12

Blood pressure, diabetes and BMI in postmenopausal women

Although the overall prevalence of coronary heart disease is known to be lower in women than in men, cardiovascular disease (CVD) is a major cause of death in older women (Lion et al., 1993). Moreover, women have a lower survival rate, especially after acute myocardial infarction (Dittrich et al., 1988). There may be several explanations for this worse outcome : firstly incident cases occur more than 10 years later in women than in men (Lerner and Kannel, 1986). A woman frequently has more severe disease at presentation, because of concomitant cardiovascular risk factors such as diabetes and hypertension (Dittrich et al., 1988).

At present, the mechanisms of this sex difference are not well understood. These risk factors may have a stronger impact in women (Fetters et al., 1996). In addition, their detrimental effects may be increased by relationships with other risk factors. Diabetes mellitus and hypertension are strongly related to other metabolic and clinical abnormalities, including dyslipidemia, obesity, insulin resistance and hyperinsulinemia (Reaven, 1988). The synergism between these independent cardiovascular risk factors makes it difficult to differentiate the influence of each factor, but they could jointly accelerate the development of atherosclerosis.

Cardiovascular events rarely occur in women before the fifties (Bush, 1990 ; Gorodeski, 1994). In contrast, ageing women tend to have a similar incidence as men. Around the time of menopause, several changes occur which could contribute to increase the risk of cardiac disease in women. Hyperinsulinemia, non insulin-dependent diabetes and hypertension show a higher prevalence among middle-aged and older women (Gorodeski, 1994). However, for most risk factors, the independent effects of the loss of ovarian function and age need to be clearly established.

This chapter reviews the importance of diabetes, hypertension and obesity on cardiovascular mortality and morbidity in women, and also assesses the possible impact of menopause on the prevalence and incidence of diabetes, hypertension and obesity.

In order to quantify the predictive power of the different cardiovascular risk factors in women, only prospective and case-control studies were retained. In

addition, special attention was given to those presenting quantitative results. It was not possible to focus on postmenopausal women, because most studies included middle-aged women without specifying their menopausal status. Other studies followed women 65 years and older.

Several types of study can provide information on the specific impact of menopause :

- prospective studies, comparing risk factor levels before and after the onset of menopause in the same women, are the best way to obtain reliable results. But the number of subjects included is often limited because of the cost and logistics involved and follow-up may introduce some biases.
- cross-sectional analyses, comparing pre and postmenopausal women, may present problems, such as a systematic difference in age between the two groups, making it difficult to differentiate the independent effects of age and menopause. Despite their potential methodological disavantages, these studies may be useful to reinforce the consistency of results.

Reports providing a satisfactory description of the study population, number of subjects, type of menopause and biological measurements were selected.

Diabetes and glucose metabolism

The reported studies (table 12.I) clearly show that women with diabetes mellitus have an increased risk of cardiovascular disease and cardiovascular mortality. The Mayo Clinic Study reported a comparison between incident cases of cardiovascular events among Rochester women from 1960 to 1982 and controls initially free of coronary heart disease, matched by sex, age and duration of medical records. Diabetes was an independent risk factor : the estimated odds ratio was 4.8 for myocardial infarction (MI) and sudden death (SD) after adjustment for age, smoking, diabetes, menopausal status and estrogen use, while it was 3.0 for angina. If a direct relationship was assumed, diabetes explained 45 % of definite events, including MI and SD, and 28 % of angina events (Beard et al., 1989). The different prospective investigations, such as the Framingham Heart Study (Kannel et al., 1991) and the New Haven Study (Seeman et al., 1993), led to the same conclusion. The excess risk was around 3 or 4 for the various clinical endpoints in diabetic women, whereas diabetes was not associated with the cardiovascular risk in men over 65 years (Seeman et al., 1993).

Moreover, the Bedford Survey suggested that altered glucose tolerance, without diagnosed diabetes, conferred a 5-fold increase in coronary heart disease mortality among women as compared with non diabetics (Jarrett et al., 1982).

