



Bénéfices de l'activité physique sur la santé cardiovasculaire de la femme, tout au long de la vie

Carina ENEA et Nathalie DELPECH

Prévalence des maladies cardiovasculaires chez la femme

Les MCV en quelques chiffres:

- 35% de la mortalité féminine dans le monde
- 275 millions de femmes diagnostiquées en 2019
- 8,8 millions de décès en 2019

Globalement les MCV chez la femmes sont:

- sous-étudiées, sous-diagnostiquées et mal-soignées
- ♀ sous-représentées dans les essais cliniques.

THE LANCET

The Lancet women and cardiovascular disease Commission:
reducing the global burden by 2030

Published: May 17, 2021

Vogel *et al.*, Lancet 2021



Différences inter-sexes dans la temporalité et les types de MCV

Armas-Rojas *et al.*, Lancet Public Health 2019

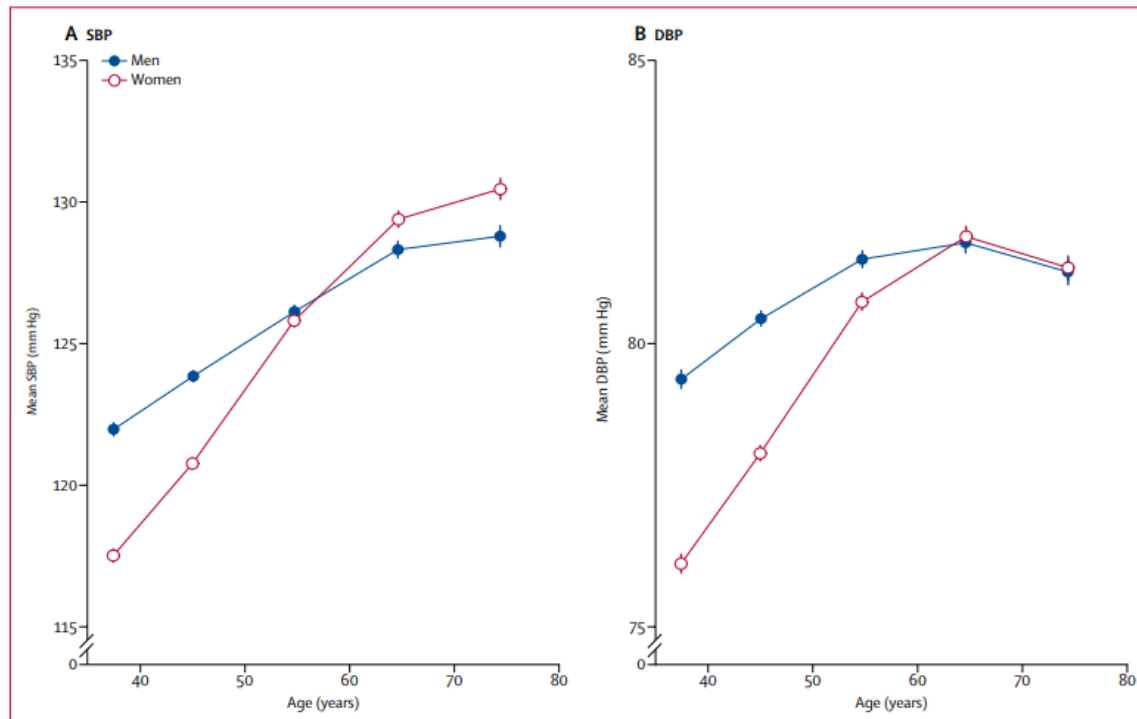


Figure 1: Mean blood pressure, by age and sex

(A) SBP. (B) DBP. Data are mean (95% CI). Means are standardised for area. Analyses in 136 111 participants. DBP=diastolic blood pressure. SBP=systolic blood pressure.

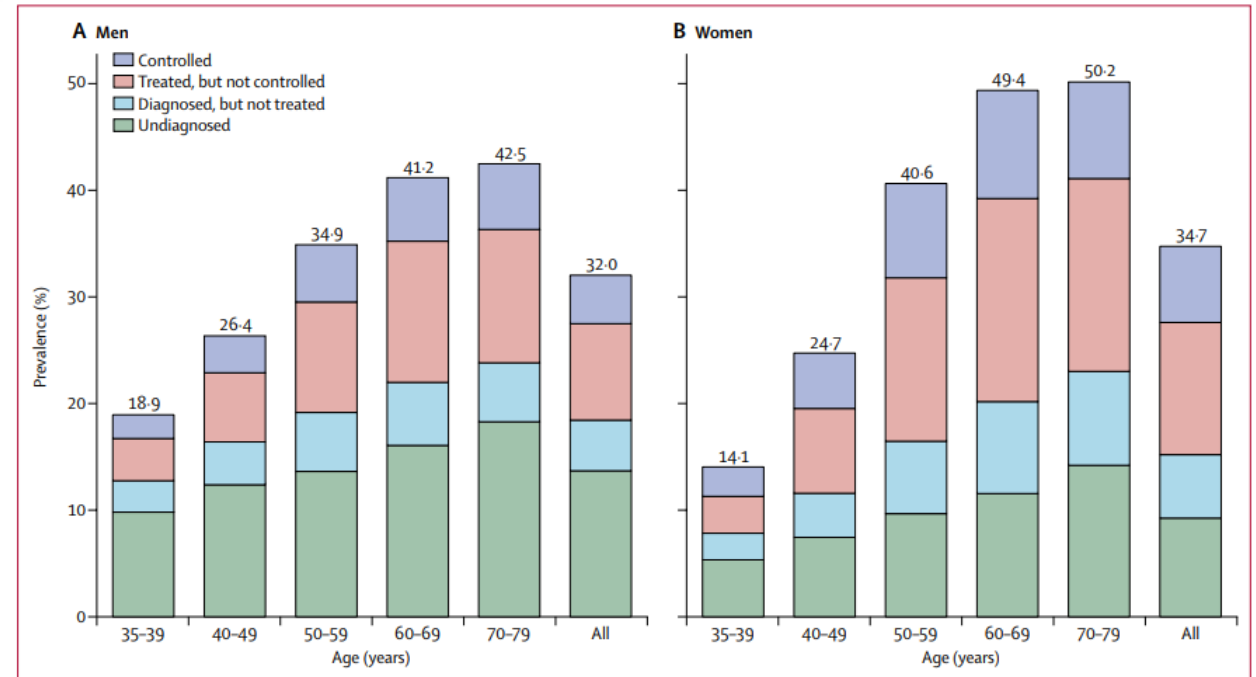


Figure 2: Prevalence of hypertension, by age and sex

(A) Men. (B) Women. Controlled hypertension at baseline is defined as systolic blood pressure less than 140 mm Hg and diastolic blood pressure less than 90 mm Hg. Prevalence is standardised for area and, where appropriate, age. The analysis included 136 111 participants. All=participants aged 35–79 years.

Différences inter-sexes dans la temporalité et les types de MCV

Leening *et al.*, *BMJ* 2014

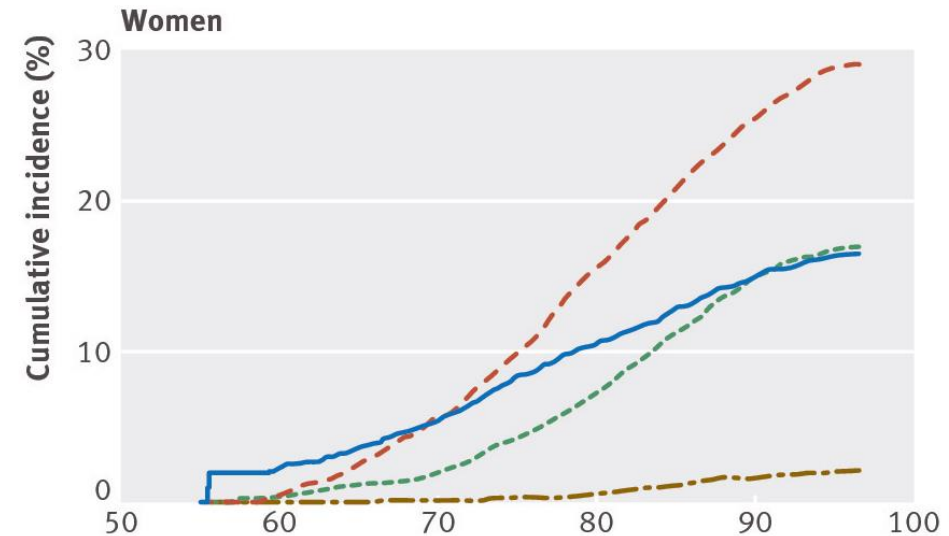
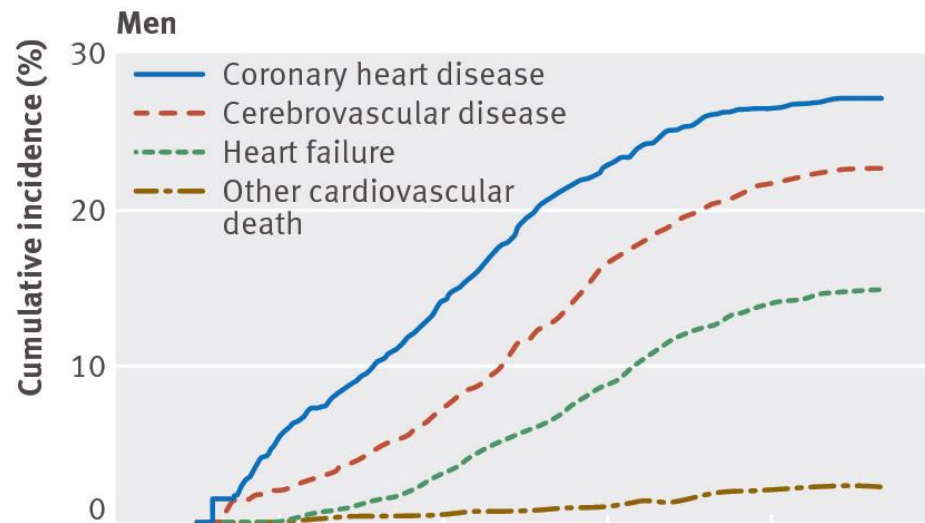


Fig 2 Cumulative incidence of first cardiovascular disease manifestations adjusted for competing non-cardiovascular death for men (left) and women (right) aged 55. Coronary heart disease was defined as myocardial infarction, coronary revascularisation, or death from coronary heart disease. Cerebrovascular disease was defined as stroke, transient ischaemic attack, or carotid revascularisation. Other cardiovascular death included all cardiovascular mortality other than fatal coronary heart disease or stroke

