RESEARCH FINDINGS October 2010

# HOW DOES EMPLOYMENT AFFECT CARDIOVASCULAR RISK? A LIFE-COURSE APPROACH IN THE 1958 COHORT

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Being in work is generally believed to be good for health (Black, 2008). However, working patterns and conditions can also influence health. For example, night work is estimated to increase the risk of coronary heart disease (CHD) by 40% (Bøggild and Knutsson, 1999). Studies have also reported associations for long work hours with several cardiovascular outcomes, but the evidence is inconsistent (van der Hulst, 2003).

There are several ways in which such workplace factors could increase the risk of cardiovascular disease (CVD).

(i) Direct metabolic disturbances due to insufficient recovery or sleep loss, and/or disruption of the 24-hour cycle (circadian rhythm). There is a growing literature relating sleep loss to weight gain and obesity, but whether it is a causal effect is unknown (Willyard, 2008). Levels of blood lipids and glucose are reported to be higher following consumption of a meal during the biological night compared to the same meal eaten during the biological day, suggesting circadian disruption of metabolic processes which could increase the risk of CVD (Hampton *et al.*, 1996).

(ii) Changes in health behaviours (e.g. diet, physical activity) (Knutsson and Bøggild, 2000). Health behaviours accounted for 32% of the association between work stress and CHD in British civil servants (Chandola *et al.*, 2008).

(iii) Neuroendocrine effects of work stress: workplace factors could influence CVD through neuroendocrine responses to stress if abnormal cortisol secretion patterns are involved in the development of the metabolic syndrome and CVD as suggested (Bjorntorp and Rosmond, 2000). Studies have reported dysregulation of cortisol secretion in association with night-work (Weibel *et al.*, 1996).

(iv) Confounding by early life circumstances: individuals who experience an unfavourable social environment in early life are at greater risk of CVD independent of their circumstances in adulthood, therefore associations for workplace factors could be due to circumstances earlier in life (Hemmingsson and Lundberg, 2006).

This research used data from the 1958 British birth cohort (National Child Development Study) collected up to age 45 years. This document presents the results from the project in three areas:

- whether associations between shift work and CVD risk factors were mediated by health behaviours;
- whether associations between night work, long working hours (>48hours per week) and risk factors for CVD were explained by pre-employment factors; and
- whether night work or long working hours influenced cortisol secretion.

## Key findings

The key findings of the project are as follows:

- Regular night work was related to adverse levels of a range of biological CVD risk factors in mid-life which were partially explained by socioeconomic factors and health behaviours.
- Working more than 48 hours per week was associated with an increased waist circumference.
- A substantial proportion of the relationships were explained by early life risk factors for CVD reflecting social and health disadvantage originating earlier in life.
- Cortisol secretion was elevated in night workers and lower in men working more than 48 hours per week.

## Workplace factors and CVD risk factors

The distribution of workplace exposures is presented in Table 1. About 20% worked >48 hours per week and 56% worked outside the standard working day at least once a week. Evening work was most common for both men and women (54% and 37% respectively) and 13% worked at night or early morning. 30% worked at night (10pm-7am) at least once a month. There was a substantial overlap of night and early morning shift work: about 50% of those working nights also worked mornings, while 94% and 75% of night and morning workers respectively also worked evenings (not presented).

Long working hours (>48 hours per week) was mainly associated with increased adiposity (body mass index — BMI and waist circumference — WC) (Table 2). Night-work (night or early mornings ≥1 per month) was associated with most of the CVD risk factors examined except for blood pressure and total cholesterol.

## Shift work, health behaviours and CVD risk factors

Separate analyses of shift work types showed associations primarily for night/morning work (Table 3) rather than evening or weekend work in men. Adjustments for socio-economic and occupational factors explained a large proportion of the associations. Health behaviours per se (diet, physical activity, smoking, alcohol consumption) did not explain much of the observed associations, although adiposity explained a large proportion of the blood based measures, such as triglyceride. Findings for women were similar but weaker (data not presented).

