circumference in only men. Baseline physical activity did not influence waist change, but an increase was associated with a decreasing waist circumference.

The incidence of abdominal obesity was 10% in men and 15% in women (Table 1). Of all risk factors, high blood pressure had the highest incidence (48 and 30%, respectively), and the incidences of the metabolic syndrome were 8% for men and 7% for women. The metabolic syndrome and all cardiometabolic factors showed significant trends that became worse with an increasing waist (with one exception, LDL cholesterol in women). The odds ratios (95% CI) for an incident metabolic syndrome were 7.9 (4.4–13.9) in men and 4.7 (2.7–8.0) in women who increased their waist by ≥7 cm, compared with a stable waist circumference. Results were not changed after adjusting for baseline waist circumference or BMI. Adjusting for 9-year BMI change, only the metabolic syndrome ($P < 0.0001$) in both sexes and fasting insulin in women ($P = 0.02$) remained statistically significant. Further adjustment for change in smoking habits or physical activity did not alter these associations.

Of those abdominally obese at baseline, 19% of men and 10% of women improved at 9 years (Table 1). High blood pressure was the abnormality that improved the least. Of those with the metabolic syndrome at baseline, 47% of men and 38% of women no longer had it at 9 years. A decreasing waist circumference was beneficially associated with the syndrome, triglycerides, and insulin in both men and women and blood pressure in women. Further adjustment for baseline waist circumference or BMI did not alter these results, but after adjustment for change in BMI, relations remained significant only in women for the syndrome, triglycerides, and blood pressure. These improvements were not due to starting or continuing drug treatment (data not shown).

From the [1]Institut National de la Santé et de la Recherche Médicale, Unité 780-IFR69, Epidemiological and Biostatistical Research, Villejuif, France; the [2]Université Paris Sud, Kremlin Bicêtre, France; and the [3]Institut Inter-Régional pour la Santé, La Riche, France.
Address correspondence and reprint requests to Beverley Balkau, INSERM U780-IFR69, 16 Ave. Paul Vaillant-Couturier, 94807, Villejuif, France. E-mail: balkau@vjf.inserm.fr.
Received for publication 15 December 2006 and accepted in revised form 2 April 2007.
Published ahead of print at http://care.diabetesjournals.org on 27 April 2007. DOI: 10.2337/dc06-2542.
*A complete list of the members of the DESIR Study Group can be found in the APPENDIX.
Abbreviations: DESIR, Data from an Epidemiological Study on the Insulin Resistance Syndrome.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Age-adjusted odds ratios of the incidence of cardiometabolic parameters according to change in waist circumferences*