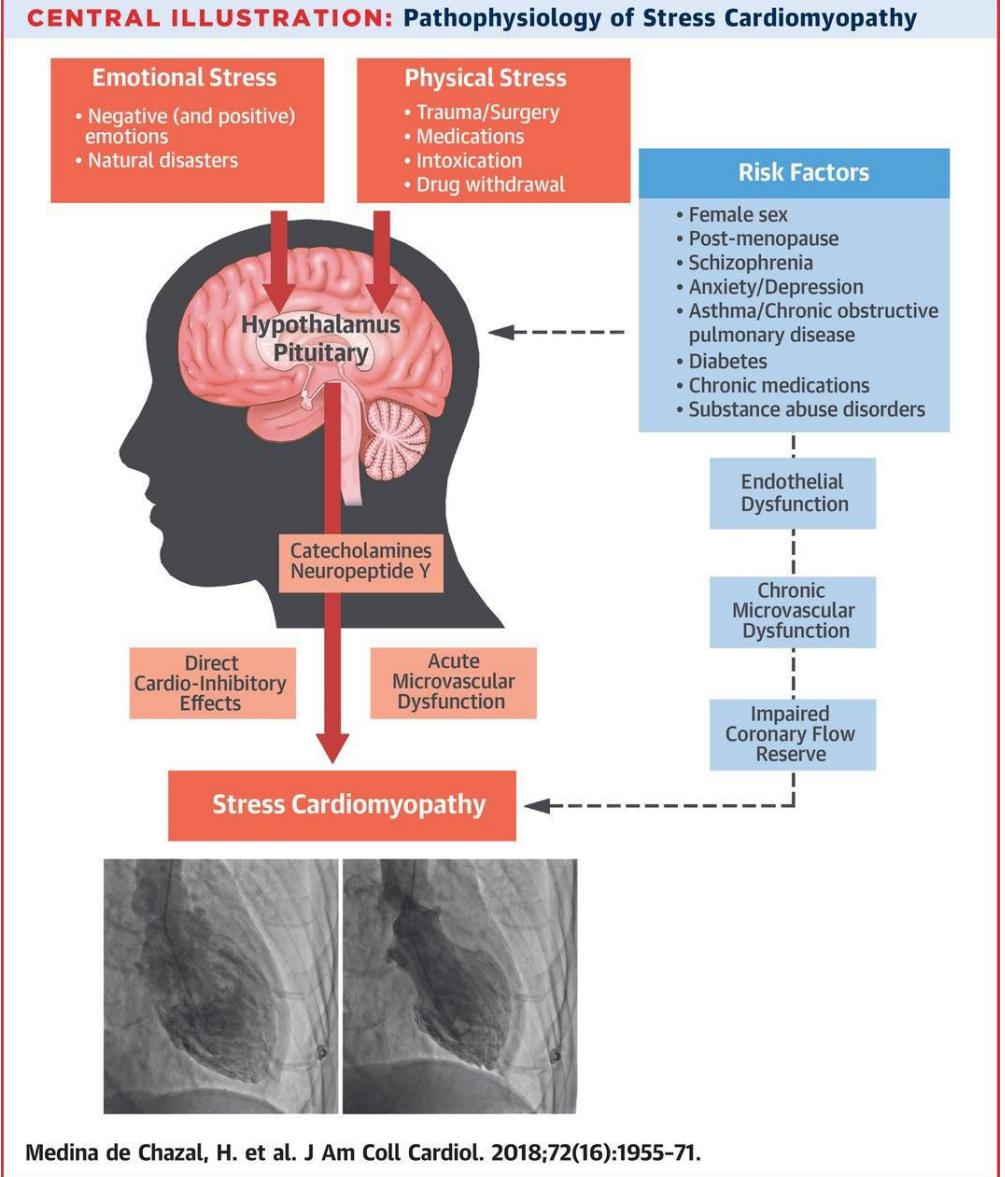
Axe cerveau → cœur

Altered limbic and autonomic processing supports brain-heart axis in Takotsubo syndrome

Christian Templin^{1*†}, Jürgen Hänggi^{2†}, Carina Klein², Marlene S. Topka², Thierry Hiestand¹, Rena A. Levinson¹, Stjepan Jurisic¹, Thomas F. Lüscher^{3,4}, Jelena-Rima Ghadri^{1‡}, and Lutz Jäncke^{2,5‡}

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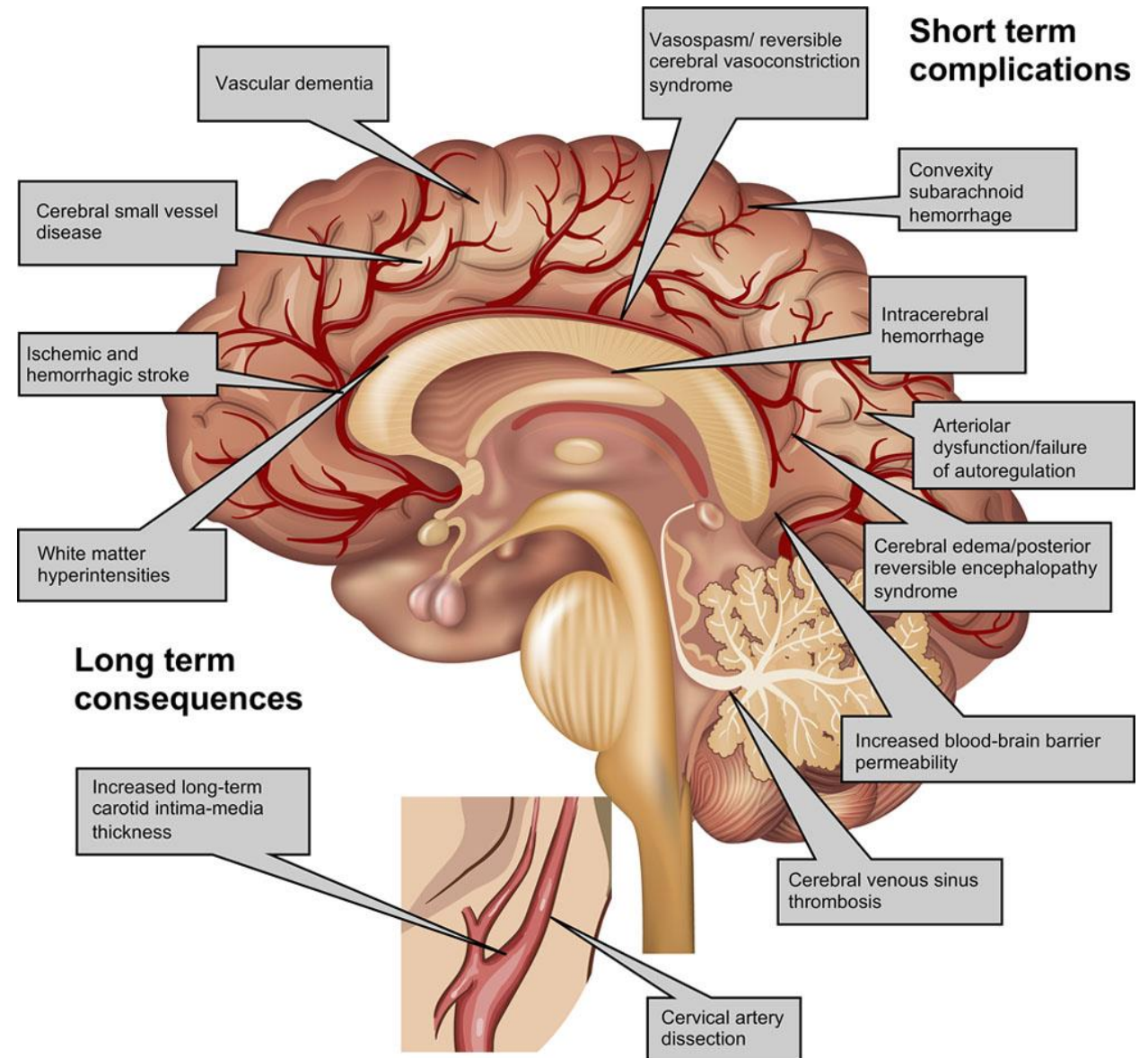
Received 12 March 2018; revised 30 August 2018; editorial decision 8 November 2018; accepted 25 February 2019; online publish-ahead-of-print 5 March 2019



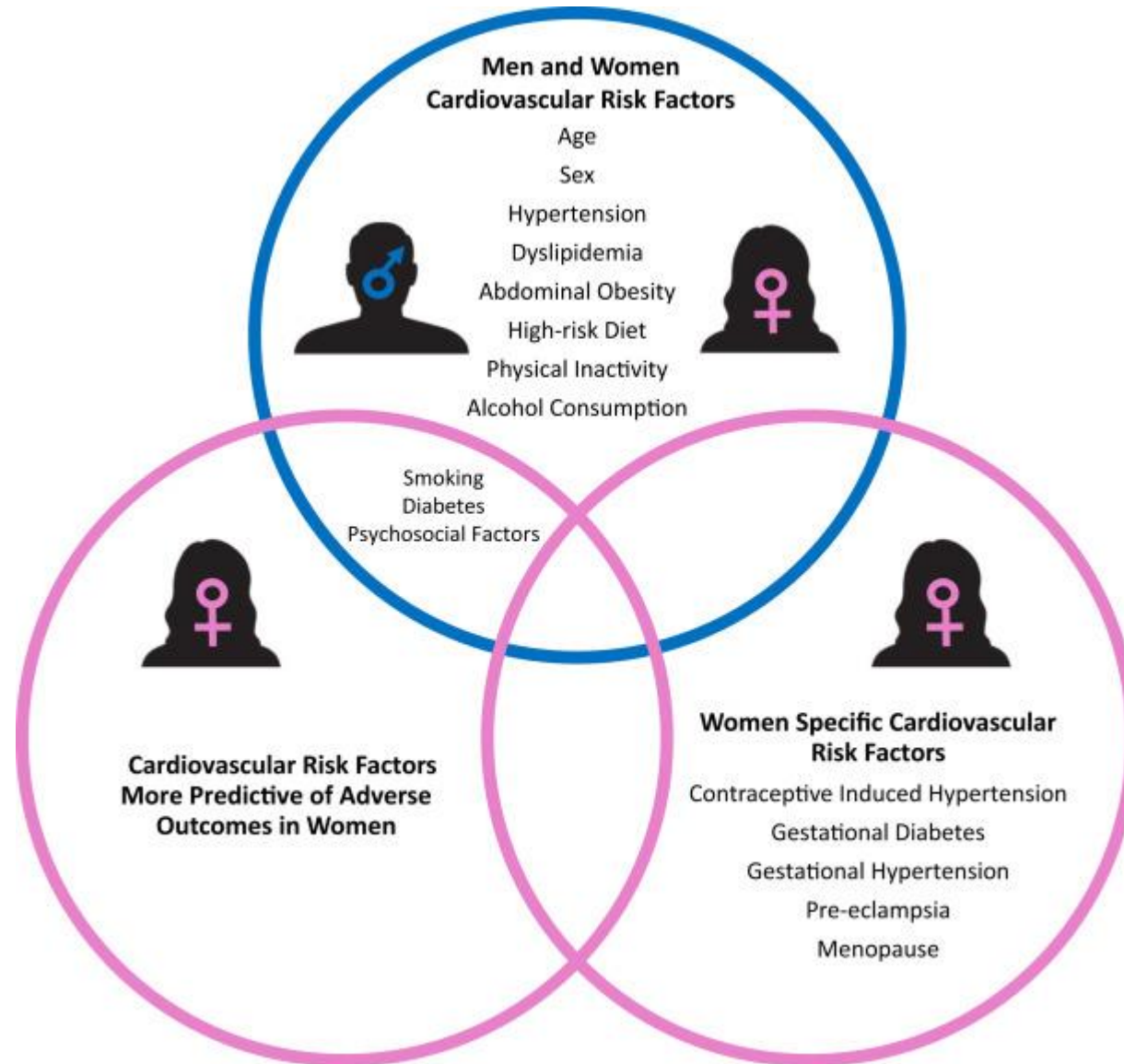
Axe cœur → cerveau

Miller et al., Hypertension 2019

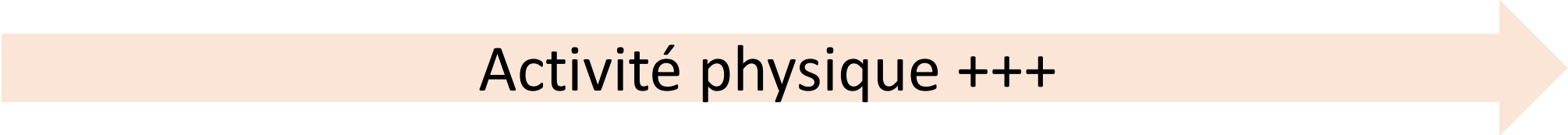
« Preeclampsia and Cerebrovascular Disease »