| | Men Number (%) | Women Number (%) | Overall Number (%) |
|---|---|---|---|
| **Total hours worked/week** | | | |
| <35 | 150 (4.0) | 1,639 (46.5) | 1,789 (24.6) |
| 35-40 | 1,428 (38.0) | 1,234 (35.0) | 2,662 (36.5) |
| 41-48 | 878 (23.3) | 331 (9.4) | 1,209 (16.6) |
| >48 | 1,305 (34.7) | 323 (9.2) | 1,628 (22.3) |
| **Shift work ≥1/week, 42 years** | | | |
| Any shift work* | 2,543 (65.8) | 1,498 (45.1) | 4,041 (56.2) |
| Night (2200-0400) | 615 (15.9) | 324 (9.8) | 939 (13.0) |
| Morning (0400-0700) | 729 (18.9) | 270 (8.1) | 999 (13.9) |
| Evening (1800-2200) | 2,091 (54.1) | 1,220 (36.8) | 3,311 (46.1) |
| Weekend | 1,266 (32.7) | 778 (23.4) | 2,044 (28.5) |

**TABLE 1. CHARACTERISTICS OF 4,132 MALE AND 3,784 FEMALE MEMBERS OF THE 1958 COHORT WHO WERE IN PAID EMPLOYMENT AT 45 YEARS**
* Outside the hours of 0700 and 1800 or on weekends.

| | Hours worked per week | | | | Night or early morning work | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean[a] | | | | Mean[a] | | | |
| | ≤48h | >48h | Difference (95%CI)[b] | Adjusted difference (95%CI)[c] | < 1/ month | ≥ 1/ month | Difference (95%CI)[b] | Adjusted difference (95%CI)[c] |
| BMI (kg/m²) | 27.2 | 27.9 | 0.31 (0.02, 0.61)* | 0.30 (-0.02, 0.61) | 27.2 | 27.9 | 0.38 (0.11, 0.66)* | 0.35 (0.07, 0.63)* |
| WC (cm) | 90.6 | 96.5 | 0.97 (0.23, 1.72)* | 1.00 (0.22, 1.79)* | 90.8 | 95.3 | 0.71 (0.02, 1.39)* | 0.58 (-0.11, 1.27) |
| SBP (mmHg) | 125.7 | 130.2 | -0.51 (-1.55, 0.53) | -0.16 (-1.24, 0.92) | 126.2 | 128.9 | -0.13 (-1.08, 0.81) | -0.12 (-1.07, 0.83) |
| DBP (mmHg) | 78.3 | 80.7 | -0.29 (-1.02, 0.44) | -0.17 (-0.92, 0.59) | 78.6 | 79.9 | -0.12 (-0.77, 0.52) | -0.10 (-0.75, 0.56) |
| Trig (mmol/l) | 1.62 | 1.91 | -0.31 (-4.14, 3.68) | -0.46 (-4.47, 3.72) | 1.63 | 1.85 | 4.35 (0.73, 8.10)* | 4.46 (0.78, 8.28)* |
| Chol (mmol/l) | 5.84 | 6.02 | 0.03 (-0.05, 0.11) | 0.00 (-0.08, 0.08) | 5.85 | 5.99 | 0.04 (-0.03, 0.11) | 0.05 (-0.02, 0.12) |
| HDL (mmol/l) | 1.54 | 1.45 | 0.00 (-0.02, 0.03) | 0.00 (-0.03, 0.02) | 1.54 | 1.56 | -0.03 (-0.05, 0.00)* | -0.03 (-0.05, 0.00)* |
| HbA1c (%) | 5.20 | 5.24 | 0.11 (-0.50, 0.73) | 0.24 (-0.41, 0.89) | 5.19 | 5.26 | 0.44 (-0.07, 0.95) | 0.37 (-0.14, 0.89) |
| CRP (mg/l)[d] | 0.93 | 0.92 | 1.19 (-6.19, 9.15) | 2.26 (-5.52, 10.68) | 0.91 | 0.96 | 7.98 (0.83, 15.65)* | 7.56 (0.34, 15.31)* |
| Fib (g/l)[d] | 2.94 | 2.89 | 0.01 (-0.03, 0.05) | 0.02 (-0.02, 0.06) | 2.93 | 2.92 | 0.04 (0.00, 0.08)* | 0.04 (0.00, 0.07) |

