Shiftwork and cardiometabolic outcomes

Dr Anil Adisesh
FACULTY/PRESENTER DISCLOSURE

• Faculty: Dr Anil Adisesh

• Relationships with commercial interests:
  - None
Aims

1) Participants will be able to describe the features of metabolic syndrome
2) Participants will be able to discuss the impact of shiftwork on cardiovascular outcomes
3) Participants will be able to compare and contrast the effects of physical activity and sedentary behaviour at work on cardiovascular outcomes.
Mail Online
Shift work ‘ruins men's sex lives and makes it harder for them to father children’

CBC news Health
How delaying meal times can affect your body clock
Timed meal changes could help shift workers who make up about 20% of workforce
By Amina Zafar, CBC News
Published: Jun 01, 2017 9:40 PM ET

The Atlantic
How Night Shifts Perpetuate Health Inequality
Methods for approaching them as safely as possible

The Tribune
Female police officers handle shift work better

5
SHIFT WORK

“The standard workday unfolds during an 8-5 timeframe”
SHIFT WORK

“night shifts at least 3 h of work between 24:00 and 05:00”
“Any work that takes place outside of normal working hours.”
SHIFT WORK

“Any worker who typically works two or three hours of his/her work ‘day’ during the night (approximately 6pm – 6 am).”
SHIFT WORK

Four categories of shift workers are: evening, night, rotating and irregular. (Statistics Canada 2002)
SHIFT WORK

• A regular evening shift refers to work beginning after 3:00 p.m. and ending before midnight.
• A regular night shift refers to work beginning after 11:00 p.m. and ending before 11:00 am.
• A rotating shift changes periodically from days to evenings or to nights.
• A split shift, or irregular shift has two or more distinct periods each day; e.g., a bus driver working from 6:30 a.m. to 10:30 a.m. and from 2:00 to 6:00 p.m.
CPTP : Canada’s Largest Population Cohort Study
CPTP: Regional Cohorts
Participant Consent

Participants gave expressed consent for their information & biological samples to be:

– collected, stored, and used for research by Canadian and International researchers
– enriched with linkage to provincial administrative health databases, Vital Statistics, and Cancer Registries
– updated with linkage data for the next 30 years re-contacted as needed for study updates and future research projects.
Baseline Questionnaire Domains

- Demographics (incl. postal code)
- Education
- Medical check ups and screening
- Women’s reproductive health
- Personal medical history
- Use of prescribed medication (past year)
- Family health history
- Sleep
- Sun exposure
- Alcohol use
- Tobacco use and second hand smoke exposure
- Physical activity
- Ethnicity, country of birth (participant, parents, grandparents) and first language
- Employment – status, job title, business type, working schedule
- Income
- Height, weight & waist/hip circumferences
- Nutrition
- Mental Health (PHQ-9/GAD-7)
- Occupational & Residential History
## Data & Biosamples

<table>
<thead>
<tr>
<th>Questionnaire data</th>
<th>DNA containing samples</th>
<th>Physical measures</th>
<th>Urine samples</th>
<th>Toenail clippings</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 303,830 (<strong>35,154</strong>) participants</td>
<td>• Venous blood &gt;145,000 (<strong>23,343</strong>)</td>
<td>• Up to 90,954 (<strong>21,453</strong>) participants</td>
<td>• 101,379 (<strong>11,324</strong>) participants</td>
<td>• 32,418 participants of Atlantic PATH</td>
</tr>
<tr>
<td>• Demographics</td>
<td>• Blood spots 31,597 (<strong>12,013</strong>)</td>
<td>• Height</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Lifestyle</td>
<td>• Saliva &gt;27,000 (<strong>8,373</strong>)</td>
<td>• Weight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Risk factors</td>
<td></td>
<td>• Waist &amp; hip circumferences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Health history</td>
<td></td>
<td>• Grip strength</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Follow-up questionnaires in progress</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
31173 participants aged 35-69 years (9438 men and 21735 women)

3380 age ≥ 65 years
40 current pregnancy
90 missing key variables
3494 total

27679 participants

6712 unemployed, unpaid, retired, homework, student, or missing
6852 missing working schedule
96 missing education
7095 total

20584 participants (4155 shiftworkers and 16429 nonshiftworkers)

1:2 matching according to age (≤2 years), sex, and education

12413 participants (4155 shiftworkers and 8258 matched nonshiftworkers)
Question on current employment included in the Atlantic Path Questionnaire

Which one of the following best describes your working schedule in your current job?