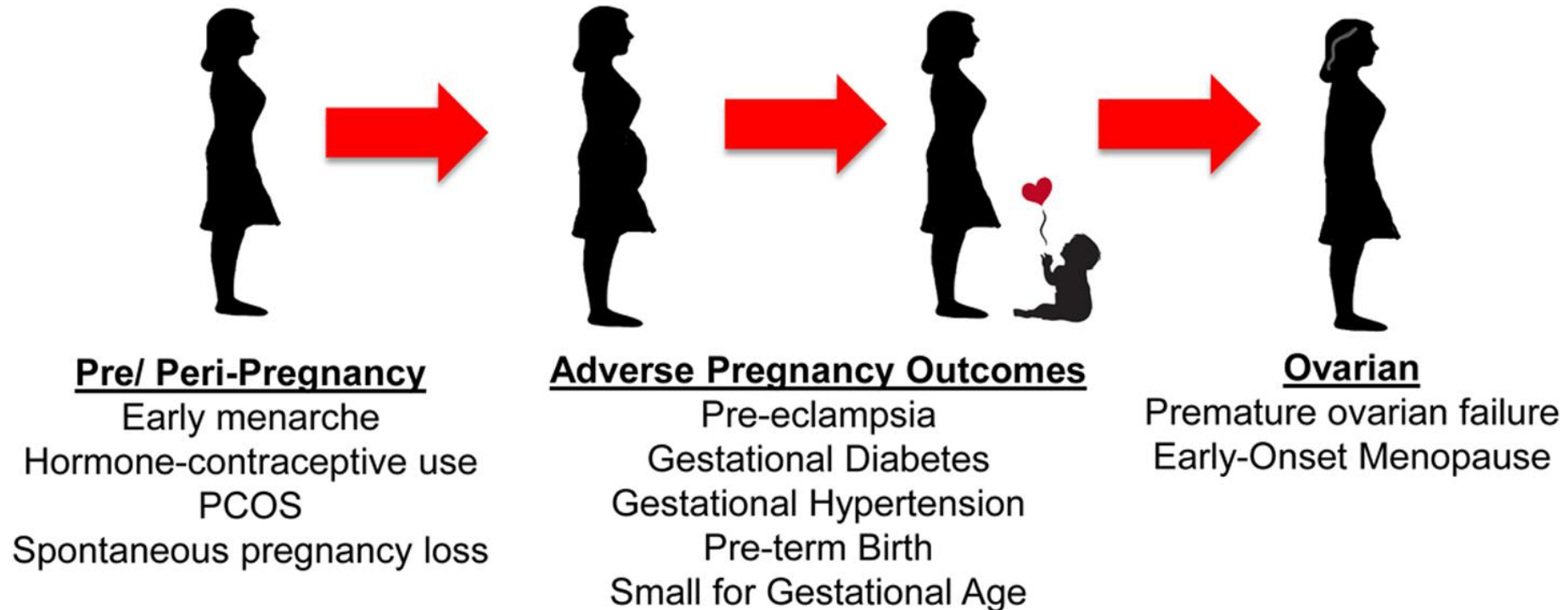
Des facteurs de risques spécifiques à la femme...



...qui varient en fonction de l'âge

Activité physique +++ 

Agarwala *et al.*, *Circulation* 2020



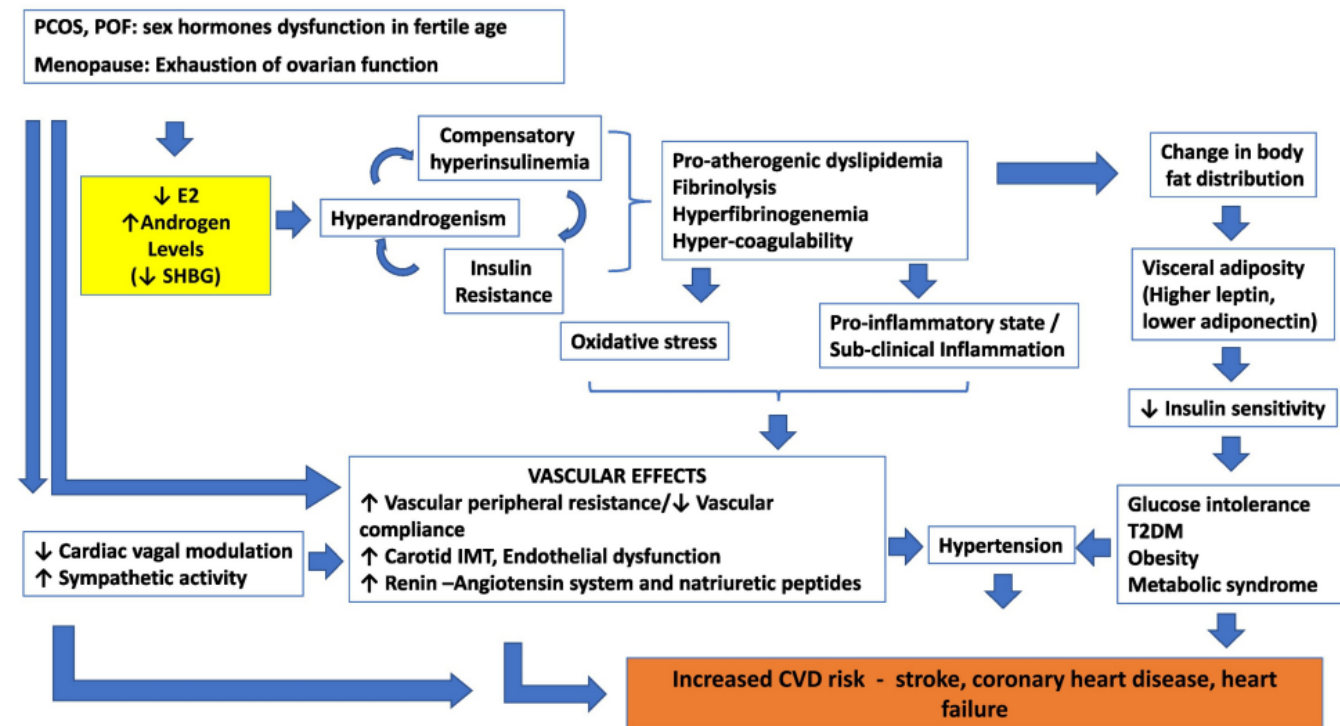
Chez la femme jeune en âge de procréer



Syndrome des Ovaires Polykystiques (SOPK) et MCV

Maffei *et al.*, *International Journal of Cardiology*, 2020

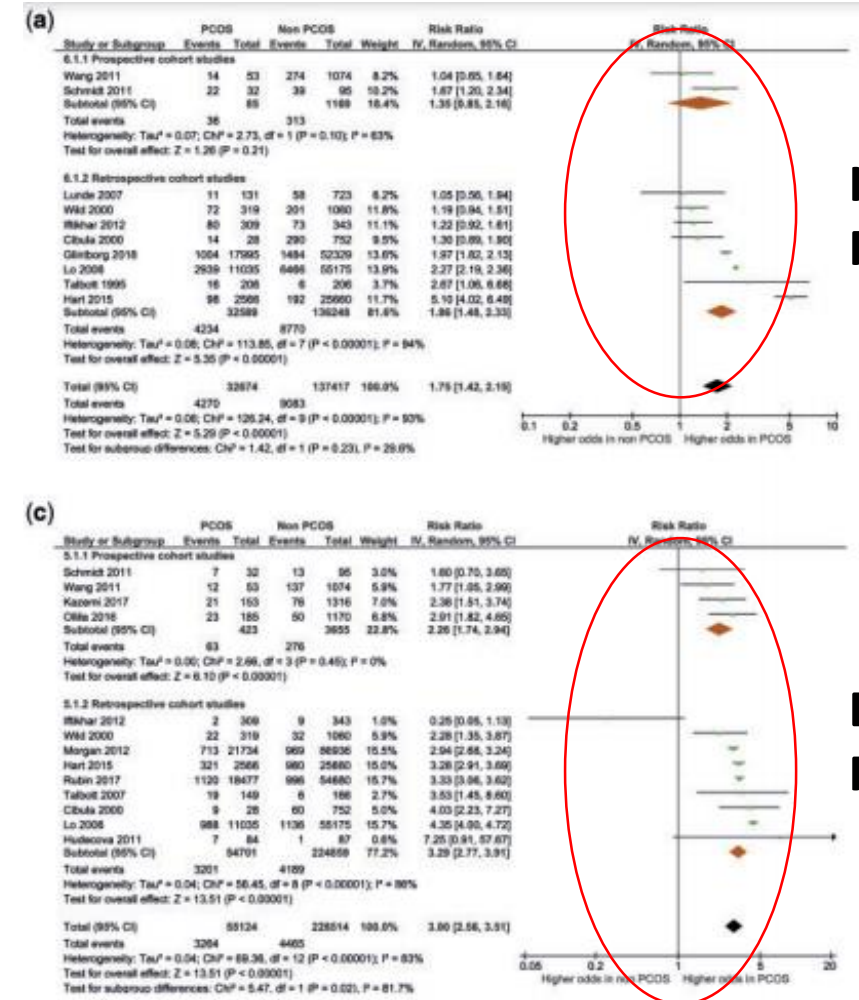
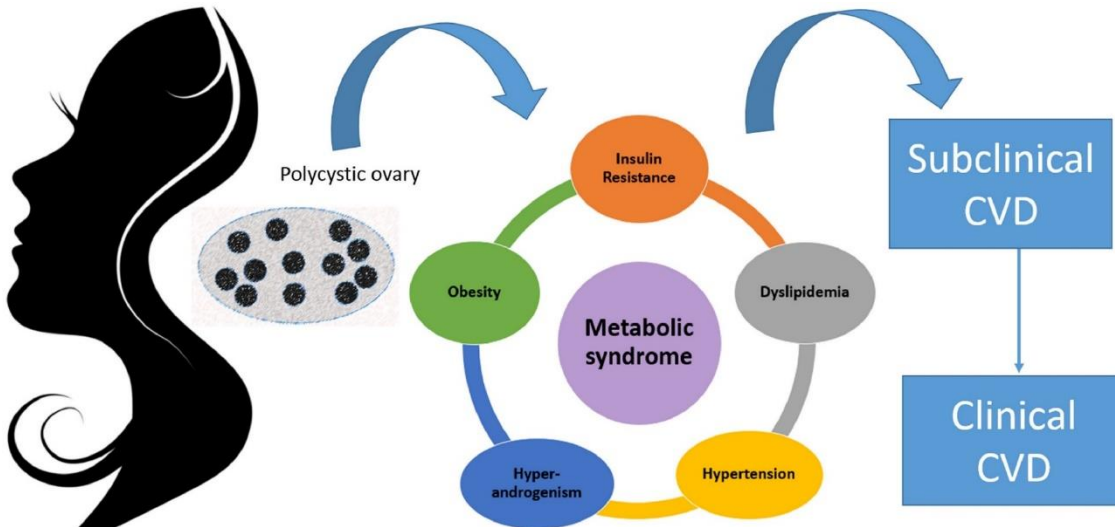
- Pathologie endocrinienne complexe, assez fréquente chez les femmes jeunes.
- Prévalence comprise entre 5 et 20%, selon les études et les critères retenus.
- Dysfonction ovarienne: modification du ratio androgènes/oestrogènes → troubles cardio-métaboliques.



→ Augmentation du risque de MCV

Long-term cardiometabolic disease risk in women with PCOS: a systematic review and meta-analysis

Wekker *et al.*, *Human Reproduction Update* 2020



Hypertension
RR = 1,75

Diabète Type II
RR = 3,00

Figure 2. Forest plots and funnel plot for meta-analysis of hypertension and type 2 diabetes among women with PCOS compared to women without PCOS. (a) Forest plot for hypertension (HT); (b) Funnel plot for meta-analysis of HT; (c) Forest plot for and type 2 diabetes (T2D); (d) Funnel plot for meta-analysis of T2D. The dashed lines in the funnel plots indicate the aggregated point estimate for the corresponding meta-analysis.

SOPK, MCV et exercice

RESEARCH

Open Access



Exercise, or exercise and diet for the management of polycystic ovary syndrome: a systematic review and meta-analysis

Kite *et al.*, *Systematic Reviews* 2019

Conclusion: Statistically beneficial effects of exercise were found for a range of metabolic, anthropometric, and cardiorespiratory fitness-related outcomes. However, caution should be adopted when interpreting these findings since many outcomes present modest effects and wide CIs, and statistical effects in many analyses are sensitive to the addition/removal of individual trials. Future work should focus on rigorously designed, well-reported trials that make comparisons involving both exercise and diet.