	Incidence (%)	≤−3 cm	−2.9 to +2.9 cm	3–6.9 cm	≥7 cm	*P* for trend
Men						
n		250	542	488	659	
Incidence						
Waist circumference >102 cm	177/1,716 (10)	No cases	1	5.00 (4.29–10.0)	21.25 (10.9–41.2)	<0.0001
Glucose ≥6.1 mmol/l	121/1,583 (8)	0.79 (0.40–1.57)	1	1.18 (0.72–1.94)	1.68 (1.03–2.72)	0.01
Blood pressure ≥130/85 mmHg or treated for hypertension	276/579 (48)	0.58 (0.32–1.07)	1	0.93 (0.61–1.42)	1.49 (0.95–2.33)	0.008
Triglycerides ≥1.7 mmol/l	181/1,498 (12)	0.78 (0.42–1.44)	1	1.21 (0.78–1.86)	2.29 (1.53–3.44)	<0.0001
HDL cholesterol <1.03 mmol/l	94/1,738 (5)	0.64 (0.27–1.50)	1	1.39 (0.79–2.42)	1.97 (1.14–3.41)	0.001
LDL cholesterol ≥4.13 mmol/l	240/1,280 (19)	0.85 (0.51–1.41)	1	1.23 (0.85–1.78)	1.39 (0.96–2.02)	0.02
Insulin ≥57.3 pmol/l	492/1,401 (35)	0.67 (0.45–1.00)	1	1.57 (1.18–2.09)	2.33 (1.73–3.14)	<0.0001
NCEP metabolic syndrome	135/1,693 (8)	0.57 (0.19–1.72)	1	2.39 (1.28–4.44)	7.87 (4.46–13.88)	<0.0001
Improvement						
Waist ≤02 cm	29/152 (19)	32.1 (6.84–151)	1	No cases	No cases	<0.0001
Glucose <6.1 mmol/l	137/285 (48)	0.69 (0.34–1.41)	1	0.62 (0.33–1.15)	0.69 (0.36–1.32)	0.5
Blood pressure <130/85 mmHg and not treated for hypertension	213/1,289 (17)	1.03 (0.66–1.63)	1	0.77 (0.52–1.14)	0.76 (0.50–1.14)	0.09
Triglycerides <1.7 mmol/l	187/370 (51)	0.95 (0.50–1.81)	1	0.81 (0.48–1.38)	0.45 (0.25–0.81)	0.01
HDL cholesterol ≥1.03 mmol/l	71/130 (55)	1.25 (0.37–4.20)	1	0.55 (0.21–1.46)	0.74 (0.30–1.84)	0.3
LDL cholesterol <4.13 mmol/l	288/588 (49)	1.35 (0.82–2.22)	1	0.91 (0.59–1.40)	1.09 (0.69–1.72)	0.5
Insulin <57.3 pmol/l	101/467 (22)	1.45 (0.78–2.70)	1	0.93 (0.54–1.62)	0.27 (0.13–0.57)	<0.0001
No NCEP metabolic syndrome	83/175 (47)	0.93 (0.41–2.12)	1	0.59 (0.27–1.32)	0.38 (0.16–0.91)	0.03
Women						
n		250	542	488	659	
Incidence						
Waist >88 cm	250/1,679 (15)	No cases	1	7.91 (3.52–17.8)	39.4 (18.2–85.1)	<0.0001
Glucose ≥6.1 mmol/l	73/1,845 (4)	0.28 (0.06–1.24)	1	0.83 (0.38–1.83)	2.72 (1.49–4.96)	<0.0001
Blood pressure ≥130/85 mmHg or treated for hypertension	306/1,013 (30)	1.18 (0.72–1.94)	1	1.53 (1.04–2.23)	1.52 (1.07–2.17)	0.0370
Triglycerides ≥1.7 mmol/l	140/1,784 (8)	1.11 (0.57–2.17)	1	1.14 (0.66–1.96)	2.23 (1.40–3.54)	0.0006
HDL cholesterol <1.29 mmol/l	193/1,759 (11)	0.70 (0.38–1.31)	1	1.09 (0.70–1.69)	1.88 (1.29–2.75)	<0.0001
LDL cholesterol ≥4.13 mmol/l	294/1,552 (19)	0.82 (0.52–1.30)	1	0.80 (0.56–1.15)	1.13 (0.82–1.55)	0.2
Insulin ≥52.8 pmol/l	479/1,455 (33)	0.71 (0.47–1.09)	1	1.21 (0.89–1.65)	2.55 (1.92–3.38)	<0.0001
NCEP metabolic syndrome	131/1,815 (7)	0.48 (0.16–1.45)	1	1.28 (0.67–2.45)	4.69 (2.77–7.93)	<0.0001
Improvement						
Waist ≤88 cm	29/260 (10)	54.9 (7.09–426)	1	No cases	No cases	<0.0001
Glucose <6.1 mmol/l	35/94 (37)	0.29 (0.07–1.24)	1	0.23 (0.07–0.83)	0.44 (0.14–1.37)	0.7
Blood pressure <130/85 mmHg and not treated for hypertension	196/926 (21)	0.90 (0.54–1.49)	1	0.66 (0.42–1.03)	0.37 (0.23–0.57)	<0.0001
Triglycerides <1.7 mmol/l	93/155 (60)	1.78 (0.61–5.18)	1	0.64 (0.26–1.62)	0.45 (0.20–1.03)	0.008
HDL cholesterol ≥1.29 mmol/l	82/180 (46)	2.53 (0.94–6.82)	1	0.84 (0.33–2.15)	1.43 (0.63–3.23)	0.4
LDL cholesterol <4.13 mmol/l	217/387 (56)	1.00 (0.54–1.87)	1	0.92 (0.53–1.62)	0.81 (0.48–1.37)	0.4
Insulin <52.8 pmol/l	109/484 (23)	1.31 (0.69–2.50)	1	0.67 (0.36–1.22)	0.47 (0.27–0.81)	0.0005
No NCEP metabolic syndrome	47/124 (38)	3.78 (1.28–11.13)	1	0.45 (0.14–1.50)	0.68 (0.25–1.87)	0.003