A night shift is work during the early hours of the morning, after midnight. An evening shift is work during the evening ending at or before midnight. Choose one only.

- Regular daytime schedule or shift
- Regular evening shift
- Regular night shift
- Rotating shift, changing periodically from days to evenings or to nights
- Split shift, consisting of two or more distinct periods each day
- Irregular schedule or on call
- Other, please specify_________________________________________
Method of Data Analysis

Responses were grouped into four categories of shift workers:

1. Regular day-time worker
2. Day-time shift worker
3. Evening or occasional night shift worker
   *Includes:* regular evening shift
   rotating shift
   split shift
   irregular or on call
4. Regular night shift worker
Method of Data Analysis

multivariable regression analysis: adjusted for socio-demographic and behavioural factors, and chronic disease status where appropriate (province, ethnicity, marital status, BMI)
Shift workers compared with non-shift workers

37.2 (95% CI, 35.6, 38.8) v 37.5 (36.0, 39.1) P= 0.068 on a Healthy Eating Index

7.13 (7.00, 7.25) v 7.10 (6.98, 7.22) P= 0.209 hours/day Sleep duration
Male shift workers 6.92 (6.68, 7.16) v 6.94 (6.71, 7.18) P= 0.489
Female shift workers 7.21 (7.06, 7.35) v 7.15 (7.00, 7.29) P= 0.05

41.9% v 31.3% engage in high levels of physical activity
Male shift workers 36% (1.19-1.56) more likely to be physically active
Female shift workers 69% (1.54-1.86) more likely to be physically active

5.03 (4.70, 5.36) hours v 5.76 (5.43, 6.08) P<0.001 sitting time per day
Male shift workers 5.1 (4.4, 5.7) v 5.4 hours (4.7, 6.1) P<0.001
Female shift workers 4.96 (4.58, 5.34) v 5.89 (5.52, 6.26) P<0.001
Sedentary Time and Its Association With Risk for Disease Incidence, Mortality, and Hospitalization in Adults
A Systematic Review and Meta-analysis

Type 2 diabetes Incidence

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Incidence Rate</th>
<th>95% CI</th>
<th>Risk Ratio</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dunstan et al, 2005 (5)</td>
<td>Australia</td>
<td>2.340</td>
<td>(1.407–3.892)</td>
<td>3.276</td>
<td>0.001</td>
</tr>
<tr>
<td>Hu et al, 2003 (49)</td>
<td>United States</td>
<td>1.770</td>
<td>(1.242–2.523)</td>
<td>3.156</td>
<td>0.002</td>
</tr>
<tr>
<td>Krishnan et al, 2009 (50)</td>
<td>United States</td>
<td>1.860</td>
<td>(1.542–2.243)</td>
<td>6.492</td>
<td>0.000</td>
</tr>
<tr>
<td>Ford et al, 2010 (51)</td>
<td>United States</td>
<td>1.840</td>
<td>(1.319–2.567)</td>
<td>3.587</td>
<td>0.000</td>
</tr>
<tr>
<td>Hu et al, 2001 (6)</td>
<td>United States</td>
<td>2.870</td>
<td>(1.459–5.646)</td>
<td>3.054</td>
<td>0.002</td>
</tr>
<tr>
<td>Knapp–Hartung estimator</td>
<td></td>
<td>1.91</td>
<td>(1.64–2.22)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Heterogeneity ($I^2 = 0.000; P = 0.68; Q = 2.306$)

Biswa's Ann Intern Med. 2015
Multivariable adjusted sitting time by shiftwork

- Non-shiftworker
- Day-time shiftworker
- Evening shiftworker
- Regular night shiftworker
Shift workers compared with non-shift workers