Exercise Interventions in Polycystic Ovary Syndrome: A Systematic Review and Meta-Analysis

Patten *et al.*, *Frontiers in physiology* 2019

→ **Recommandations = 120 min/semaine à intensité modérée à vigoureuse**

Chez la femme enceinte

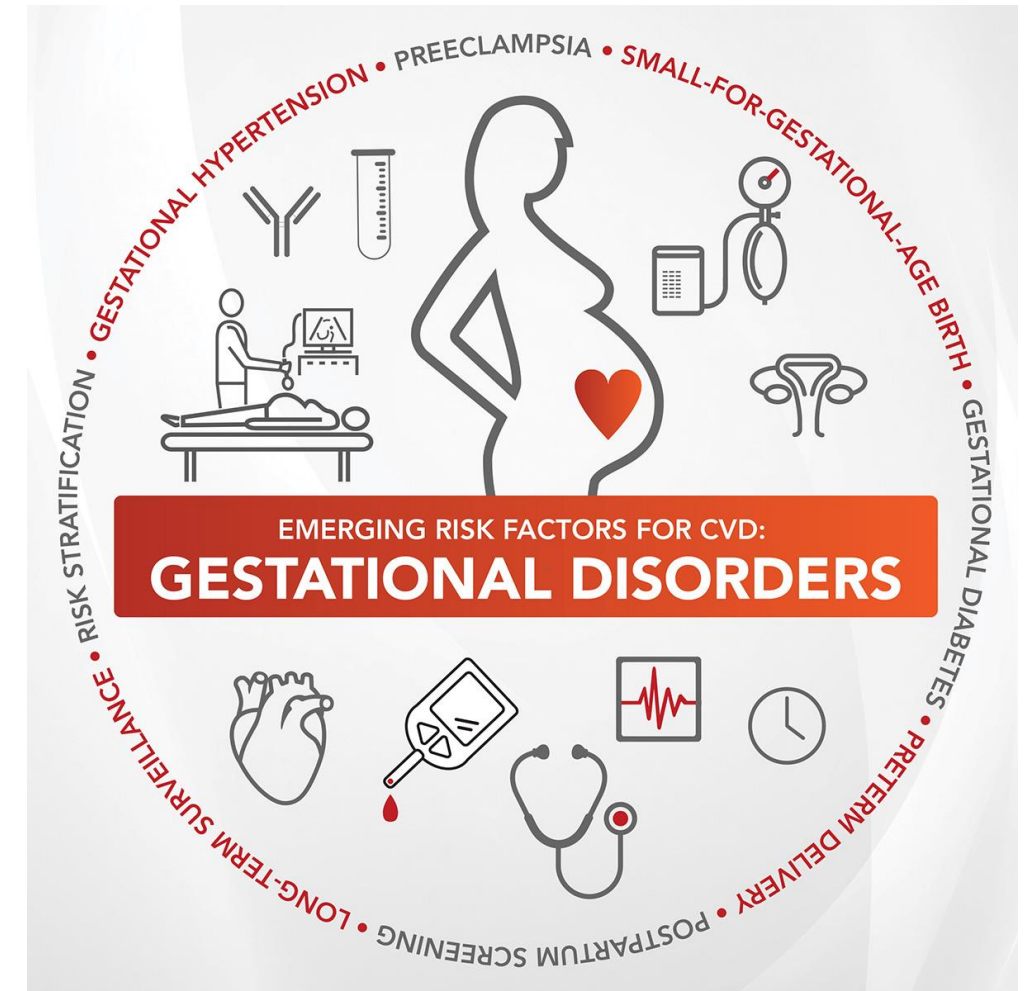
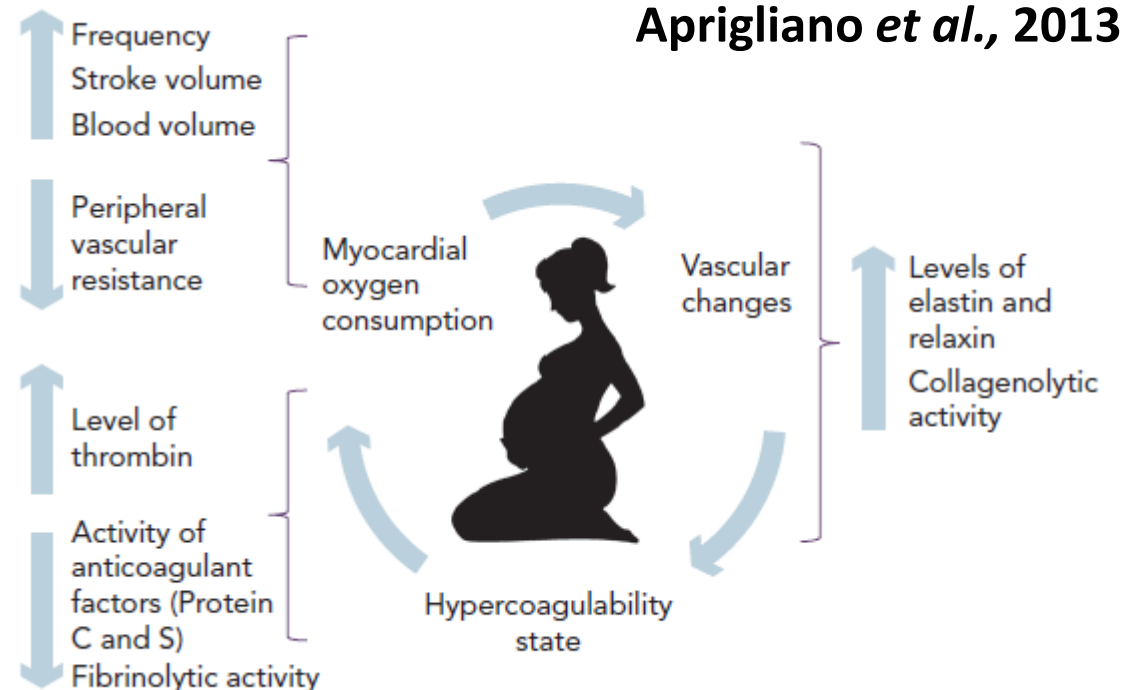


Troubles hypertensifs gestationnels et MCV

Grossesse =

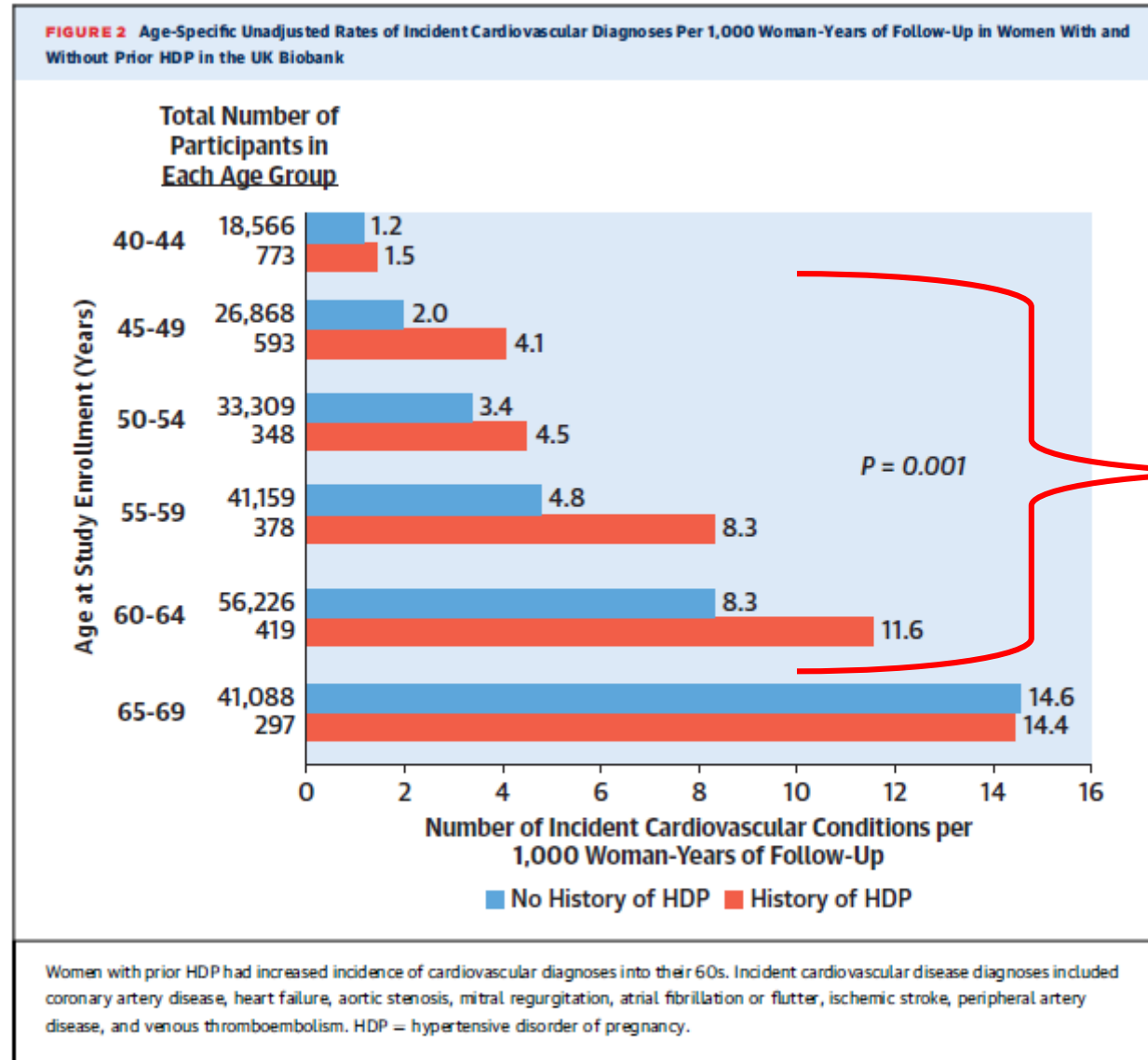
→ mise à l'épreuve du système cardiovasculaire