Hyperglycemia could be the underlying cause, but the Lipid Research Clinic Prevalence Study failed to demonstrate that the high fasting glucose induced

Table 12.I : Impact of diabetes and altered glucose metabolism on CVD mortality and morbidity in women

Authors	Study Design	Study Population	Outcome(s)	Results
Jarrett et al. (1982)	The Bedford Survey UK Prospective 10-year follow-up (1962-1972)	N ? range of age ?	CHD causes of death	Borderline diabetics vs Nondiabetics OR=5.2 Diabetics vs Borderline diabetics OR=2.1
Barrett-Connor et al. (1984)	The Lipid Research Clinic Prevalence Study USA Prospective 9-year follow-up since 1972-74	Upper-middle class Community 1 780 women 50-79 years	Death from IHD	for women ≥ 65 y Fasting plasma glucose : ns
Beard et al. (1989)	The Mayo Clinic Study USA Case/control (1960-1982)	241 women 482 control 40-59 years	MI (90), SD (18) and Angina (133)	MI and SD OR=4.8 AR=45% Angina OR=3.0 AR=28%
Kannel et al. (1991)	The Framingham Heart Study USA Prospective 26-year follow-up since 1948	2 506 women 30-62 years	CHD, stroke, peripheral arterial disease and cardiac failure	Overall endpoints RR=2.7 AR=5%
Seeman et al. (1993)	The New Haven Study USA Prospective 6-year follow-up (1982-1988)	Non-institutionalized 1 643 women ≥ 65 years	Non fatal MI and CHD mortality	MI OR=3.2 ns in men CHD mortality OR=4.5 ns in men

by diabetes and impaired glucose tolerance was independently related to death from ischemic heart disease in women older than 65 years (Barrett-Connor et al., 1984).

Few observational studies (table 12.II) have investigated the changes in glucose and insulin metabolism in postmenopause. Two recent cross-sectional European studies did not observe any difference in mean fasting glucose and insulin levels between pre- and postmenopausal women (Dallongeville et al., 1995 ; Casiglia et al., 1996).

Using an intravenous glucose tolerance test (IVGTT), which is a more sensitive and specific method, it has been reported that in healthy postmenopausal women, age at menopause is positively related to fasting insulin levels, as well as to the pancreatic insulin response, after adjustment for chronological age and Body-Mass Index (BMI=weight(kg)/height^2 (m)). But there were no changes in glucose parameters (Proudler et al., 1992). A more methodologically valid study clarified these findings, estimating the insulin secretion, sensitivity and clearance by minimal model analysis after IVGTT. It found that menopause was associated with a decreased pancreatic insulin response (–51 %), which was well counterbalanced by higher insulin sensitivity (+50 %), which resulted in reduced hepatic insulin elimination (Walton et al., 1993).

Blood pressure and hypertension

Several studies (table 12.III) have shown that hypertension is positively and independently associated with cardiovascular events in women. In the Mayo Clinic case-control study, the odds ratio (OR) for the association between hypertension and definite events, including myocardial infarction and sudden death, was 4.8 after adjustment for age, smoking, diabetes, menopausal status and estrogen use ; for angina pectoris the OR was 3.0. If a direct relationship was assumed, hypertension accounted for 45 % of all definite cardiovascular events in this community. The corresponding attributable risk was 28 % for angina (Beard et al., 1989).

As concerns prospective studies, in the Framingham Heart Study, a 26-year follow-up of women aged 30 to 62 years at entry, showed a threefold increased risk of cardiovascular disease in hypertensive women as compared with normotensive women. The attributable risk was 55 % (Kannel et al., 1991). In a population-based sample of non-institutionalized subjects over 65 years old in the Netherlands, elevated systolic blood pressure (SBP) was also positively associated with mortality from ischemic heart disease among women, even after adjustment for confounding factors (Weijenberg et al., 1994). The oldest study is the only one which found no significant relation-

Table 12.II : Glucose metabolism and menopause (cross-sectional studies)

Authors	Study Population	N/age	Menopause	Results
Proudler et al. (1992)	Healthy Caucasian women no HRT use USA	86 postMp 43-61 years	Natural or surgical (hysterectomy with the conservation of one ovary)	Menopausal age positively related to fasting plasma insulin, insulin area, incremental insulin area Glucose ns
Walton et al. (1993)	Non-obese Caucasian women no HRT use for 3 months USA	66 preMp 21-45 years 92 postMp 43-61 years	Natural menopause : no menstruations for at least 6 months Surgical menopause ?	postMp vs preMp Insulin sensitivity + 50 % Pancreatic insulin secretion -51% Non-insulin dependent glucose disposal - 30 %
Dallongeville et al. (1995)	Volunteers for a standard check-up HRT non-users No gynecological surgery France	790 preMp 1 377 postMp 45-65 years	Only natural menopause : no menstruation for at least 12 months	No differences in mean fasting glucose
Casiglia et al. (1996)	Community (Mirano) 1978 and 1994 Italy	1978 : 60 age-matched preMp and postMp 1994 : 37 age-matched preMp and postMp mean age 49	Natural menopause : no menstruation for at least 6 months Surgical menopause ?	No differences in mean blood glucose levels