**TABLE 2. MEAN LEVELS OF CVD RISK FACTORS BY WORKPLACE FACTORS** *p<0.05.

a For triglycerides, HbA1c and CRP geometric means and percentage differences are presented.
b Adjusted for sex. SBP, DBP and triglycerides are also adjusted for time of day; HbA1c is adjusted for type 1 and type 2 diabetes treatment. Weighted for non-response at 45 years.
c Additional adjustment for hours worked/week or night/early morning work (whichever appropriate), job control and job demands.
d CRP excludes values >10mg/L (n=154) and Fib excludes values >5g/L (n=9).

| Outcome | Unadjusted | Adjustments | | | | | |
|---|---|---|---|---|---|---|---|
| | | Confounders[a] | % | Health behaviours[b] | % | All | % |
| BMI | 0.086 (0.045, 0.126) | 0.058 (0.012, 0.103) | -33 | 0.089 (0.048, 0.129) | 3 | 0.060 (0.015, 0.105) | -30 |
| WC | 0.060 (0.025, 0.096) | 0.046 (0.006, 0.085) | -23 | 0.063 (0.027, 0.098) | 5 | 0.051 (0.011, 0.090) | -15 |
| Triglyceride[c] | 0.057 (0.007, 0.107) | 0.051 (-0.005, 0.107) | -11 | 0.014 (-0.033, 0.061) | -75 | 0.025 (-0.027, 0.077) | -56 |
| HDL | -0.059 (-0.107, -0.011) | -0.076 (-0.130, -0.023) | 29 | 0.006 (-0.038, 0.050) | -110 | -0.024 (-0.072, 0.025) | -59 |
| HbA1c[d] | 0.057 (0.011, 0.103) | 0.025 (-0.023, 0.074) | -56 | 0.026 (-0.019, 0.070) | -54 | 0.005 (-0.042, 0.053) | -91 |
| CRP | 0.091 (0.045, 0.136) | 0.076 (0.025, 0.126) | -16 | 0.044 (0.003, 0.085) | -52 | 0.052 (0.007, 0.098) | -43 |
| Fibrinogen | 0.062 (0.013, 0.111) | 0.037 (-0.018, 0.092) | -40 | 0.014 (-0.033, 0.061) | -77 | 0.010 (-0.042, 0.062) | -84 |

**TABLE 3. DIFFERENCES IN CVD BIOMARKER SD SCORES (95% CI) PER UNIT INCREASE IN NIGHT/MORNING WORK WITH ADJUSTMENTS FOR CONFOUNDERS AND HEALTH BEHAVIOURS IN MEN**

Index of night/morning work is sum of participation in night and early morning work ∃/week (range 0-2).
a social class, total hours worked/week, employee or self employed, evening/weekend work index.
b physical activity, diet, smoking and alcohol (plus BMI and WC in blood marker models).
c adjusted for time of day.
d adjusted for diabetes treatment.
% change calculated as 100X(coeffadj-coeffunadj/coeffunadj).

## The role of early life (pre-employment) factors

The relationships between work factors and adiposity, triglycerides and CRP (the relevant associations identified from Table 2) were reduced by 30-50% when early life factors were taken into account (Table 4). BMI at 16 years was a key explanatory factor for the night-work relationships.

| | Model I | Model II | %* |
|---|---|---|---|
| BMI (kg/m2) | | | |
| >48 h/week | 0.30 (-0.02, 0.61) | 0.23 (-0.04, 0.50) | -23 |
| Night work | 0.35 (0.07, 0.63) | 0.14 (-0.11, 0.38) | -60 |
| WC (cm) | | | |
| >48 h/week | 1.00 (0.22, 1.79) | 0.71 (0.01, 1.41) | -29 |
| Night work | 0.58 (-0.11, 1.27) | 0.14 (-0.49, 0.77) | -76 |
| Triglycerides (% change) | | | |
| Night work | 4.46 (0.78, 8.28) | 3.00 (-0.58, 6.59) | -33 |
| C-reactive protein (% change) | | | |
| Night work | 7.56 (0.34, 15.31) | 4.15 (-2.68, 10.99) | -45 |

**TABLE 4. DIFFERENCE IN MEAN LEVELS OF RISK FACTORS (95%CI) FOR NIGHT WORK AND LONG WORK HOURS WITH ADJUSTMENTS FOR EARLY LIFE CVD RISK FACTORS**

Model 1: adjusted for sex, night work or work hours (whichever relevant), job control, job demands.
Model II: model I with adjustment for early life factors.
Missing confounder data imputed and the sample is weighted for non-response at 45years.
* % change calculated as 100X(coeffII-coeffI/coeffI).