→ THG associés à une \nearrow du risque de MCV



Troubles hypertensifs gestationnels et MCV

Honigberg, JACC 2019



Période critique au moment de la péri-ménopause

Troubles hypertensifs gestationnels, MCV et exercice

Blog | British Journal of
Sports Medicine

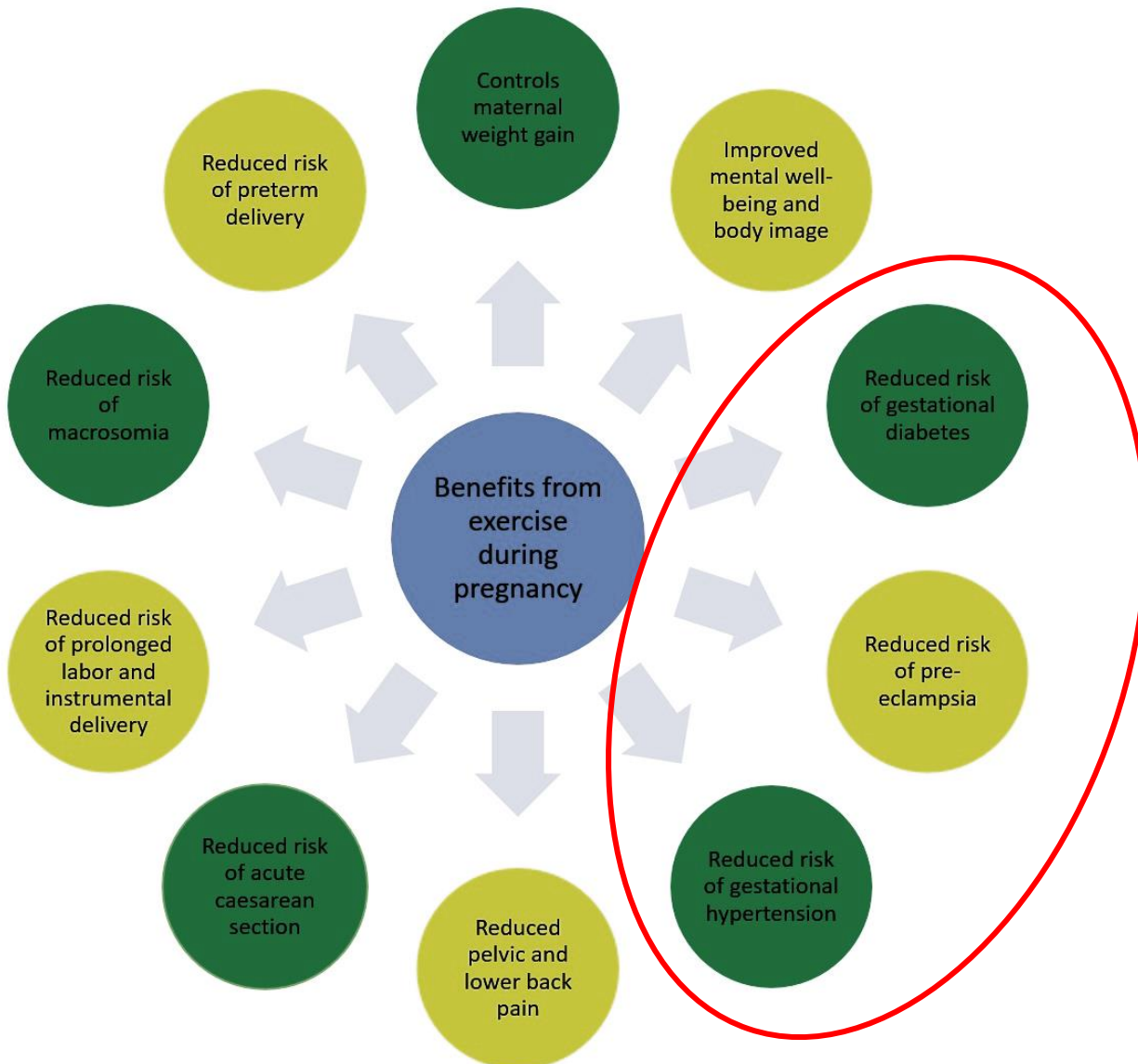
Is it safe to exercise during pregnancy?

Posted on [July 11, 2019](#) by [BMJ](#)

By Ida Lysdahl Fahrenholtz

Figure 1. Maternal and fetal benefits of exercise during pregnancy. Based on Bø et al., 2016; 2017; Silva et al., 2017; Haakstad et al., 2018.

Green bobbles indicate moderate to high evidence, yellow bobbles indicate presumed benefits/low evidence.



Troubles hypertensifs gestationnels, MCV et exercice

➤ du risque de développer des troubles hypertensifs gestationnels (RR = 0,70; Magro-Malosso *et al.*, 2017)



AOGS SYSTEMATIC REVIEW

Exercise during pregnancy and risk of gestational hypertensive disorders: a systematic review and meta-analysis

ELENA R. MAGRO-MALOSSO¹, GABRIELE SACCONI² , MARIAROSARIA DI TOMMASO¹, AMANDA ROMAN³ & VINCENZO BERGHELLA³

¹Department of Health Science, Division of Pediatrics, Obstetrics and Gynecology, Careggi Hospital University of Florence, Florence, ²Department of Neuroscience Reproductive Sciences and Dentistry, School of Medicine, University of Naples Federico II, Naples, Italy, and ³Division of Maternal-Fetal Medicine, Department of Obstetrics and Gynecology, Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, USA

Key words

Physical activity, exercise in pregnancy, preterm birth, hypertension, obesity

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Conflict of interest

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

Please cite this article as: Magro-Malosso ER, Saccone G, Di Tommaso M, Roman A, BergHELLA V. Exercise during pregnancy and risk of gestational hypertensive disorders: a systematic review and meta-analysis. *Acta Obstet Gynecol Scand* 2017; 96:921–931.

Received: 14 February 2017

Accepted: 28 March 2017

DOI: 10.1111/aogs.13151

Abstract

Introduction. Gestational hypertensive disorders, including gestational hypertension and preeclampsia, are one of the leading causes of maternal morbidity and mortality. The aim of our study was to evaluate the effect of exercise during pregnancy on the risk of gestational hypertensive disorders. **Material and methods.** Electronic databases were searched from their inception to February 2017. Selection criteria included only randomized controlled trials of uncomplicated pregnant women assigned before 23 weeks to an aerobic exercise regimen or not. The summary measures were reported as relative risk with 95% confidence intervals. The primary outcome was the incidence of gestational hypertensive disorders, defined as either gestational hypertension or preeclampsia. **Results.** Seventeen trials, including 5075 pregnant women, were analyzed. Of them, seven contributed data to quantitative meta-analysis for the primary outcome. Women who were randomized in early pregnancy to aerobic exercise for about 30–60 min two to seven times per week had a significant lower incidence of gestational hypertensive disorders (5.9% vs. 8.5%; relative risk 0.70, 95% confidence interval 0.53–0.83; seven studies, 2517 participants), specifically a lower incidence of gestational hypertension (2.5% vs. 4.6%; relative risk 0.54, 95% confidence interval 0.40–0.74; 16 studies, 4641 participants) compared with controls. The incidence of preeclampsia (2.3% vs. 2.8%; relative risk 0.79, 95% confidence interval 0.45–1.38; six studies, 2230 participants) was similar in both groups. The incidence of cesarean delivery was decreased by 16% in the exercise group. **Conclusions.** Aerobic exercise for about 30–60 min two to seven times per week during pregnancy, as compared with being more sedentary, is associated with a significantly reduced risk of gestational hypertensive disorders overall, gestational hypertension, and cesarean delivery.



Troubles hypertensifs gestationnels, MCV et exercice

➤ du risque de prééclampsie lorsque l'AP est pratiquée avant la grossesse et au tout début de la grossesse (RR = 0,65, Aune *et al.*, 2014)

Physical Activity and the Risk of Preeclampsia *A Systematic Review and Meta-Analysis*

Dagfinn Aune,^{a,b,c} Ola Didrik Saugstad,^d Tore Henriksen,^e and Serena Tonstad^{a,f}

Background: Physical activity has been hypothesized to reduce the risk of preeclampsia, but epidemiologic studies have not shown consistent results. Therefore, we conducted a systematic review and dose-response meta-analysis of epidemiologic studies.

Methods: PubMed, Embase, and Ovid databases were searched for case-control and cohort studies of physical activity and preeclampsia up to 2 November 2012. We estimated summary relative risks (RRs) using a random effects model.

Results: Fifteen studies were included. The summary RR for high versus low prepregnancy physical activity was 0.65 (95% confidence interval [CI] = 0.47–0.89, $I^2 = 0\%$; $n = 5$). In the dose-response analysis, the summary RR was 0.72 (0.53–0.99; $I^2 = 0\%$; $n = 3$) per 1 hour per day and 0.78 (0.63–0.96; $I^2 = 0\%$; $n = 2$) per 20 metabolic equivalent task (MET)-hours per week. The summary RR for high versus low physical activity in early pregnancy was 0.79 (0.70–0.91; $I^2 = 0\%$; $n = 11$). In the dose-response analysis, the summary RR per 1 hour per day was 0.83 (0.72–0.95; $I^2 = 21\%$; $n = 7$) and 0.85 (0.68–1.07; $I^2 = 69\%$; $n = 3$) per 20 MET-hours per week. A nonlinear association was observed for physical activity before pregnancy and risk of preeclampsia (test for nonlinearity, $P = 0.03$), but not for physical activity in early pregnancy (test for nonlinearity, $P = 0.37$), with a flattening of the curve at higher levels of activity. Both walking and greater intensity of physical activity were inversely associated with preeclampsia.

Conclusions: Our analysis suggests a reduced risk of preeclampsia with increasing levels of physical activity before pregnancy and during early pregnancy.

(*Epidemiology* 2014;25: 331–343)

Preeclampsia is an important cause of maternal multiorgan failure and death, preterm birth, intrauterine growth restriction, and increased perinatal mortality; it is estimated to affect 3% to 5% of pregnant women in the developed world.¹ Worldwide, hypertensive disorders of pregnancy are responsible for 12% of maternal deaths during pregnancy and the puerperium.² Preeclampsia is a pregnancy-specific disorder characterized by hypertension (blood pressure $\geq 140/90$ mmHg) and proteinuria in the second half of pregnancy.³ The pathophysiology of preeclampsia involves endothelial dysfunction, vasoconstriction, activated hemostasis, and multiorgan injury affecting the liver, kidney, and brain.⁴ The clinical picture of preeclampsia exhibits great variability from prolonged mild forms to rapidly developing multiorgan failure.

The causes of preeclampsia are not well understood,



Troubles hypertensifs gestationnels, MCV et exercice

Ming et al. BMC Pregnancy and Childbirth
<https://doi.org/10.1186/s12884-018-2068-7>

(2018) 18:440

BMC Pregnancy and Childbirth

RESEARCH ARTICLE

Open Access

The effect of exercise during pregnancy on gestational diabetes mellitus in normal-weight women: a systematic review and meta-analysis



Wai-Kit Ming^{1,2,3†}, Wenjing Ding^{1†}, Casper J. P. Zhang⁴, Lieqiang Zhong¹, Yuhang Long¹, Zhuyu Li¹, Cong Sun¹, Yanxin Wu¹, Hanqing Chen¹, Haitian Chen¹ and Zilian Wang^{1*}

Abstract

Background: Gestational diabetes mellitus (GDM) is one of the most common complications during pregnancy, and it has both short- and long-term adverse effects on the health of mothers and fetuses. To investigate the effect of exercise during pregnancy on the occurrence of GDM among normal-weight pregnant women.

Methods: We searched for studies published between January 1994 and June 2017 that appeared in the Web of Science, Scopus, ClinicalTrials.gov or Cochrane library databases. Randomized controlled trials that investigated the preventive effect of exercise on GDM in normal-weight women were included. Interventions including any confounding factors (e.g., dietary) were excluded. We extracted maternal characteristics, the diagnostic criteria of GDM, and basic information for intervention and obstetric outcomes. The primary outcome was the occurrence of GDM, and the secondary outcomes included gestational weight gain, gestational age at birth, birth weight, and the odds of cesarean section. A meta-analysis was conducted based on calculations of pooled estimates using the random-effects model.

Results: Eight studies were included in this systematic review and meta-analysis. Exercise during pregnancy was shown to decrease the occurrence of GDM [RR = 0.58, 95% CI (0.37, 0.90), $P = 0.01$ and RR = 0.60, 95% CI (0.36, 0.98), $P = 0.04$ based on different diagnosis criteria, respectively] in normal-weight women. Regarding secondary outcomes, exercise during pregnancy can decrease gestational weight gain [MD = -1.61, 95% CI (-1.99, -1.22), $P < 0.01$], and had no significant effects on gestational age at birth [MD = -0.55, 95% CI (-1.57, 0.47), $P = 0.29$], birth weight [MD = -18.70, 95% CI (-52.49, 15.08), $P = 0.28$], and the odds of cesarean section [RR = 0.88, 95% CI (0.72, 1.08), $P = 0.21$], respectively.

Conclusions: Exercise during pregnancy can ostensibly decrease the occurrence of GDM without reducing gestational age at delivery and increasing the odds of cesarean section in normal-weight women.