Data are odds ratio (95% CI) or ratio (%). *P* values are adjusted for age.

CONCLUSIONS— A changing waist circumference affected cardiometabolic risk factors, and this was most clearly seen for the metabolic syndrome, which accumulates the effects of individual abnormalities. After accounting for changes in BMI, reducing waist by ≥3 cm only had a significant beneficial effect on the metabolic syndrome in women, and increasing waist by ≥7 cm had a detriment effect in both sexes.

Overall, those who reduced their waist were older and more abdominally obese, and fewer men smoked at baseline. Such men and women might be receptive toward targeted intervention. Further, an increase in physical activity had beneficial effects in our study. The only other report that we have found on the effects of waist circumference change on cardiometabolic risk factors is a 10-year study of Chinese adults (13). Both waist and BMI change, together, were related to change in systolic blood pressure and hypertension. In our European population, a comparable result was found only in women.

Though not all individuals were able to be followed-up, there were no differences in baseline waist circumference or changes in waist circumference over 3 and 6 years with those studied.

Increasing abdominal adiposity was associated with individual cardiometabolic risk factors and their aggregation in the metabolic syndrome in both men and women. Unfortunately, a decreasing waistline did not always have a large effect on risk factors, as aging is also inherent when following populations. The metabolic syndrome was still associated with changing waist circumference after taking account of changing BMI, indicating the importance of this simple clinical measure.

Acknowledgments— This work was supported by cooperative contracts between Institut National de la Santé et de la Recherche Médicale (INSERM), Caisse Nationale d'Assurances Maladies des Travailleurs Salariés, Lilly, Novartis Pharma, and Sanofi-Aventis, by INSERM (Réseaux en Santé Publique, Interactions entre les Determinants de la Santé), by the Association Diabète Risque Vasculaire, the Fédération Française de Cardiologie, La Fondation de France, l'Association de Langue Française pour l'Etude du Diabète et des Maladies Métaboliques, l'Office National Interprofessionnel des Vins, Ardix Medical, Bayer Diagnostics, Becton Dickinson, Cardionics, Merck Santé, Novo Nordisk, Pierre Fabre, Roche, and Topcon.

P. P. was supported by grant from Sanofi-Aventis (France).

We thank I. Villadary for her suggestions.

APPENDIX

Members of the DESIR Study Group

Institut National de la Santé et de la Recherche Médicale (INSERM) U780: B. Balkau, P. Ducimetière, and E. Eschwège; INSERM U367: F. Alhenc-Gelas; Centre Hospitalier Universitaire d'Angers: Y. Gallois and A. Girault; Hôpital Bichat: F. Fumeron and M. Marre; Centres d'Examens de Santé: Alençon-Angers-Blois-Caen-Chartres-Châteauroux-Cholet-Le Mans-Orléans-Tours; Institut de Recherche en Médecine Générale: J. Cogneau; Médecins Généralistes des Départements; Institut inter-Régionale pour la Santé: C. Born, E. Cacès, M. Cailleau, J.G. Moreau, F. Rakotozafy, J. Tichet, and S. Vol.