Body mass index, kg/m²

29.6 (95% CI, 28.9, 30.4) v 29.2 (95% CI, 28.4, 29.9) P<0.001 All

30.6 (95% CI, 29.1, 32.2) v 30.1 (95% CI, 28.6, 31.6) P=0.004 Male shift workers

29.4 (95% CI, 28.5, 30.3) v 29.0 (95% CI, 28.1, 29.9) P=0.010 Female shift workers
Multivariable adjusted odds ratios (95% confidence intervals) obesity and abdominal obesity by sex in shiftworkers v. non-shiftworkers

<table>
<thead>
<tr>
<th></th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obesity</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.30 (1.12, 1.50)</td>
</tr>
<tr>
<td>Female</td>
<td>1.13 (1.02, 1.25)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Abdominal obesity</strong></th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1.20 (1.03, 1.39)</td>
</tr>
<tr>
<td>Female</td>
<td>1.07 (0.97, 1.18)</td>
</tr>
</tbody>
</table>
Thin outside fat inside

“TOFI” thin-outside-fat-inside

“Skinny Fat”
Shift workers compared with non-shift workers

Fat mass index, kg/m$^2$

11.2 (10.5, 12.0) v 10.9 (10.2, 11.7) P=0.003 All
11.9 (10.0, 13.8) v 11.7 (9.7, 13.6) P=0.173 Males
11.1 (10.2, 11.9) v 10.7 (9.9, 11.5) P=0.005 Females

- BMI does not always reflect true body fatness—low muscle and high body fat
- increased body fat and normal BMI
- normal weight obesity associated with MetS and insulin resistance
### Medical conditions and shiftwork - all subjects

<table>
<thead>
<tr>
<th>Condition</th>
<th>Non-shift work (n)</th>
<th>Shift work (n)</th>
<th>BMI Corr. OR (CI 95)</th>
<th>Fat Mass Index Corr. OR (CI 95)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>363/8253</td>
<td>237/4155</td>
<td>1.28 (1.07, 1.53)</td>
<td>1.28 (1.02, 1.60)</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>2394/8253</td>
<td>1211/4155</td>
<td>0.99 (0.91, 1.08)</td>
<td>0.98 (0.88, 1.09)</td>
</tr>
<tr>
<td>Depression</td>
<td>955/5844</td>
<td>523/2801</td>
<td>1.10 (0.97, 1.25)</td>
<td>1.05 (0.89, 1.23)</td>
</tr>
</tbody>
</table>

Self-reported diabetes mellitus.
Self-reported coronary heart disease, stroke, or hypertension or systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg.
PHQ-9 ≥ 10 and/or current use of antidepressants.
Medical conditions and shiftwork - males only

<table>
<thead>
<tr>
<th>Condition</th>
<th>Non-shift work (n)</th>
<th>Shift work (n)</th>
<th>BMI Corr. OR (CI 95)</th>
<th>Fat Mass Index Corr. OR (CI 95)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>156/2697</td>
<td>98/1375</td>
<td>1.28 (0.97, 1.69)</td>
<td>1.14 (0.79, 1.63)</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>922/2697</td>
<td>468/1375</td>
<td>0.97 (0.84, 1.12)</td>
<td>0.95 (0.79, 1.14)</td>
</tr>
<tr>
<td>Depression</td>
<td>194/1918</td>
<td>106/984</td>
<td>0.93 (0.71, 1.21)</td>
<td>0.87 (0.61, 1.23)</td>
</tr>
</tbody>
</table>

Self-reported diabetes mellitus.
Self-reported coronary heart disease, stroke, or hypertension or systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg.
PHQ-9 ≥ 10 and/or current use of antidepressants.
Medical conditions and shiftwork - females only

<table>
<thead>
<tr>
<th>Condition</th>
<th>Non-shift work (n)</th>
<th>Shift work (n)</th>
<th>BMI Corr. OR (CI 95)</th>
<th>Fat Mass Index Corr. OR (CI 95)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td>207/5556</td>
<td>139/2780</td>
<td>1.27 (1.00, 1.60)</td>
<td>1.39 (1.04, 1.85)</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>1472/5556</td>
<td>743/2780</td>
<td>0.99 (0.89, 1.11)</td>
<td>1.00 (0.87, 1.13)</td>
</tr>
<tr>
<td>Depression</td>
<td>761/3926</td>
<td>417/1817</td>
<td>1.20 (1.04, 1.38)</td>
<td>1.12 (0.94, 1.34)</td>
</tr>
</tbody>
</table>

