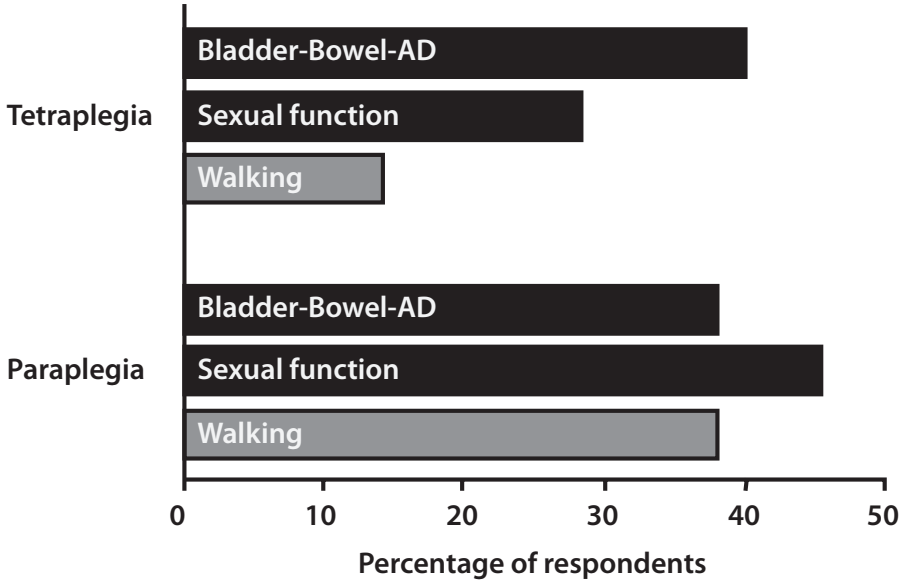
# AUTONOMIC FUNCTION IS A HIGH PRIORITY




*'an ailment not to be treated'*

Modified from Anderson 2004

# CARDIOVASCULAR AUTONOMIC PATHWAYS

## Parasympathetic:

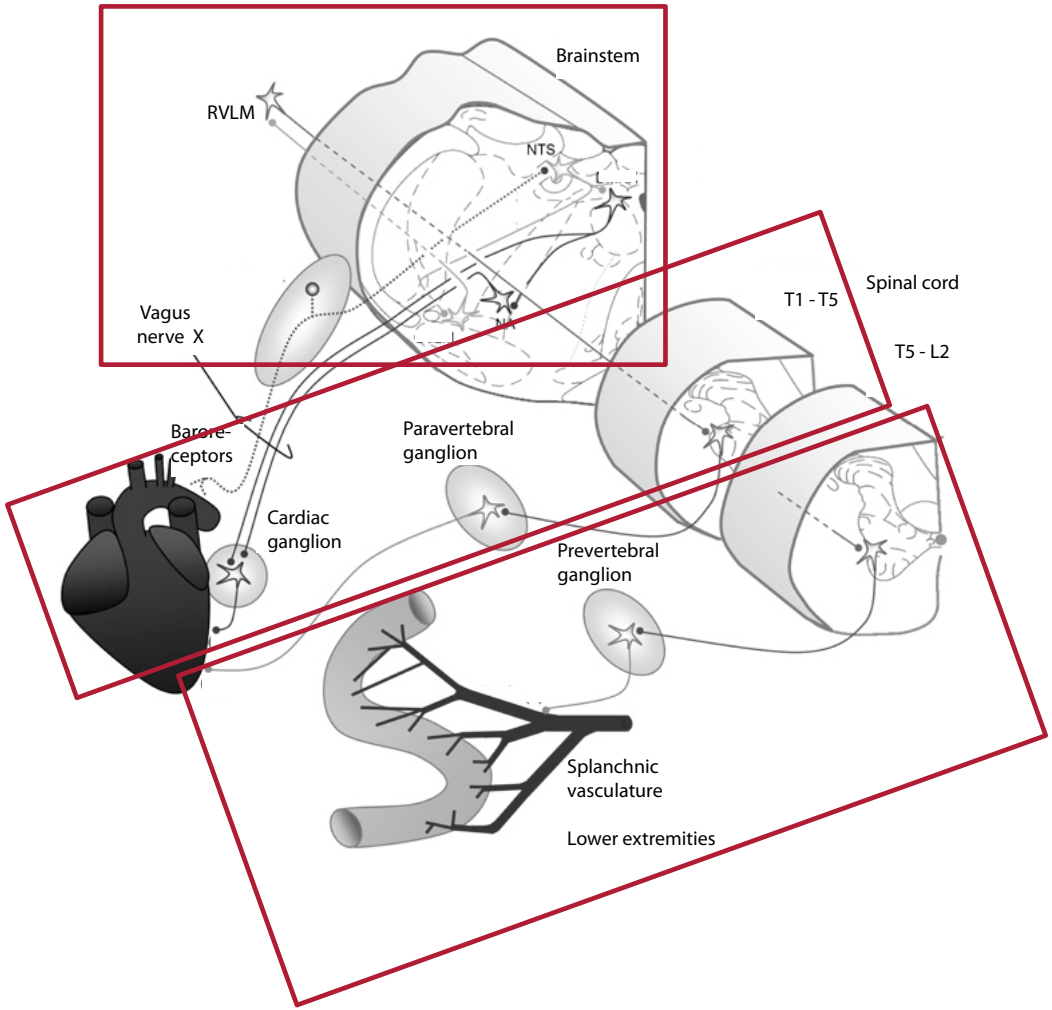
Unaffected by SCI

## Sympathetic:

Control of the heart at T1-T5

Control of the vasculature T1-L2

Splanchnic: T6-T10



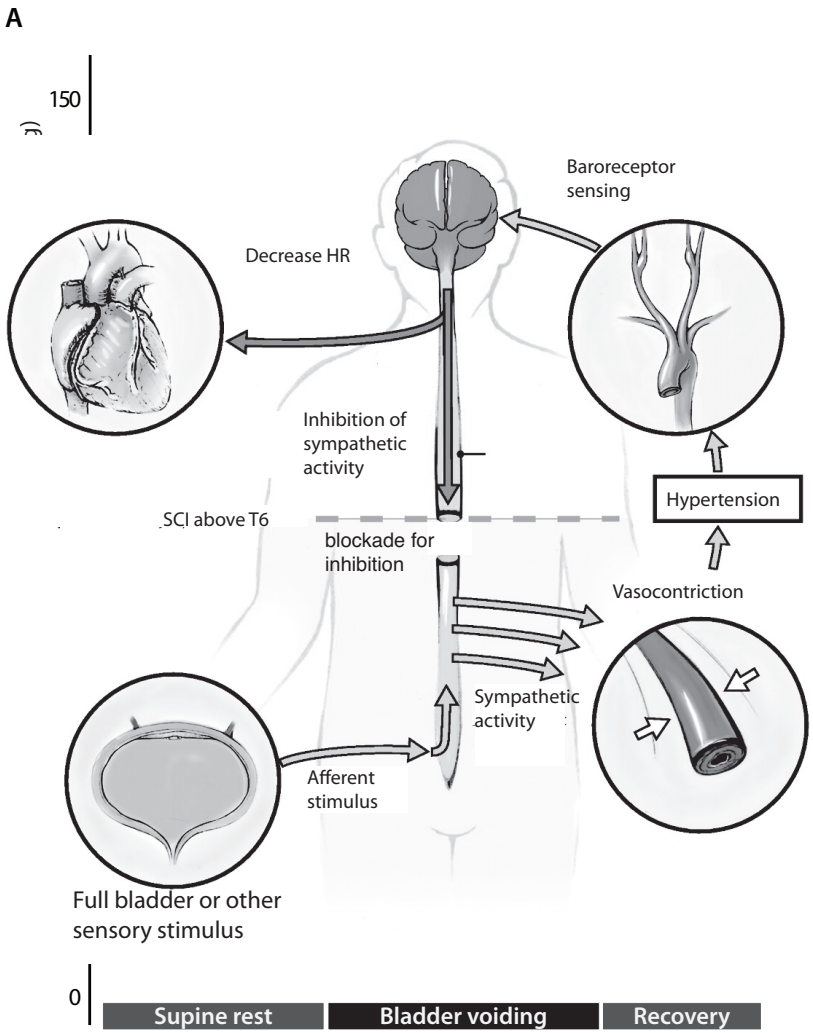

Modified from Inskip 2009

# CARDIOVASCULAR AUTONOMIC DYSFUNCTION

Low resting blood pressure