Keywords: Exercise, Gestational diabetes mellitus, Systematic review, Meta-analysis

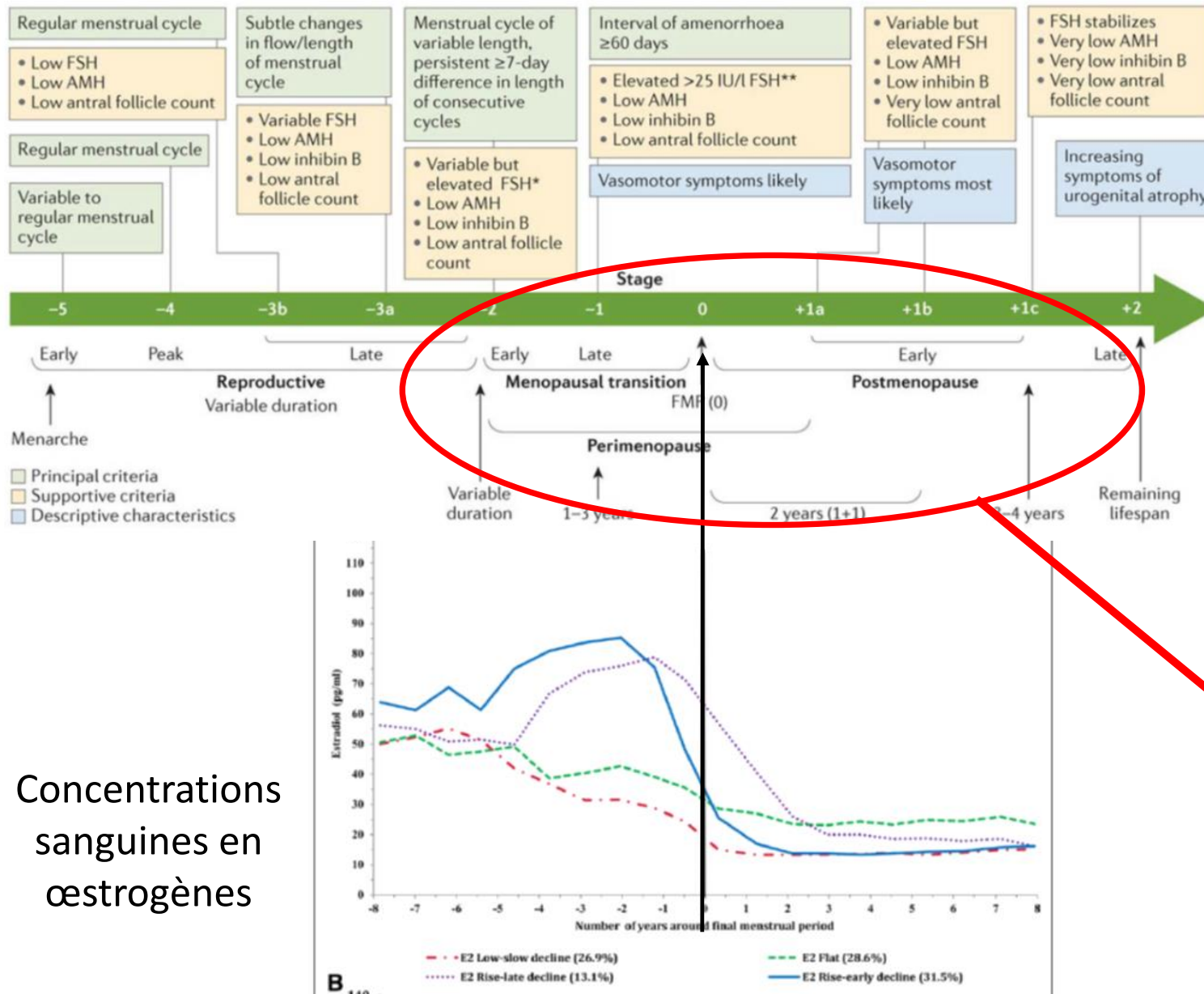
➤ du risque de développer un diabète gestationnel (RR = 0,58; Ming *et al.*, 2018)



Chez la femme ménopausée



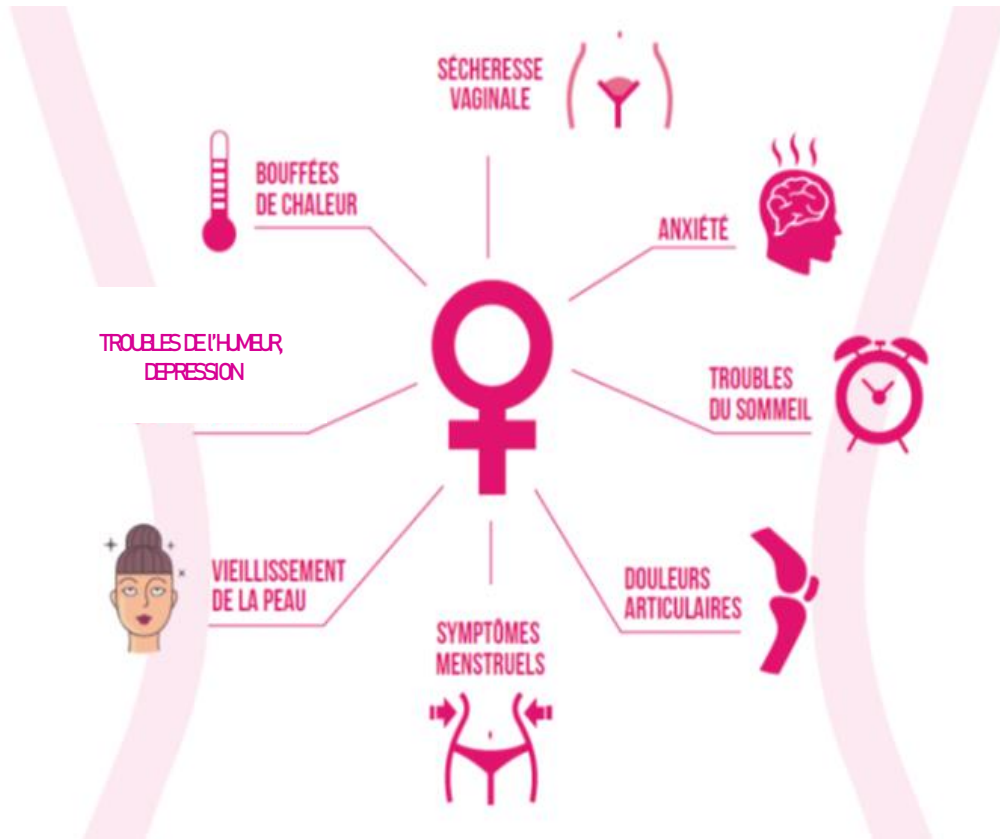
Ménopause: *meno* = « menstrues » *pause* = cessation



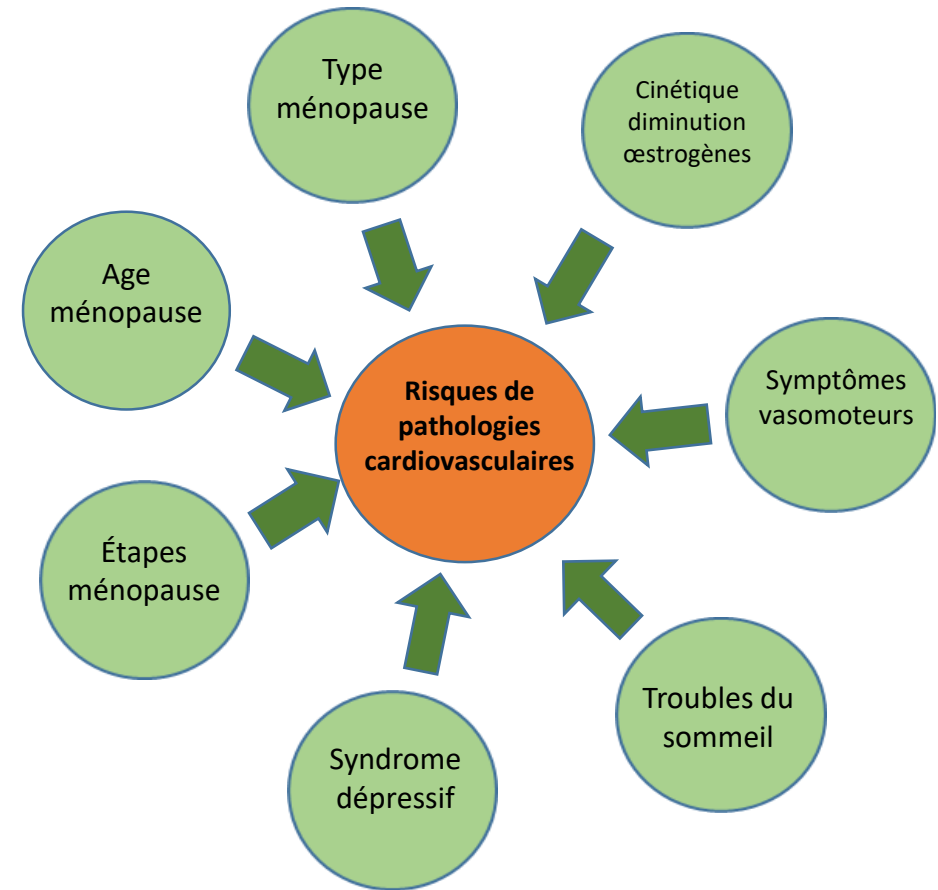
El Khoudary *et al*, *Circulation*, 2020