Table 12.III : Impact of blood pressure and hypertension on CVD mortality and morbidity in women

Authors	Study Design	Study Population	Outcome(s)	Results
Barrett-Connor et al. (1984)	The Lipid Research Clinic Prevalence Study USA Prospective 9-year follow-up since 1972/74	Upper-middle class Community 1 780 women 50-79 years at entry free of heart disease	Death from Ischemic Heart Disease	for women ≥ 65 years SBP ns
Beard et al. (1989)	The Mayo Clinic Study USA Case/control (1960-1982)	241 cases 40-59 years	MI (90), SD (18) and Angina (133)	Hypertension (SBP 160mm Hg or DBP 95mm Hg or antihypertensive therapy) MI and SD OR=4.8 AR=45 % Angina OR=3.0 AR=28 %
Kannel et al. (1991)	The Framingham Heart Study USA Prospective 26-year follow-up since 1948	2 506 30-62 years at entry	CHD, stroke, peripheral arterial disease and cardiac failure	Overall endpoints RR=3.2 AR=55 %
Weijenberg et al. (1994)	Prospective 17-year follow-up since 1971 Netherlands	135 non-institutionalized ≥ 65 years	Death from Ischemic Heart Disease	145 SBP<165mm Hg vs SBP<145mm Hg RR=3.6 SBP≥165mm Hg vs SBP<145mm Hg RR=4.1 p-trend<0.05

ships between levels of SBP and death from ischemic heart disease (Barrett-Connor et al., 1984).

Authors who investigated changes in blood pressure around menopause drew inconsistent conclusions. Among the three prospective studies (table 7.IV), two reported that the menopause had no significant effects on the trend in systolic blood pressure or diastolic blood pressure (DBP) (Akahoshi et al., 1996 ; Casiglia et al., 1996). In contrast, longitudinal data from a study in the Netherlands showed that the onset of menopause lowered SBP on an average of 3.9 mmHg. This decrease continued in early menopause (≤ 6 years after menopause), but it was followed by an increase in SBP, which reversed the previous decrease. No changes were observed in DBP (Van Bereijstein et al., 1992).

Many cross-sectional studies (table 12.V) of different populations showed no significant differences in mean systolic and diastolic blood pressures when postmenopausal and premenopausal women were compared (Berge et al., 1994 ; Davis et al., 1994 ; Ueda et al., 1995). As concerns positive results, mean diastolic blood pressure, not systolic BP, was significantly higher in postmenopausal women (78.7 mmHg vs 77.5 mmHg) in a French cross-sectional study (Dallongeville et al., 1995). Finally, Staessen et al. (1989) found a clear association between menopause and blood pressure in a random sample of middle-aged women from two Belgian districts. Firstly, the odds of being hypertensive, as defined by the WHO criteria (SBP≥ 160 mmHg and/or DBP≥ 95 mmHg) or antihypertensive drug use, were 2.3 for postmenopausal compared with premenopausal women. In addition, the age-related increase in SBP was steeper in postmenopausal women (naturally or surgically) than in premenopausal women. Their levels of DBP were also higher (Staessen et al., 1989).

Obesity and body-fat distribution

Positive associations between obesity and the risk of cardiovascular disease among women have been demonstrated in the two largest prospective studies (table 12.VI). In the Framingham Heart Study, the Metropolitan Relative Index at baseline, which corresponds to the percentage of desirable weight (the ratio of actual weight to the midpoint of the range weight at the specific height in reference tables, x100), was a significant predictor of total CVD after taking into account potential confounding factors (Hubert et al., 1983). The degree of obesity defined according to the Body Mass Index (BMI=weight (kg)/height^2 (m)) was also associated with the risk of CHD in the Nurse's Health Study involving more than 120,000 middle-aged women. After adjustment for age and smoking, the risk was more than three times higher among the women with severe obesity (BMI≥29) than among those with a BMI lower than 21. The corresponding attributable risk was 40 %.