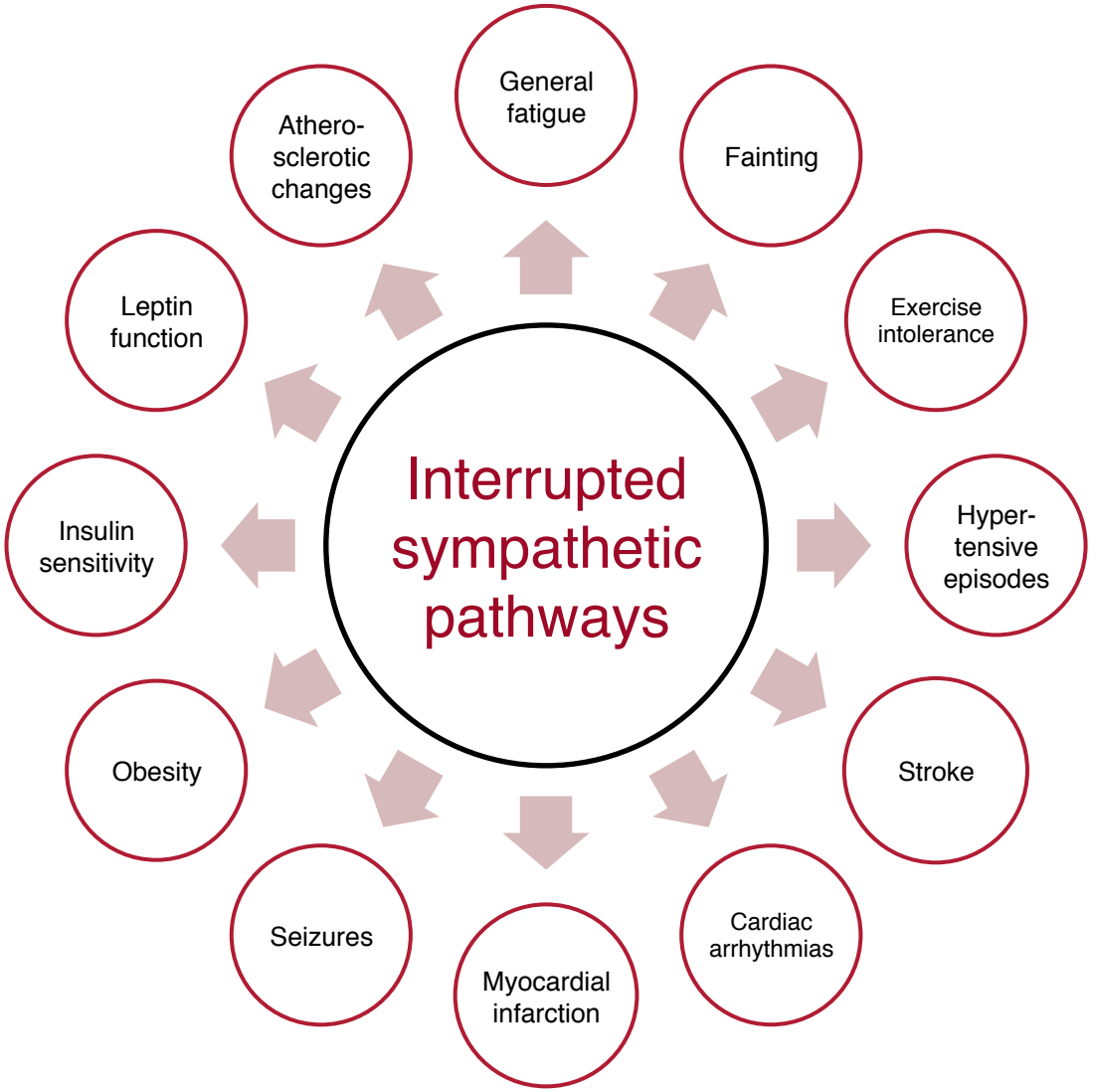
Orthostatic hypotension (OH)

Autonomic dysreflexia (AD)




Modified from Blackmer, 2003

# MANY CARDIOVASCULAR CONSEQUENCES OF INTERRUPTED SYMPATHETIC PATHWAYS



# ROLE IN CARDIOVASCULAR DISEASE RISK

# OUTLINE

Prevalence of cardiovascular autonomic dysfunction

Contribution of autonomic dysfunction to cardiovascular disease risk

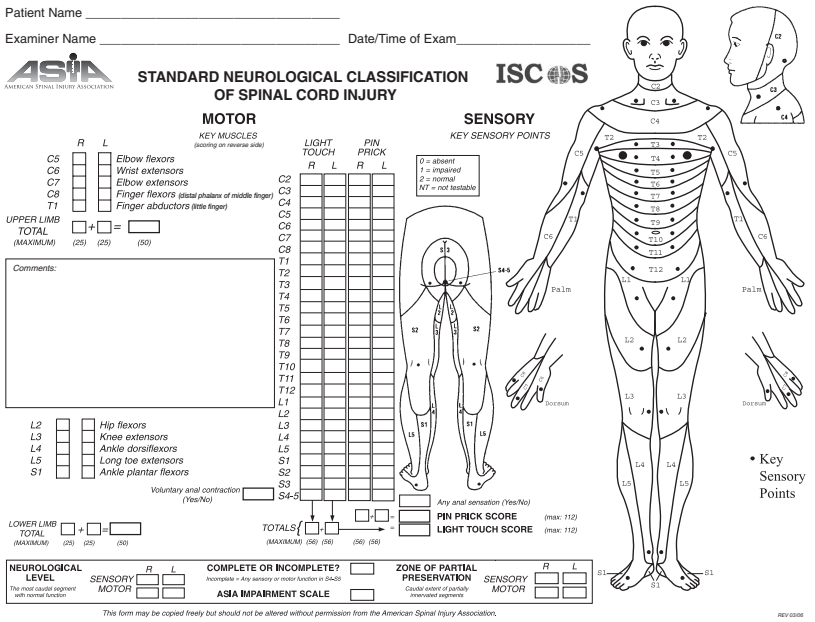
Waist circumference: the best marker for obesity after SCI

ECG-based predictors for cardiac arrhythmias after SCI

# PREVALENCE OF CARDIOVASCULAR AUTONOMIC DYSFUNCTION

Autonomic dysfunction only recently included in standard AIS assessment

Changes over time not yet investigated



# AIMS

I. to determine the prevalence of hypotension during and after inpatient rehabilitation

II. to investigate the time course of blood pressure, resting and peak heart rate, during and after inpatient rehabilitation