References

1. Larsson B, Svardsudd K, Welin L, Wilhelmsen L, Bjorntorp P, Tibblin G: Abdominal adipose tissue distribution, obesity, and risk of cardiovascular disease and death: 13 year follow up of participants in the study of men born in 1913. *BMJ* 288:1401–1404, 1984
2. Rexrode KM, Carey VJ, Hennekens CH, Walters EE, Colditz GA, Stampfer MJ, Willett WC, Manson JE: Abdominal adiposity and coronary heart disease in women. *JAMA* 280:1843–1848, 1998
3. Rexrode KM, Buring JE, Manson JE: Abdominal and total adiposity and risk of coronary heart disease in men. *Int J Obes Relat Metab Disord* 25:1047–1056, 2001
4. Yusuf S, Hawken S, Ounpuu S, Bautista L, Franzosi MG, Commerford P, Lang CC, Rumboldt Z, Onen CL, Lisheng L, Tanomsup S, Wangai P Jr, Razak F, Sharma AM, Anand SS, INTERHEART Study Investigators: Obesity and the risk of myocardial infarction in 27,000 participants from 52 countries: a case-control study. *Lancet* 366:1640–1649, 2005
5. Ohlson LO, Larsson B, Svardsudd K, Welin L, Eriksson H, Wilhelmsen L, Bjorntorp P, Tibblin G: The influence of body fat distribution on the incidence of diabetes mellitus: 13.5 years of follow-up of the participants in the study of men born in 1913. *Diabetes* 34:1055–1058, 1985
6. Kissebah AH, Peiris AN: Biology of regional body fat distribution: relationship to non-insulin-dependent diabetes mellitus. *Diabete Metab Rev* 5:83–109, 1989
7. Carey VJ, Walters EE, Colditz GA, Solomon CG, Willett WC, Rosner BA, Speizer FE, Manson JE: Body fat distribution and risk of non-insulin-dependent diabetes mellitus in women: the Nurses' Health Study. *Am J Epidemiol* 145:614–619, 1997
8. Wei M, Gaskill SP, Haffner SM, Stern MP: Waist circumference as the best predictor of noninsulin dependent diabetes mellitus (NIDDM) compared with body mass index, waist/hip ratio and other anthropometric measurements in Mexican Americans: a 7-year prospective study. *Obes Res* 5:16–23, 1997
9. Bertrais S, Balkau B, Vol S, Forhan A, Calvet C, Marre M, Eschwege E: Relationships between abdominal body fat distribution and cardiovascular risk factors: an explanation for women's healthier cardiovascular risk profile: the DESIR Study. *Int J Obes Relat Metab Disord* 23: 1085–1094, 1999
10. Despres JP, Moorjani S, Lupien PJ, Tremblay A, Nadeau A, Bouchard C: Regional distribution of body fat, plasma lipoproteins, and cardiovascular disease. *Arteriosclerosis* 10:497–511, 1990
11. Stolk RP, Suriyawongpaisal P, Aekplakorn W, Woodward M, Neal B; InterASIA Collaborative Group: Fat distribution is strongly associated with plasma glucose levels and diabetes in Thai adults: the InterASIA study. *Diabetologia* 48:657–660, 2005
12. Canoy D, Luben R, Welch A, Bingham S, Wareham N, Day N, Khaw KT: Fat distribution, body mass index and blood pressure in 22,090 men and women in the Norfolk cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC-Norfolk) study. *J Hypertens* 22:2067–2074, 2004
13. Chuang SY, Chou P, Hsu PF, Cheng HM, Tsai ST, Lin IF, Chen CH: Presence and progression of abdominal obesity are predictors of future high blood pressure and hypertension. *Am J Hypertens* 19:788–795, 2006
14. Balkau B, Vernay M, Mhamdi L, Novak M, Arondel D, Vol S, Tichet J, Eschwege E; D.E.S.I.R. Study Group: The incidence and persistence of the NCEP (National Cholesterol Education Program) metabolic syndrome. The French D.E.S.I.R. study. *Diabetes Metab* 29:526–532, 2003
15. Hillier TA, Fagot-Campagna A, Eschwege E, Vol S, Cailleau M, Balkau B, the DESIR Study group: Weight change and changes in the metabolic syndrome as the French population moves towardoverweight: the DESIR cohort. *Int J Epidemiol* 35:190–196, 2006
16. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults: Executive summary of the third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *JAMA* 285:2486–2497, 2001