Table 12.IV : Blood pressure and menopause in longitudinal studies

Authors	Follow-up	Study Population	N/age	Menopause	Results
Van Bereijstein et al. (1992)	3 × 4 years of follow-up	Community (Ede) The Netherlands	37 PeriMp 139 EarlyMp 63 LateMp 49-56 years	PeriMp (start –2 years) EarlyMp (start +2 y.) LateMp (start +6 y.)	PeriMp SBP –3.1mm Hg EarlyMp DBP –1.5mm Hg *PostMp* SBP +4.5mm Hg
Akahoshi et al. (1996)	10-year follow-up –5 to +5 around the onset of menopause (1958/59-1983/84)	Community (Nagasaki) Japan	579 natural postMp (mean age 49) and 134 surgical postMp (mean age 43) age- and time-matched preMp	NatMp: at least 12 months of amenorrhea SurMp : hysterectomy	Natural or Surgical no significant effect on the trend of SBP
Casiglia et al. (1996)	2 examinations : 1978 and 1994	Community (Mirano) Italy	51 preMp to postMp 37 postMp to postMp mean age 49	NatMp : no menstruation for at least 6 months Surgical menopause ?	Same increase in SBP and DBP for women who became and those who were already menopausal

Table 12.V : Blood pressure and menopause in cross-sectional studies

	Study Population	N/age	Menopause	Results
Staessen et al. (1989)	Random sample of 2 districts Belgium	278 preMp 184 postMp (64 surgically) 35-59 years	NatMp (reported definitive cessation of menstruation) SurMp (hysterectomy)	RR=2.3 for hypertension steeper slope of SBP on age for postmenopausal women
Berge et al. (1994)	Healthy medical staff members No medications Norway	113 preMp (mean age 39 years) 46 postMp (mean age 55 years)	Confirmed by hormonal dosages Only NatMp ≥ 1 year	No differences in mean SBP and DBP
Davis et al. (1994)	South rural and north urban areas (2 surveys combined 1983/84-1987/88) Poland	372 preMp 357 postMp 46-52 years	Currently no menstrual periods	No differences in mean SBP and DBP
Dallongeville et al. (1995)	Volunteers for a standard check-up HRT non-users No gynecological surgery France	790 preMp 1,377 postMp 45-65 years	Only NatMp : no menstruation for at least 12 months	No differences in mean SBP higher meanDBP
Ueda et al. (1995)	31 centers Within center randomly selected The WHO-cardiac Study 19 countries	3 012 women 49-55 years	NoMp (menses the previous year) EarlyMp (no menses for 1 or 2 years) DefMp (no menses for > 2 years)	the highest mean SBP and DBP for EarlyMp group But no differences

Table 12.VI : Impact of body weight and body fat distribution on CVD mortality and morbidity in women

Authors	Study Design	Population (N/age)	Outcome(s)	Results
Hubert et al. (1983)	Prospective 26-year follow-up since 1948 The Framingham Heart Study USA	2 818 20-62 years	Angina pectoris, MI, coronary insufficiency, SD and non sudden coronary death	Metropolitan relative weight (MRW) = % of desirable weight MRW significant predictor of total CVD in both women <50 years and ≥50 years
Barrett-Connor et al. (1984)	Prospective The Lipid Research Clinic Prevalence Study USA 9-year follow-up since 1972/1974	Upper-middle class Community 1 780 50-79 years at entry	Death from Ischemic Heart Disease	for women ≥ 65 years BMI ns
Manson et al. (1990)	Prospective USA The Nurse's Health Study 8-year follow-up since 1976	115 886 30-55 years	Non fatal MI fatal CHD	BMI ≥ 29 vs BMI<21 RR=3.3 AR=40 % 25<BMI<29 vs BMI<21 RR=1.8
Prineas et al. (1993)	Prospective The Iowa Women's Health Study USA 4-year follow-up since 1986	drivers' license in 1985 41 177 women 55-69 years (98% postmenopausal)	CAD specific cause of death written on the certificate	Tertile 3 (>0.860) vs Tertile 1 (<0.790) of WHR RR=2.0 trend across tertiles BMI ns

Moreover, the risk was also increased by 80 % for the women who were moderately overweight (25≤BMI<29) as compared with the leanest. However, after controling for other classical risk factors, including hypertension, diabetes and hypercholesterolemia, the relationship was weaker (Manson et al., 1990).

Two other American prospective studies (table 12.VI) showed no significant associations between BMI and death from coronary heart disease (Barrett-Connor et al., 1984 ; Prineas et al., 1993). But CVD mortality was dose-related with the Waist-to-Hip Ratio (WHR), a marker of central adiposity, even after controling for other cardiovascular risk factors. The relative risk was 2.2 for the highest tertile of WHR as compared with the lowest (Prineas et al., 1993).