III. to evaluate the influence of personal and lesion characteristics on these cardiovascular variables

# STUDY METHODS

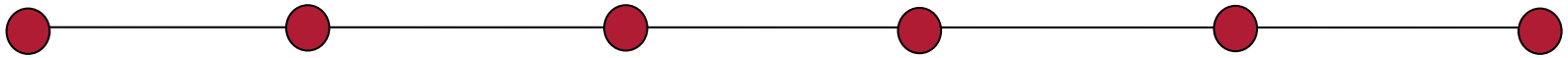
197 participants with SCI

## Characteristics:

- Age & sex
- AIS score
- Time since injury
- Medical history

## Cardiovascular variables:

- Resting blood pressure
- Resting heart rate
- Peak heart rate (exercise)
- Hypotension



Start of rehabilitation

3 months

Discharge

1 year

2 years

5 years

# PREVALENCE OF HYPOTENSION

## Time course:

no change

## Lesion level (cervical):

Odds **4.2** times greater than low lesion group

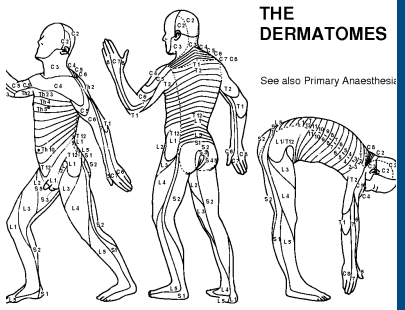
Odds **2.7** times greater than high thoracic group

## Age:

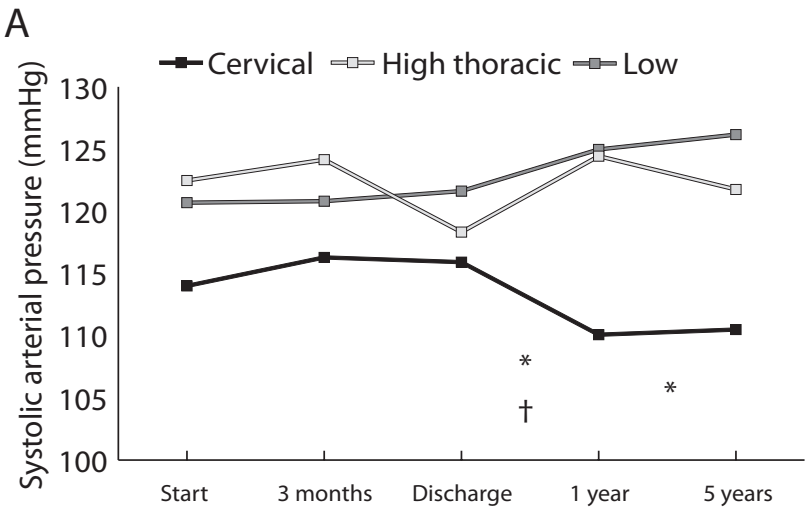
Odds decreased with age, 0.75 per 10-years

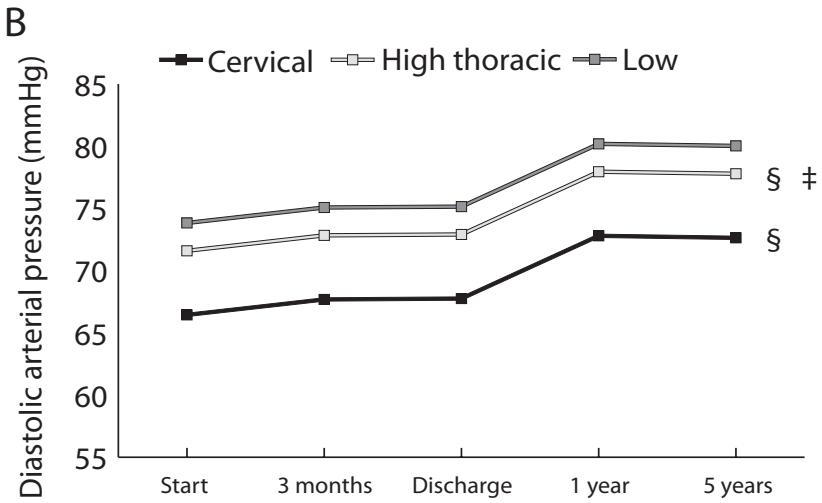
## Sex:

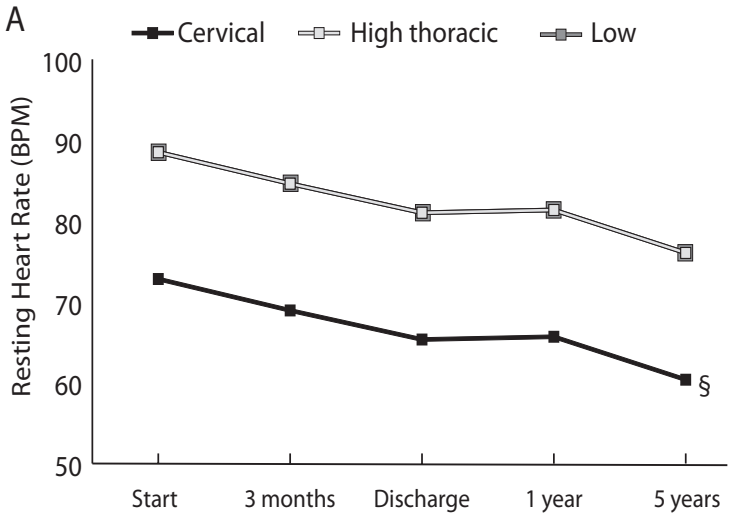
Men **2.2** times greater odds

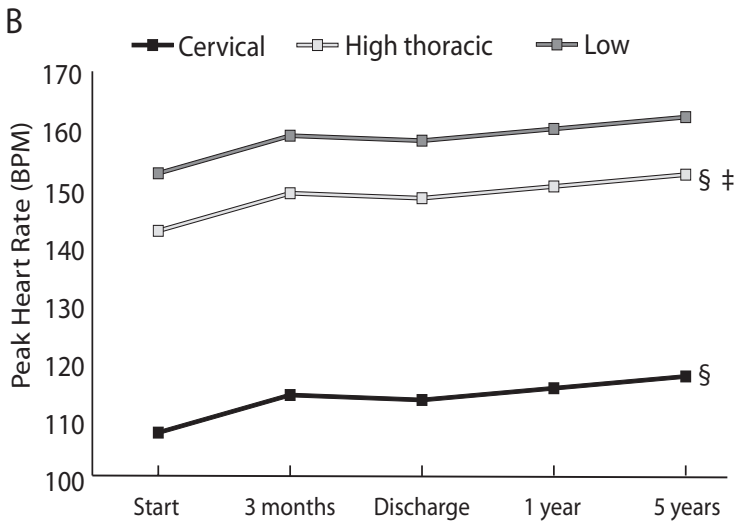



# BLOOD PRESSURE AND HEART RATE CHANGES OVER TIME



# CONCLUSIONS

Hypotension was common after spinal cord injury

Impaired heart rate response to exercise

Cardiovascular dysfunction mostly after cervical lesions

No improvement over time

# OUTLINE

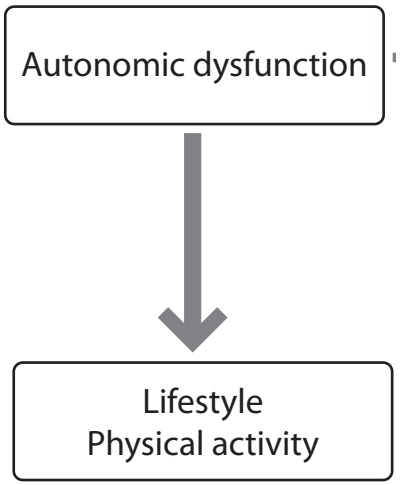
Prevalence of cardiovascular autonomic dysfunction

Contribution of autonomic dysfunction to cardiovascular disease risk

Waist circumference: the best marker for obesity after SCI

ECG-based predictors for cardiac arrhythmias after SCI

# CONTRIBUTION OF AUTONOMIC DYSFUNCTION TO CARDIOVASCULAR DISEASE RISK




Low blood pressure

Fatigue

Barrier participation physical activity

Deficient increase in heart rate

Insufficient perfusion of muscles

Poor exercise tolerance

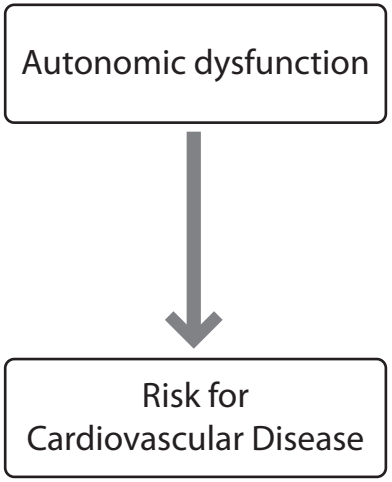
Sympathetic control interrupted

Leptin effects impaired

Resting metabolic rate decreased

Insulin receptor function

Insulin sensitivity



# AIMS

I. to determine the differences in cardiovascular disease risk between those with and without cardiovascular autonomic impairment after SCI, and able-bodied controls

II. to investigate the contribution of autonomic impairments, physical activity levels, and their interaction to cardiovascular disease risk after SCI