Self-reported diabetes mellitus.
Self-reported coronary heart disease, stroke, or hypertension or systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg.
PHQ-9 ≥ 10 and/or current use of antidepressants.
### Medical conditions and shiftwork category

<table>
<thead>
<tr>
<th>Condition</th>
<th>Day Shift work (n)</th>
<th>Evening Shift work (n)</th>
<th>Night Shift work OR (CI 95)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (CI 95)</td>
<td>OR (CI 95)</td>
<td></td>
</tr>
<tr>
<td><strong>Diabetes</strong></td>
<td>134/2387</td>
<td>27/322</td>
<td>76/1446</td>
</tr>
<tr>
<td></td>
<td>1.27 (1.00, 1.61)</td>
<td>1.85 (1.02, 3.36)</td>
<td>1.18 (0.86, 1.60)</td>
</tr>
<tr>
<td></td>
<td>1.27 (0.95, 1.69)</td>
<td>1.92 (0.93, 3.95)</td>
<td>1.13 (0.75, 1.71)</td>
</tr>
<tr>
<td><strong>Cardiovascular disease</strong></td>
<td>710/2387</td>
<td>106/322</td>
<td>395/1446</td>
</tr>
<tr>
<td></td>
<td>0.97 (0.86, 1.09)</td>
<td>1.15 (0.85, 1.57)</td>
<td>0.99 (0.85, 1.15)</td>
</tr>
<tr>
<td></td>
<td>0.95 (0.83, 1.08)</td>
<td>1.26 (0.85, 1.85)</td>
<td>1.02 (0.84, 1.23)</td>
</tr>
<tr>
<td><strong>Depression</strong></td>
<td>290/1679</td>
<td>46/206</td>
<td>187/916</td>
</tr>
<tr>
<td></td>
<td>1.05 (0.89, 1.24)</td>
<td>1.09 (0.71, 1.68)</td>
<td>1.18 (0.96, 1.45)</td>
</tr>
<tr>
<td></td>
<td>0.97 (0.79, 1.19)</td>
<td>1.21 (0.67, 2.20)</td>
<td>1.21 (0.91, 1.60)</td>
</tr>
</tbody>
</table>

Self-reported diabetes mellitus.
Self-reported coronary heart disease, stroke, or hypertension or systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg.
PHQ-9 ≥ 10 and/or current use of antidepressants.
Study team: Ellen Sweeney, Michael Yu, Trevor Dummer, Yong Sung Cui, V DeClercq, C Forbes, Scott Grandy, Melanie Keats, Louise Parker, Anil Adisesh

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Metabolic Syndrome

Metabolic syndrome is a clustering of risk factors that increase a person’s risk of cardiovascular disease and type 2 diabetes.¹ Metabolic syndrome is defined as having any three of the following criteria:¹

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Cut-off for men</th>
<th>Cut-off for women</th>
</tr>
</thead>
<tbody>
<tr>
<td>High waist circumference (or abdominal obesity)</td>
<td>Waist circumference ≥102 cm</td>
<td>Waist circumference ≥88 cm</td>
</tr>
<tr>
<td>High plasma triglycerides</td>
<td>≥1.7 mmol/L</td>
<td>≥1.7 mmol/L</td>
</tr>
<tr>
<td>High fasting blood glucose</td>
<td>≥5.6 mmol/L</td>
<td>≥5.6 mmol/L</td>
</tr>
<tr>
<td>Low high-density lipoprotein cholesterol</td>
<td>&lt;1.03 mmol/L</td>
<td>&lt;1.30 mmol/L</td>
</tr>
<tr>
<td>High blood pressure</td>
<td>≥130/85 mmHg</td>
<td>≥130/85 mmHg</td>
</tr>
</tbody>
</table>

Note: The use of medication for any of the above criteria is considered as meeting the specific criterion.