Three prospective reports (table 12.VII) did not give consistent results. In the Nagasaki study, the onset of menopause had no significant effect on the age-trend of BMI (Akahoshi et al., 1996). In contrast, both peri- (from two years before to two years after) and late menopause (five year follow-up starting six years after menopause) were associated with a significant increase in BMI, but this change was not adjusted for baseline values (Van Bereijstein et al., 1992). As for body-fat distribution, two examinations at a six-year interval in a small sample of volunteers showed that the onset of menopause was associated with an increase in overall fat mass and in central distribution measured by the WHR (Poehlman et al., 1995). But these results might be confounded by a decrease in the resting metabolic rate and lower leisure physical activity.

Two of the five cross-sectional studies (table 12.VIII) reported no differences in mean BMI when comparing naturally menopaused women with nonmenopausal women not taking estrogen supplements (Berge et al., 1994 ; Davis et al., 1994). According to studies using a three-group classification, it seemed that BMI was higher for women in the perimenopausal period (Pasquali et al., 1994) or for women who had just undergone menopause (Ueda et al., 1995) than in those who were premenopausal and postmenopausal. Finally, Ley et al. (1992) used dual-energy X-ray absorptiometry to assess differences in fat mass in a sample of healthy non obese white women in relation to their menopausal status. After adjustment for age and overall corpulence, the authors observed that postmenopausal women had a greater fat mass (especially intraabdominal or android fat) than premenopausal women (42.1 % vs 38.3 %).

Critical analysis

The case-control and prospective studies reported above demonstrate clearly that women with diabetes mellitus have an increased risk of cardiovascular

Table 12.VII : Body weight, body fat distribution and menopause in longitudinal studies

	Follow-up	Study Population	N/age	Menopause	Results
Van Bereijstein et al. (1992)	3 × 4 years of follow-up	Community (Ede) The Netherlands	37 PeriMp 139 EarlyMp 63 LateMp 49-56 years	PeriMp (start –2 years) EarlyMp (start +2 y.) LateMp (start +6 y.)	PeriMp BMI 0.44 kg/m^2 PostMp BMI 0.64 kg/m^2
Poehlman et al. (1995)	2 examinations at 6 years interval	Community volunteers USA no HRT	18 preMp to preMp 17 preMp to postMp 44-48 years	stopped menstruating for at least 12 months	preMp to postMp higher fat mass and higher WHR; higher lost in fat-free mass
Akahoshi et al. (1996)	–5 to +5 around the onset of menopause (1958/59-1983/84)	Community (Nagasaki) Men and women Japan	579 Nat postMp (mean age 49) and 134 Sur postMp (mean age 43) age- and time-matched preMp	NatMp : at least 12 months of amenorrhea SurMp : hysterectomy	Natural or Surgical : no significant effect on the trend of BMI

Table 12.VIII : Body weight, body fat distribution and menopause in cross-sectional studies

	Study Population	N/age	Menopause	Results
Ley et al. (1992)	Non obese healthy Caucasian Volunteers No medications UK	61 preMp (19-51 years) 70 postMp (43-63 years)	Confirmed by hormonal dosages + ammenorrhea	DEXA measurements 20% greater fat mass in postMp Android fat preMp 38.3 %, postMp 42.1 %
Berge et al. (1994)	Healthy medical staff members No medications Norway	113 preMp (mean age 39) 46 postMp (mean age 55)	Confirmed by hormonal dosages Only NatMp ≥ 1 year	No differences in mean BMI
Davis et al. (1994)	South rural and north urban areas (2 surveys combined 1983/1984- 1987/1988) Poland	372 preMp 357 postMp 46-52 years	no currently menstrual periods	No differences in mean BMI
Pasquali et al. (1994)	Community (Virgilio) The Virgilio-Menopause-Health Study - Italy	160 preMp 124 periMp 293 postMp	Confirmed by hormonal dosages Only NatMp ≥ 1 year SurMp : bilateral ovariectomy and hysterectomy periMp (at least one cycle in the previous 6 month or symptoms)	significantly higher mean BMI for periMp group (vs preMp + vs postMp) No differences in WHR
Ueda et al. (1995)	31 centers Within center randomly selected The WHO-cardiac Study	3 012 women 49-55 years	NoMp (menses the previous year) EarlyMp (no menses for 1 or 2 years) DefMp (no menses for > 2 years)	significantly higher mean BMI for EarlyMp group (vs NoMp + vs DefMp)

disease and cardiovascular mortality. Moreover, the impact of diabetes in the elderly may be stronger in women than in men (Seeman et al., 1993), although we cannot exclude a survival bias. More generally, it appears that diabetes eliminates the cardiovascular risk advantage conferred to women (Kannel and Wilson, 1995). Thus, to explain sex-related differences, a better understanding of diabetes and of its underlying mechanisms is needed.