Ménopause = processus avec une grande variabilité inter-individuelle

Ménopause et risques de pathologies cardiovasculaires

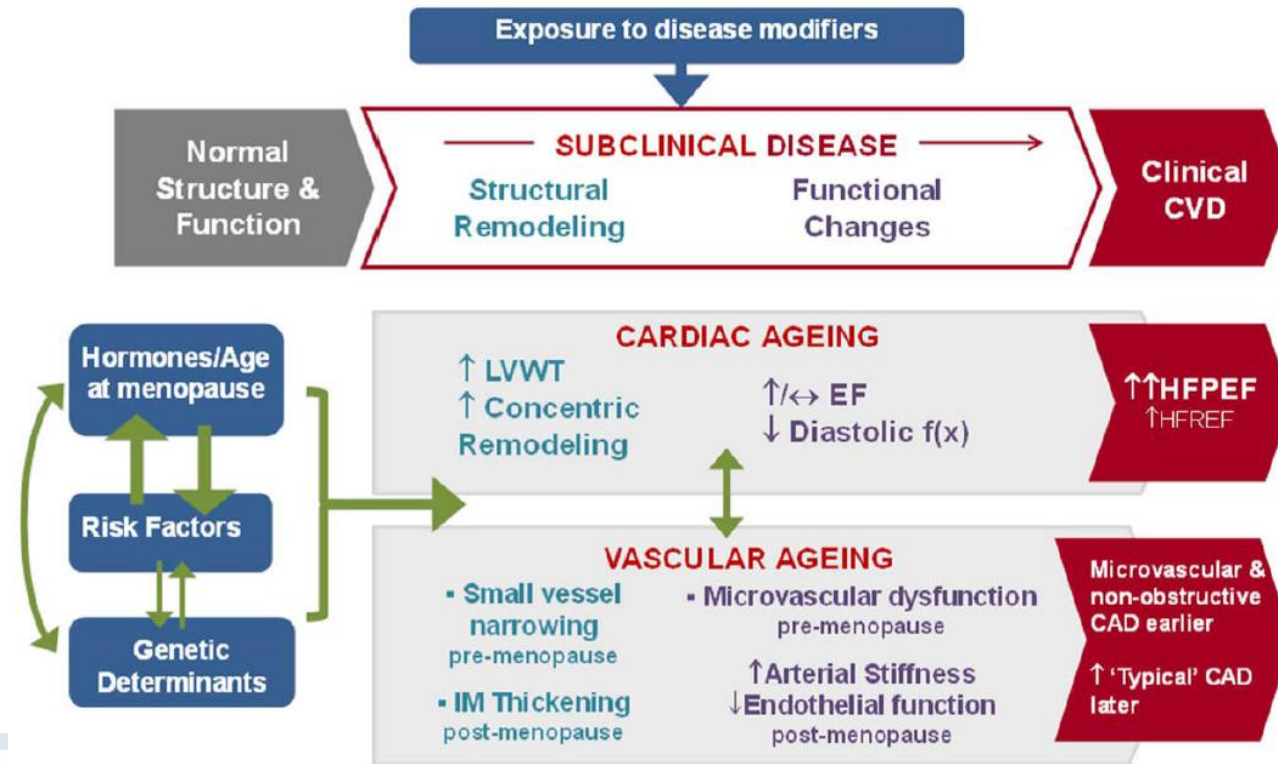


Symptômes associés à la ménopause



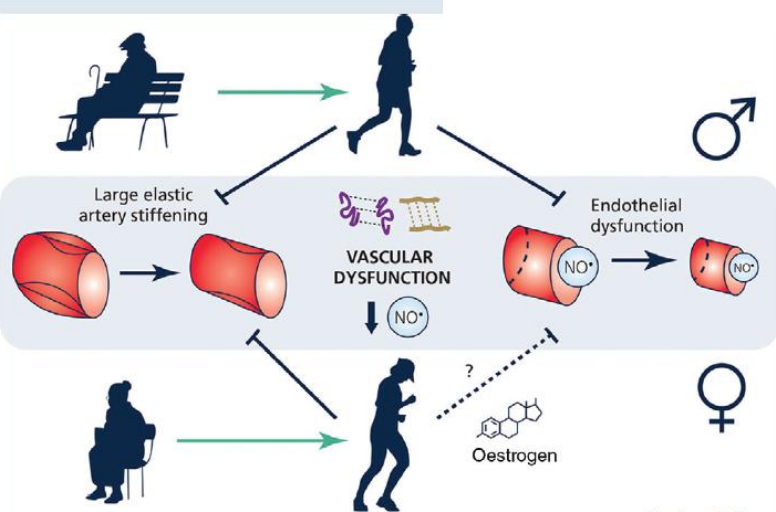
Ménopause et risques de CVD

Ménopause: remodelage vasculaire et remodelage cardiaque

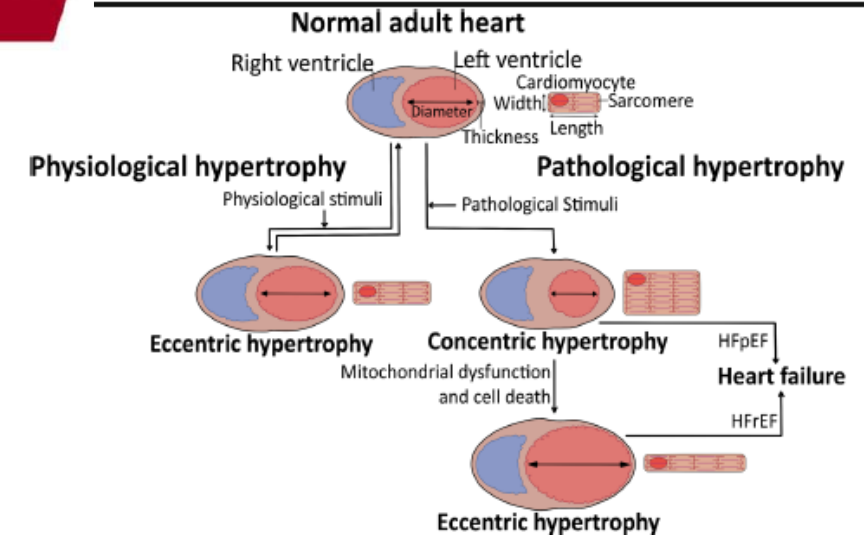


Merz & Cheng, Heart, 2016

le remodelage vasculaire et cardiaque dépend du statut hormonal



Seals et al, J. Physiol, 2012



Exercice physique chez femmes ménopausées

Pas de consensus dans le peu d'études sur les effets de l'activité physique chez la femme ménopausée

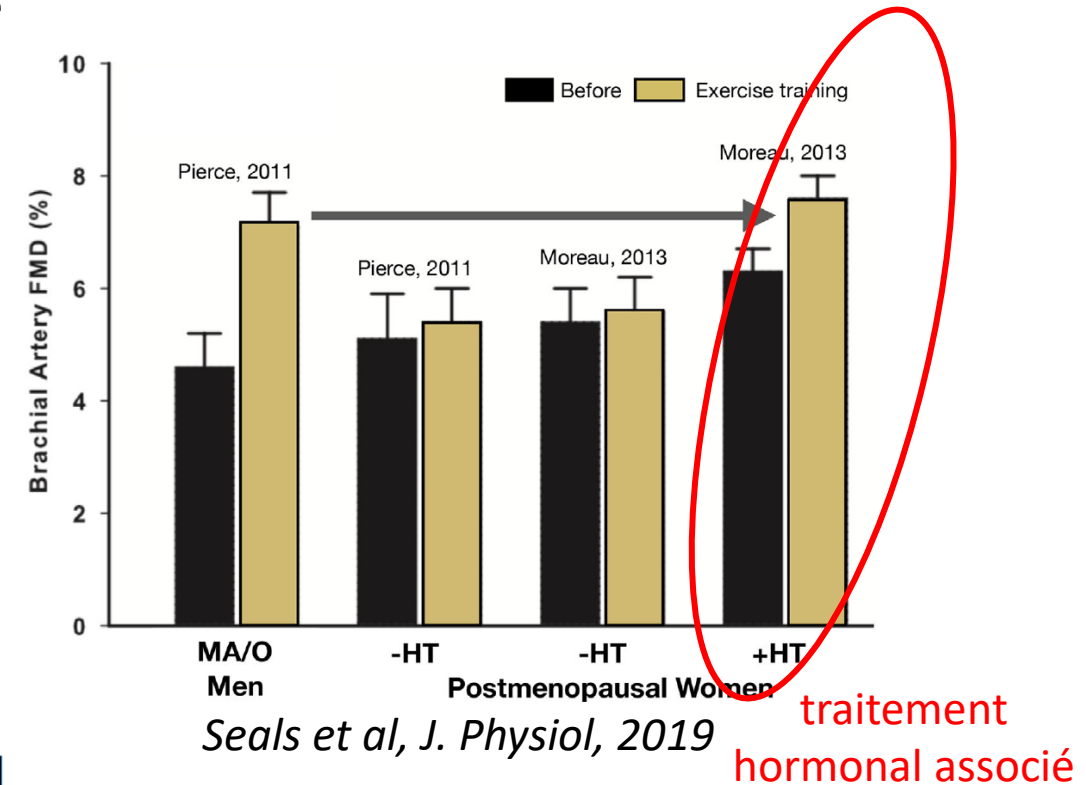
RESEARCH ARTICLE | *Aging and Exercise* JAP, 2017

Habitual aerobic exercise does not protect against micro- or macrovascular endothelial dysfunction in healthy estrogen-deficient postmenopausal women

Jessica R. Santos-Parker,¹ Talia R. Strahler,¹ Victoria M. Vorwald,¹ Gary L. Pierce,² and Douglas R. Seals¹

Combined exercise reduces arterial stiffness, blood pressure, and blood markers for cardiovascular risk in postmenopausal women with hypertension

Won-Mok Son, PhD,¹ Ki-Dong Sung, PhD,² Jae-Min Cho, MS,³ and Song-Young Park, PhD⁴
Menopause, 2016



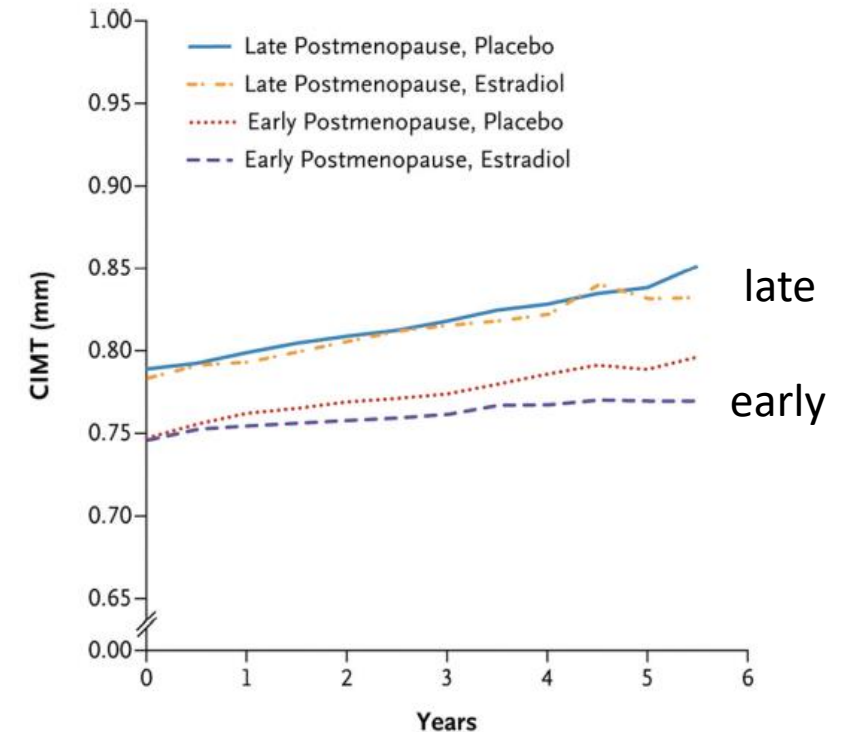
Pathologie associée

Importance de la fenêtre temporelle

N Engl J Med. 2016 March 31; 374(13): 1221–1231. doi:10.1056/NEJMoa1505241.

Vascular Effects of **Early versus Late Postmenopausal Treatment** with Estradiol

Howard N. Hodis, M.D., Wendy J. Mack, Ph.D., Victor W. Henderson, M.D., Donna Shoupe, M.D., Matthew J. Budoff, M.D., Juliana Hwang-Levine, Pharm.D., Yanjie Li, M.D., Mei Feng, M.D., Laurie Dustin, M.S., Naoko Kono, M.P.H., Frank Z. Stanczyk, Ph.D., Robert H. Selzer, M.S., Stanley P. Azen, Ph.D., and the ELITE Research Group*



Early Postmenopausal Phase Is Associated With Reduced Prostacyclin-Induced Vasodilation That Is Reversed by Exercise Training

The Copenhagen Women Study



Michael Nyberg, Jon Egelund, Camilla M. Mandrup, Mads B. Nielsen, Alexander S. Mogensen, Bente Stallknecht, Jens Bangsbo, Ylva Hellsten *Hypertension*, 2016

Importance de la fenêtre temporelle

J Physiol 597.19 (2019) pp 4915–4925

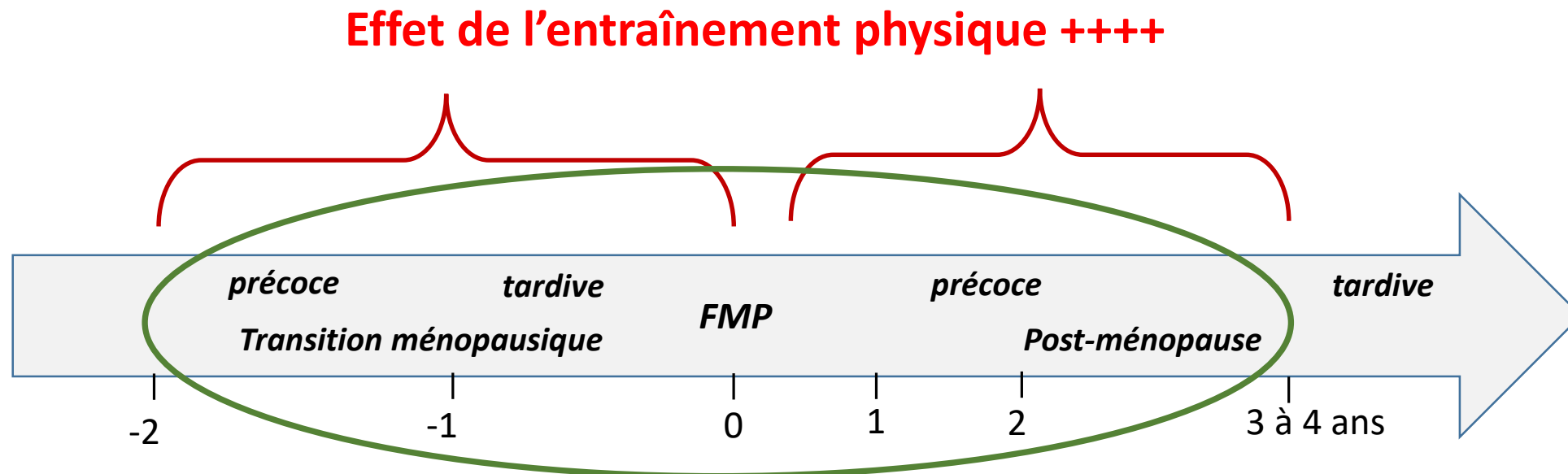
SYMPOSIUM REVIEW

The exercise timing hypothesis: can exercise training compensate for the reduction in blood vessel function after menopause if timed right?