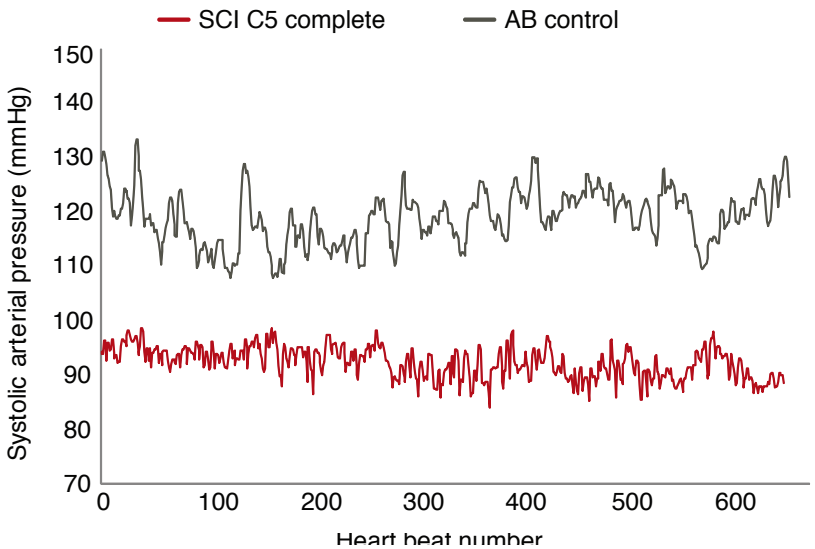
# STUDY METHODS: AUTONOMIC IMPAIRMENT

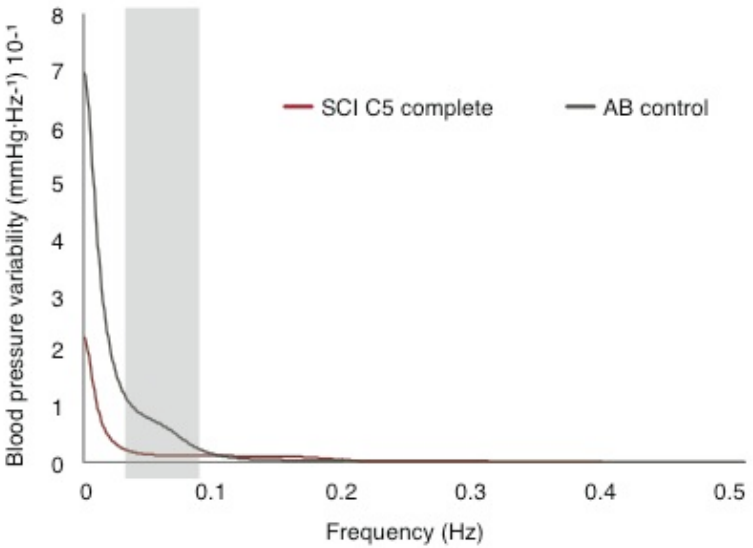
Plasma noradrenaline:

cut-off $< 0.56$ nmol/L

Low frequency systolic pressure variability:

cut-off $< 1.0$ mmHg$^2$



# STUDY METHODS: CVD RISK FACTORS AND PHYSICAL ACTIVITY LEVEL

## Cardiovascular disease risk factors:

- Blood lipid profile
- Insulin
- Glucose
- Glucose tolerance
- Insulin resistance (HOMA)


## Framingham cardiovascular disease risk score:

- Age
- Total cholesterol
- Smoking status
- Anti-hypertensive treatment
- Sex
- HDL cholesterol
- Diabetes
- ~~Systolic pressure~~


## Physical activity level:

- Physical Activity Scale for Individuals with Physical Disabilities

# STUDY METHODS: MULTIPLE REGRESSION ANALYSES

Outcome measures:

- Framingham risk score
- Other risk factors

Independent variables:

- Autonomic function (plasma NA)
- Physical activity level (PASIPD score)
- Interaction effect

Confounder variables:

- Age
- Sex
- Waist circumference

# MULTIPLE REGRESSION ANALYSES RESULTS

| | Framingham risk score | 120 min glucose | Insulin resistance | Insulin | Triglyceride | HDL | TC/HDL ratio |
|---|---|---|---|---|---|---|---|
| Intercept | -27.7 (10.4) | -4.1 (1.0) | 1.4 (0.2) | 7.0 (0.7) | -0.58 (0.6) | 1.32 (0.4) | -1.28 (1.5) |
| Autonomic function | NE | **-0.37 (0.12)** | NE | NE | NE | NE | NE |
| Physical activity | NE | NE | NE | NE | NE | NE | NE |
| Interaction | -0.17 (0.08) | NE | **0.02 (0.01)** | **0.1 (0.04)** | NE | NE | NE |
| Age | NE | | | | | | |
| Sex | NE | | | | | | |
| Waist circumference | 0.47 (0.12) | NE | NE | NE | 0.03 (0.01) | -0.01 (0.005) | 0.08 (0.02) |

# CONCLUSIONS

Autonomic impairment contributes to overall risk of cardiovascular disease

Direct or indirect effects of autonomic impairment were shown for all glucose regulation variables