As shown by Jarrett et al. (1982), lesser degrees of glucose intolerance are also predictive of subsequent coronary heart disease. Because fasting glucose is not an independent risk factor of cardiovascular disease (Barrett-Connor et al., 1984), the risk is likely to be mediated through insulin resistance and hyperinsulinemia. Elevated insulin is associated with major manifestations of CVD in both diabetics and non diabetics (Rönnemaa et al., 1991). However, hyperinsulinemia was not a significant predictor of coronary mortality in the only prospective study including women – The Busselton Study –, whereas post-load glucose was significant (Stout, 1990). Resistance to insulin-stimulated glucose uptake is present in subjects with impaired glucose tolerance and non-insulin dependent diabetes, but also in almost 25 % of nonobese subjects with normal oral glucose tolerance (Reaven, 1988). In addition, insulin resistance is interrelated to other metabolic and clinical abnormalities, which jointly could accelerate atherosclerosis.

Few studies have investigated the impact of the loss of ovarian function on glucose and insulin metabolism. Menopause results in a decrease in both pancreatic insulin secretion and insulin elimination (Proudler et al., 1992), but has never been directly related to circulating glucose and insulin concentrations in cross-sectional studies. However, insulin resistance increases with age. Thus, a gradual increase may be observed after menopause (Walton et al., 1993).

Elevated blood pressure is a major cardiovascular risk factor in women. As shown in the reported prospective studies, the positive correlation with cardiovascular mortality and morbidity is consistent, except for the oldest study (Barrett-Connor et al., 1984).

Hypertension is one of the main prevalent cardiovascular risk factors in women over 50 years. However, both systolic and diastolic blood pressure increases with age and the additional impact of the loss of ovarian function, and estrogen deficiency, on SBP and DBP levels remains controversial. Three prospective studies reported no significant global effect on the trend of SBP and DBP. Similarly, most cross-sectional studies showed no difference results between pre- and postmenopausal women.

As for the association with the incidence of hypertension, Staessen et al. (1989) found an increased risk in postmenopausal women as compared with premenopausal women, but it may be due to a difference in age between the two groups.

Recent prospective studies showed that obesity, estimated by the BMI or the Quetelet Index, is not an independent risk factor for CVD in women (Barrett-Connor et al., 1984 ; Prineas et al. 1993). Instead, obesity is associated other cardiovascular risk factors, which may confound the positive association previously observed (Manson et al., 1990). It has been suggested that, rather than overall obesity, the body-fat distribution, especially the male pattern (central or android versus gynoid type for women) may have important consequences. As reviewed elsewhere (Kissebah et al., 1989), increasing central body fat is accompanied by a progressive increase in glucose, insulin and triglyceride levels, as well as a decrease in HDL-cholesterol and an increase in blood pressure. Moreover, in women, a central fat distribution has proven to be a better predictor of the risk of coronary artery disease than BMI (Prineas et al., 1993), and to be independent of BMI.

Reported changes in weight in relation to menopause are inconsistent. Most prospective studies showed neither changes in BMI nor differences between pre and postmenopausal women, but the results may differ within the menopausal period (peri, early and late menopause) (Van Berejstein et al., 1992 ; Pasquali et al., 1994 ; Ueda et al., 1995). In contrast, menopause results in an increase in fat mass and a redistribution of body fat, with a relative increase in the proportion of android fat (Ley et al., 1992 ; Poehlman et al., 1995). These results may be influenced by a modified energy balance (lower energy expenditure because of lower leisure physical activity) but also a decrease in the basal metabolic rate in postmenopausal women (Poehlman et al., 1995).

To conclude, both menopause and age increase most cardiovascular risk factors, but it is difficult to assess the role of menopause independently of age.

Menopause seems to affect only blood pressure and glucose metabolism substantially. Instead, menopause may result in a redistribution of body fat, with a relative increase of abdominal (or central) fat. The underlying mechanisms are not well known, but they may lead progressively to insulin resistance and affect other cardiovascular risk factors such as diabetes, dyslipidemia and hypertension. Thus, there is evidence of a progressively increasing risk of CVD after menopause.

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