Current Recommended Waist Circumference Thresholds for Abdominal Obesity by Organization

<table>
<thead>
<tr>
<th>Population</th>
<th>Organization (Reference)</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europid</td>
<td>IDF (4)</td>
<td>≥94 cm</td>
<td>≥80 cm</td>
</tr>
<tr>
<td>Caucasian</td>
<td>WHO (7)</td>
<td>≥94 cm (increased risk)</td>
<td>≥80 cm (increased risk)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥102 cm (still higher risk)</td>
<td>≥88 cm (still higher risk)</td>
</tr>
<tr>
<td>United States</td>
<td>AHA/NHLBI (ATP III)* (5)</td>
<td>≥102 cm</td>
<td>≥88 cm</td>
</tr>
<tr>
<td>Canada</td>
<td>Health Canada (8,9)</td>
<td>≥102 cm</td>
<td>≥88 cm</td>
</tr>
<tr>
<td>European</td>
<td>European Cardiovascular Societies (10)</td>
<td>≥102 cm</td>
<td>≥88 cm</td>
</tr>
<tr>
<td>Asian (including Japanese)</td>
<td>IDF (4)</td>
<td>≥90 cm</td>
<td>≥80 cm</td>
</tr>
<tr>
<td>Asian</td>
<td>WHO (11)</td>
<td>≥90 cm</td>
<td>≥80 cm</td>
</tr>
<tr>
<td>Japanese</td>
<td>Japanese Obesity Society (12)</td>
<td>≥85 cm</td>
<td>≥90 cm</td>
</tr>
<tr>
<td>China</td>
<td>Cooperative Task Force (13)</td>
<td>≥85 cm</td>
<td>≥80 cm</td>
</tr>
<tr>
<td>Middle East, Mediterranean</td>
<td>IDF (4)</td>
<td>≥94 cm</td>
<td>≥80 cm</td>
</tr>
<tr>
<td>Sub-Saharan African</td>
<td>IDF (4)</td>
<td>≥94 cm</td>
<td>≥80 cm</td>
</tr>
<tr>
<td>Ethnic Central and South American</td>
<td>IDF (4)</td>
<td>≥90 cm</td>
<td>≥80 cm</td>
</tr>
</tbody>
</table>

*Recent AHA/NHLBI guidelines for metabolic syndrome recognize an increased risk for CVD and diabetes at waist-circumference thresholds of ≥94 cm in men and ≥80 cm in women and identify these as optional cut points for individuals or populations with increased insulin resistance.
Cardiometabolic effect of shift work

**strong evidence**
- body weight gain
- risk of overweight
- Impaired glucose tolerance

**insufficient evidence**
- Other metabolic outcomes, including lipid metabolism and blood pressure.

2 billion persons worldwide are now overweight or obese (Global Burden of Disease Study 2013)
The world is getting heavier, and America leads the way

The average weight of the world’s population became about 3.3 pounds heavier each decade over the last 40 years. According to *The Lancet*, “If post-2000 trends continue, the probability of meeting the global obesity target is virtually zero.” Among all high-income countries, the United States has the highest obesity rate.

NCD Risk Factor Collaboration (NCD-RisC); Projections: *The Lancet* 2015; 387:1377-96
• Shift schedules should minimise insufficient sleep and circadian disruption, forward and rapid rotation, a minimum of 11 hours recovery time between shifts, avoid long weekly working hours (<60 hours) and work shifts (<10 hours)
• Offer workers a high degree of working time control, regulate excessive working hours (including overtime and double work)
• Regularly screen for clinical sleep disorders
• Educate workers on strategies to mitigate acute sleep and fatigue problems, protect long term health:
  —Knowledge on sleep hygiene; prioritization of sleep and recovery before, during, and after work periods; napping before and during night shifts
  —Knowledge of how to use caffeine and bright light exposure at night to promote adaptation and performance
  —A healthy lifestyle: healthy diet, limited night time eating, physical activity, avoidance of smoking and excessive alcohol intake
**Primary prevention**
legislation and enforcement
organisational policy
education

**Secondary prevention**
health screening & treatment
encouraging health behaviours
modified work schedules

**Tertiary prevention**
chronic disease management

**Primordial prevention**
Management of societal 24/7 expectations?
Thank you,

Dr. Anil Adisesh

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