No effect was found of autonomic impairment on lipid profile variables

# OUTLINE

Prevalence of cardiovascular autonomic dysfunction

Contribution of autonomic dysfunction to cardiovascular disease risk

Waist circumference: the best marker for obesity after SCI

ECG-based predictors for cardiac arrhythmias after SCI

# WAIST CIRCUMFERENCE: THE BEST MARKER FOR OBESITY

Problems with existing obesity indices:

Challenging measurements

General cut-off values

Edwards et al. 2008

# AIM

To identify the best marker for obesity-related CVD risk for those with SCI, considering:

i. practicality of use

ii. ability to detect adiposity and CVD risk

# STUDY METHODS

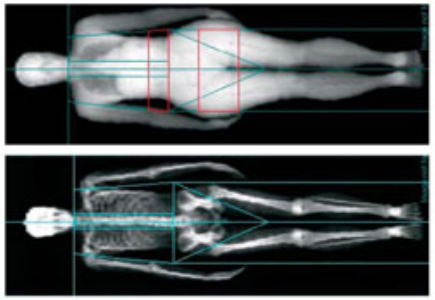
27 participants with chronic SCI

Anthropometric measures:

- Waist circumference (WC)
- Waist-to-height ratio (WHtR)
- Waist-to-hip ratio (WHR)
- BMI
- Neck circumference

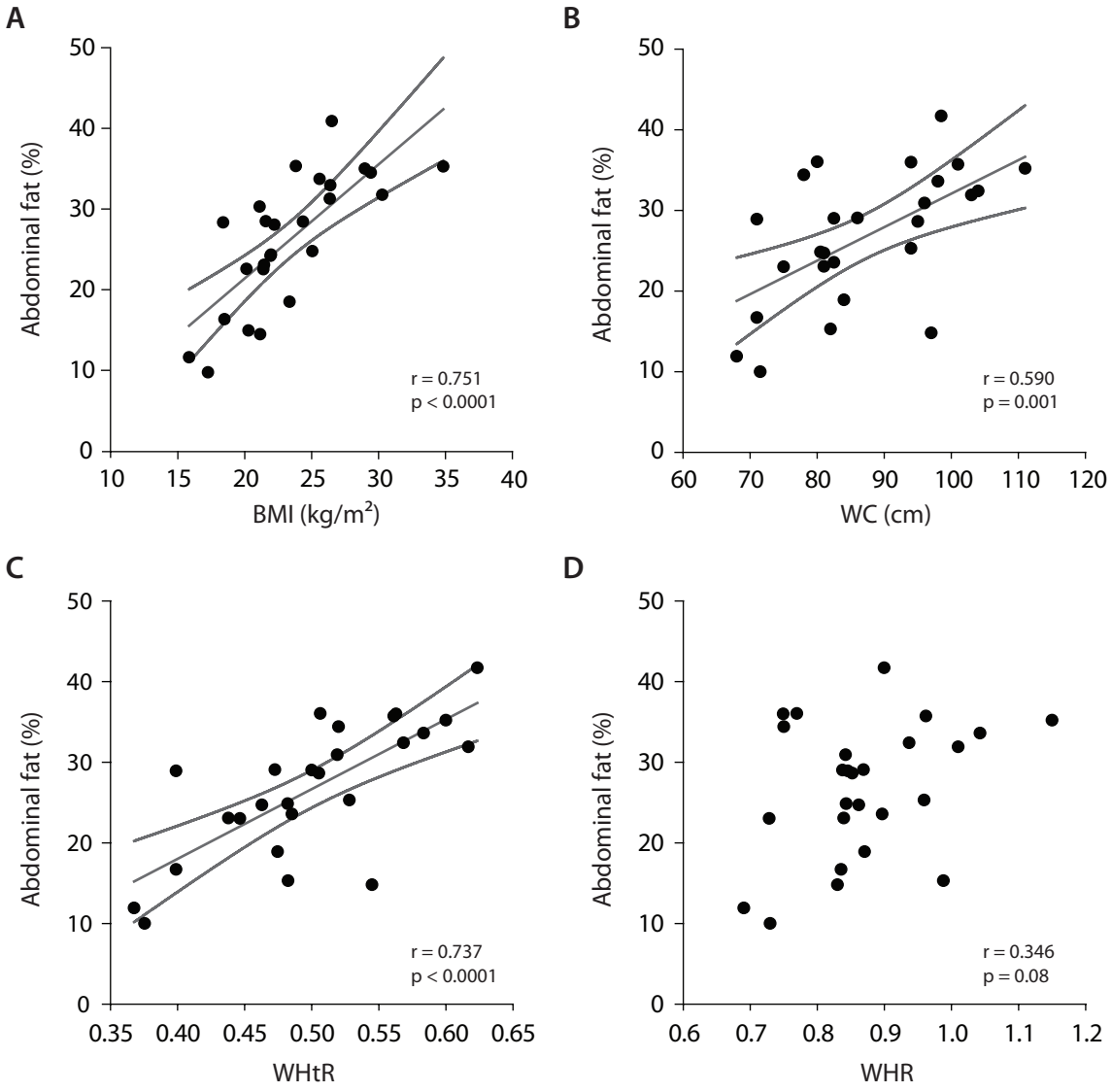
Body composition (DEXA):