L. Gliemann  and Y. Hellsten 

Department of Nutrition, Exercise and Sports, University of Copenhagen, Copenhagen, Denmark

Hypothèse de la fenêtre temporelle

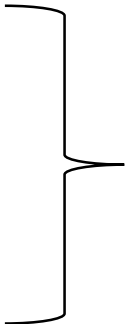


Conclusion: promotion +++ de l'activité physique chez la femme

Données disponibles actuellement:

→ Effets bénéfiques de l'AP à tous les âges de la vie d'une femme sur sa santé cardiovasculaire, mais pas que!

Mais nécessité:

- Etudes sur la physiopathologie des MCV chez les femmes
 - Etudes sur les effets de l'exercice aigu et chronique dans cette population
- 
- En fonction de leur statut hormonal

→ Amélioration de la prévention des MCV et de leur prise en charge

Programme *Women in motion*

■ Adolescence



- Ménopause
- Traitement hormonal substitutif



■ Grossesse



Conclusion: 4 étapes-clé pour réduire le risque de MCV

Agarwala *et al.*,
Circulation 2020

Step 1

Screen for Sex-specific Risk Factors:

- Prematurity
- Age at menarche
- Polycystic ovarian syndrome
- Hormone-based contraceptive use
- Recurrent spontaneous pregnancy loss
- Gestational diabetes
- Gestational HTN
- Pre-eclampsia
- Pre-term delivery
- Delivery of small for gestational age infant
- Early menopause/premature ovarian failure

Step 2

If sex-specific risk factors are present:

1. Assess for traditional CVD risk factors early and more frequently
2. Screen for, prevent, & treat intermediate phenotypes

Hypertension
Diabetes
Hyperlipidemia
Metabolic Syndrome

Stepping to Success: Reducing CVD Risk in Women

Step 3

Begin aggressive risk factor management

Implement lifestyle modifications with AHA's Life's Simple 7:

1. Manage blood pressure
2. Control cholesterol
3. Reduce blood sugar
4. Stay active
5. Eat Healthy
6. Lose weight
7. Stop Smoking



Step 4

Estimate risk & treat accordingly with consideration of sex-specific risk factors:

1. Assess 10-year ASCVD Risk/Lifetime risk
2. Treat early if borderline or intermediate risk and if sex-specific risk factors are present

La cardiologie, une spécialité médicale à dominante masculine



AAMC

Association of
American Medical Colleges

Denby *et al.*, 2020 *JAMA Intern Med*

Table 1.3 Number and Percentage of Active Physicians by Sex and Specialty, 2019

Specialty	Total Active Physicians	Male		Female	
		Number	Percent	Number	Percent
All Specialties	936,254	596,236	63.7	340,018	36.3
Allergy and Immunology	4,898	2,889	59.0	2,009	41.0
Anatomic/Clinical Pathology	12,634	7,774	61.5	4,860	38.5
Anesthesiology	42,223	31,275	74.1	10,948	25.9
Cardiovascular Disease	22,502	19,146	85.1	3,356	14.9
Child and Adolescent Psychiatry	9,782	4,500	46.0	5,282	54.0
Critical Care Medicine	13,076	9,568	73.2	3,508	26.8
Dermatology	12,505	6,133	49.0	6,372	51.0
Emergency Medicine	45,169	32,382	71.7	12,787	28.3
Endocrinology, Diabetes, and Metabolism	7,982	3,890	48.7	4,092	51.3

Table.

Comparison of First and Last Authors by Journal

Journal	No. of trials	No. (%) of trials with female authors	
		First author	Last author
Total trials			
<i>JAMA</i>	41	5 (12.2)	7 (17.1)
<i>The Lancet</i>	70	5 (7.1)	6 (8.6)
<i>NEJM</i>	89	8.5 (9.6)	7 (7.9)
Total	200	18.5 (9.3)	20 (10.0)
Large trials ^a			
<i>JAMA</i>	25	4 (16.0)	2 (8.0)
<i>The Lancet</i>	46	2 (4.3)	3 (6.5)
<i>NEJM</i>	77	7.5 (9.7)	6 (7.8)
Total	148	13.5 (9.1)	11 (7.4)
Procedural trials ^b			
<i>JAMA</i>	30	2 (6.7)	4 (13.3)
<i>The Lancet</i>	45	4 (8.9)	3 (6.7)
<i>NEJM</i>	47	2.5 (5.3)	2 (4.3)
Total	122	8.5 (7.0)	9 (7.4)

Abbreviation: *NEJM*, *New England Journal of Medicine*.

^aIndicates more than 500 participants.

^bIncludes those in the fields of interventional cardiology and electrophysiology.

La cardiologie reste la discipline la moins féminisée de toutes les spécialités médicales avec 28,2% de femmes. Ce déséquilibre est toutefois très marqué chez la génération des plus de 45 ans, avec un pic à près de 90% d'hommes chez les plus de 65 ans. Il devrait cependant s'annuler partiellement dans les années à venir, puisque les femmes représentent dès à présent plus de 40 % des cardiologues de moins de 40 ans.

Freins à l'activité physique au cours de la grossesse

Etude de Coll *et al.*, 2017

Freins intrapersonnels:

- 1) Symptômes et limitations liés à la grossesse
- 2) Contrainte de temps
- 3) Impression d'être déjà active
- 4) Manque de motivation
- 5) Peur pour la santé du bébé et sa propre santé



Freins interpersonnels:

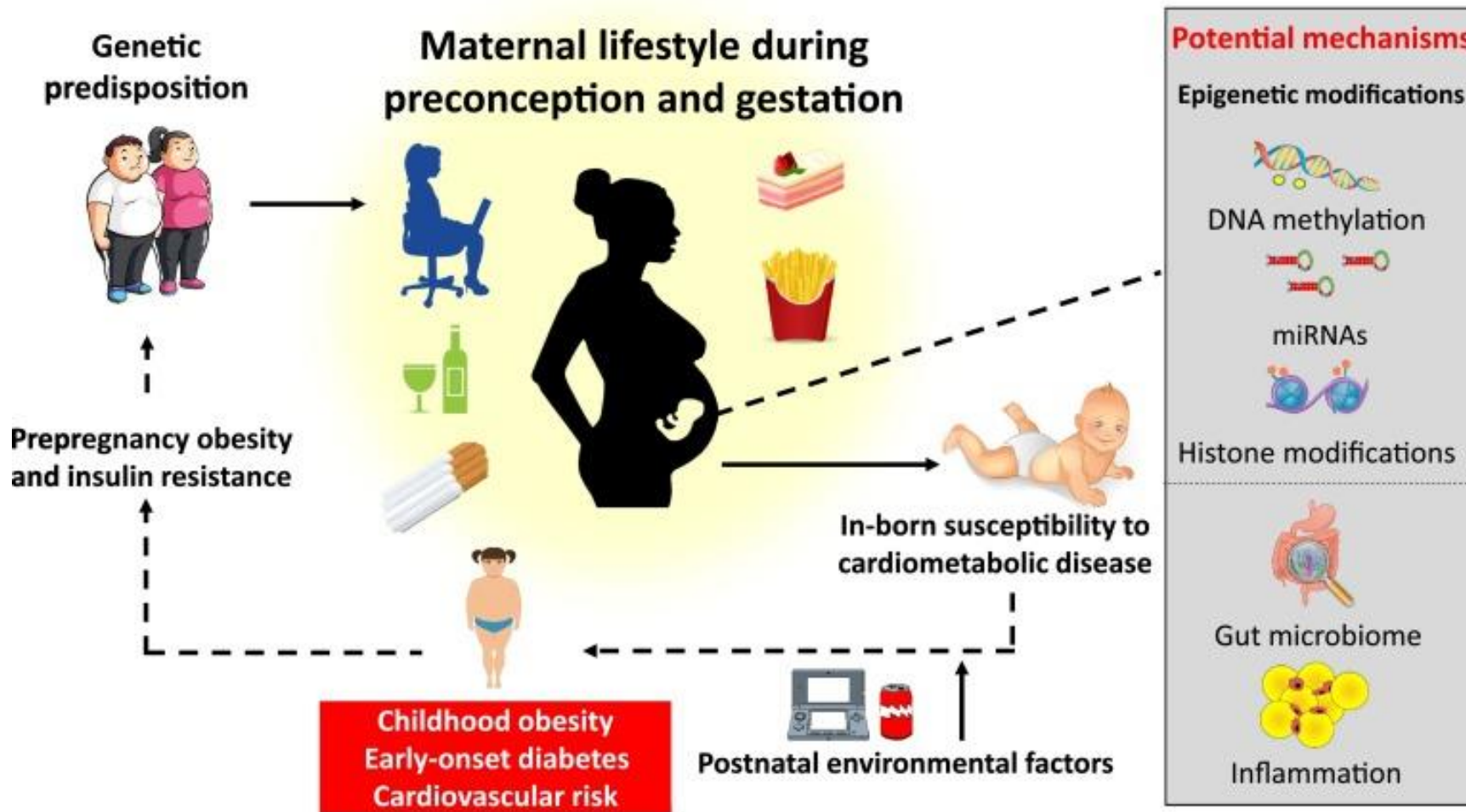
- 1) Manque d'informations et de conseils
- 2) Manque de soutien social

→ Intervention possible de professionnels spécialistes du changement de comportement

Troubles hypertensifs gestationnels, MCV et exercice

Cercle vicieux intergénérationnel des troubles cardiométaboliques

Moholdt et Hawley, 2020

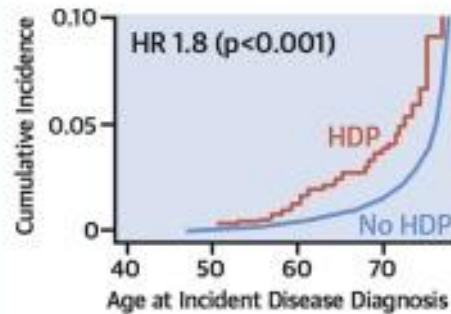


Epigénétique = facteurs contrôlant l'expression des gènes

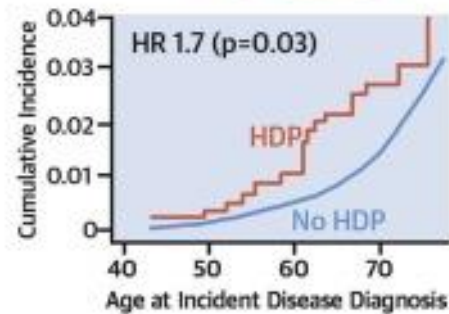
Troubles hypertensifs gestationnels et MCV

CENTRAL ILLUSTRATION: Hypertensive Disorders of Pregnancy Are Associated With Long-Term Risk of Diverse Cardiovascular Diseases

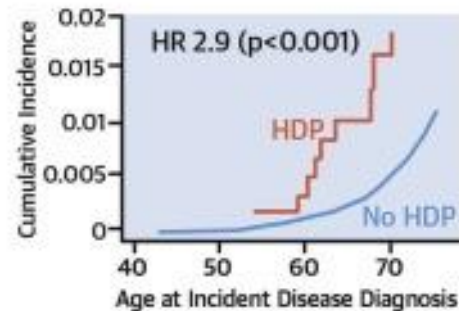
Coronary Artery Disease



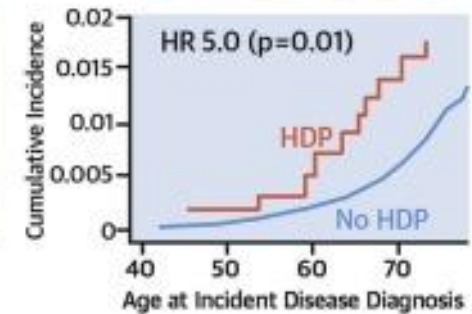
Heart Failure



Aortic Stenosis



Mitral Regurgitation



Honigberg, M.C. et al. J Am Coll Cardiol. 2019;74(22):2743-54.