## Neuroendocrine effects of work factors

Cortisol was measured on the same day at two time points (45 minutes and 3 hours after waking) to capture the initial peak and subsequent decline of cortisol secretion that occurs over the day. Night-workers had higher cortisol levels at both time points, while there was some evidence that long working hours was associated with lower cortisol levels at both time points, especially for men (data not presented).

## Conclusions

The government already recognises the health benefits of keeping people in paid employment, particularly for mental health (Black, 2008). The results from these analyses provide evidence that several mechanisms may be involved in the development of CVD risk in night-workers, but highlight that weight gain over the life-course, potentially emerging from health inequalities in early life, is a key pathway. Although there were fewer findings for extended working hours, the associations seen with waist circumference, a major risk factor for diabetes and CVD, should not be ignored.

These results taken with other studies of work and health show that particular groups of workers, such as night-workers and to a lesser extent those working >48 hours per week (i.e. above the current European Policy) are at increased risk of CVD, regardless of the underlying mechanism, and represent sub-groups of the population for which prevention could be targeted through occupational health strategies.

## References


Bjorntorp, P. and Rosmond, R. (2000) The metabolic syndrome — a neuroendocrine disorder? *British Journal of Nutrition*, 83:S49-S57.

Black, C. (2008) *Working for a Healthier Tomorrow*, The Stationary Office, London.

Bøggild, H. and Knutsson, A. (1999) Shiftwork, risk factors and cardiovascular disease, *Scandinavian Journal of Work and Environmental Health*, 25:85-99.

Chandola, T., Britton, A., Brunner, E. et al. (2008) Work stress and coronary heart disease: what are the mechanisms? *European Heart Journal*, 29:640-648.

Hampton, S.M., Morgan, L.M., Lawrence, N., *et al.* (1996) Postprandial hormone and metabolic responses in simulated shift work, *Journal of Endocrinology*, 151:259-267.
Hemmingsson, T. and Lundberg, I. (2006) Is the association between low job control and coronary heart disease confounded by risk factors measured in childhood and adolescence among Swedish males 40-53 years of age? *International Journal of Epidemiology*, 35:616-622.
Knutsson, A. and Bøggild, H. (2000) Shiftwork and cardiovascular disease: a review of disease mechanisms, *Review of Environmental Health*, 15:359-372.
van der Hulst, M. (2003) Long workhours and health, *Scandinavian Journal of Work and Environmental Health*, 29:171-188.
Weibel, L., Spiegel, K., Follenius, M., Ehrhart, J. and Brandenberger, G. (1996) Internal dissociation of the circadian markers of the cortisol rhythm in night workers, *American Journal of Physiology*, 270:E608-E613.
Willyard, C. (2008) Hungry for sleep, *Nature Medicine*, 14:477-480.

## Relevant publications by the author

Thomas, C. and Power, C. (2010) Shift work and risk factors for cardiovascular disease: a study at age 45 years in the 1958 British birth cohort. *European Journal of Epidemiology*, 25:305-14.
Thomas, C. and Power, C. (2010) Do early life exposures explain associations between workplace factors and risk factors for cardiovascular disease in mid-adulthood? *International Journal of Epidemiology*, 39:812-24.
Thomas, C., Hertzman, C. and Power, C. (2010) Night-work, long working hours, job control and cortisol secretion in mid-life: evidence from a British birth cohort. *Occupational Environmental Medicine*, 66:824-31.
Thomas, C. (2010) Effects of employment on cardiovascular risk, in Stillwell, J., Norman, P., Thomas, C. and Surridge, P. (eds.) *Spatial and Social Disparities Understanding Population Trends and Processes Volume 2*, Springer, Dordrecht, pp. 113-128.

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