- Fat percentage
- Abdominal fat percentage

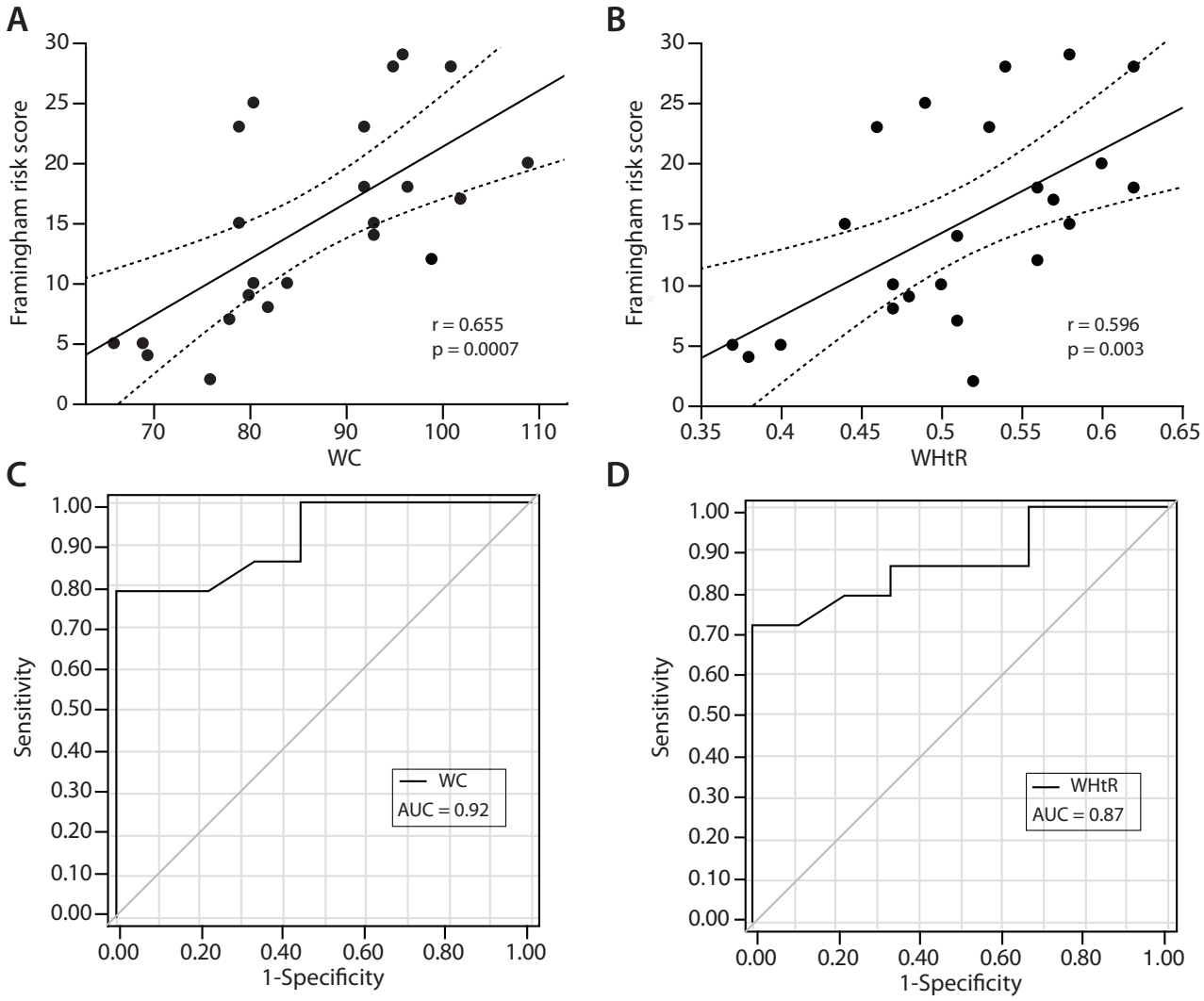


Framingham cardiovascular disease risk score

# BMI, WC AND WHtR ARE CORRELATED WITH ABDOMINAL FAT PERCENTAGE



# WC CORRELATED BEST WITH RISK SCORE



# CONCLUSIONS

Waist circumference is the best measure: simple and sensitive

Optimal cut-off from this sample: 94 cm

# GENERAL CONCLUSIONS

Cardiovascular autonomic dysfunction especially prevalent in those with high level lesions and it does not show improvement into the chronic stage

Autonomic dysfunction plays a role in the increased risk of cardiovascular disease

Important to quantify autonomic impairment as part of the standard assessment

Waist circumference (with a specific cut off) is the best, simple index for obesity-related cardiovascular disease risk

ECG parameters Tp-Te, QTVI and P-wave variability could be used to determine susceptibility to cardiac arrhythmias

# THANK YOU

## SFU Cardiovascular Physiology Lab:

Victoria Claydon

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Inderjeet Sahota
Brett Shaw
Mike Walsh

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