## Supplementary data

**Shift work is associated with 10-year incidence of atrial fibrillation in younger but not older individuals from the general population: results from the Tromsø Study**

Victor W. Zwartkruis, Ekaterina Sharashova, Tom Wilsgaard, Rudolf A. De Boer, Maja-Lisa Løchen, Michiel Rienstra

## Contents





Zwartkruis VW, *et al. Open Heart* 2022; 9:e002086. doi: 10.1136/openhrt-2022-002086

**Table S1: Hazard ratios for the association between shift work and 10-year incidence of atrial fibrillation in the total study population. The Tromsø Study**

| Hazard ratio (95% confidence interval) | p-value |
|---|---|
| *Model 1: unadjusted* | |
| 0.91 (0.59-1.42) | 0.688 |
| *Model 2: adjusted for age and sex* | |
| 1.17 (0.76-1.81) | 0.480 |
| *Model 3: adjusted for age, sex, and CHARGE-AF risk model* | |
| 1.13 (0.72-1.75) | 0.597 |
| *Model 4: adjusted for age, sex, CHARGE-AF risk model, education level, and physical activity* | |
| 1.13 (0.72-1.77) | 0.590 |

*Hazard ratios and p-values represent the association between shift work and 10-year incident AF (number of AF cases = 129) in the total study population (n = 22 339). Components of the CHARGE-AF risk model were weight, height, systolic and diastolic blood pressure, antihypertensive drug use, diabetes, smoking, and history of myocardial infarction. AF, atrial fibrillation.*

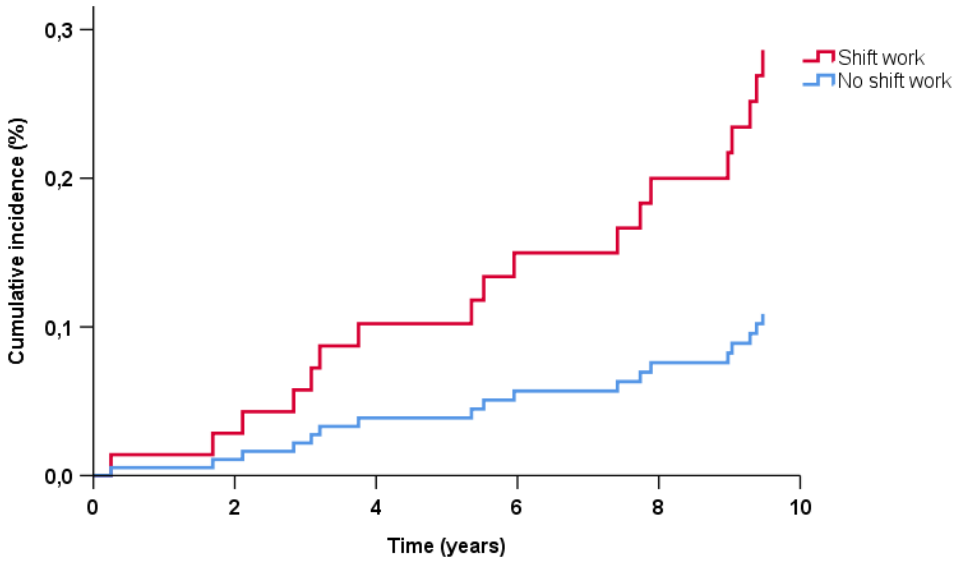


**Figure S1a:** Propensity score-adjusted Kaplan-Meier cumulative incidence plot for incident atrial fibrillation in participants <40 years with and without shift work

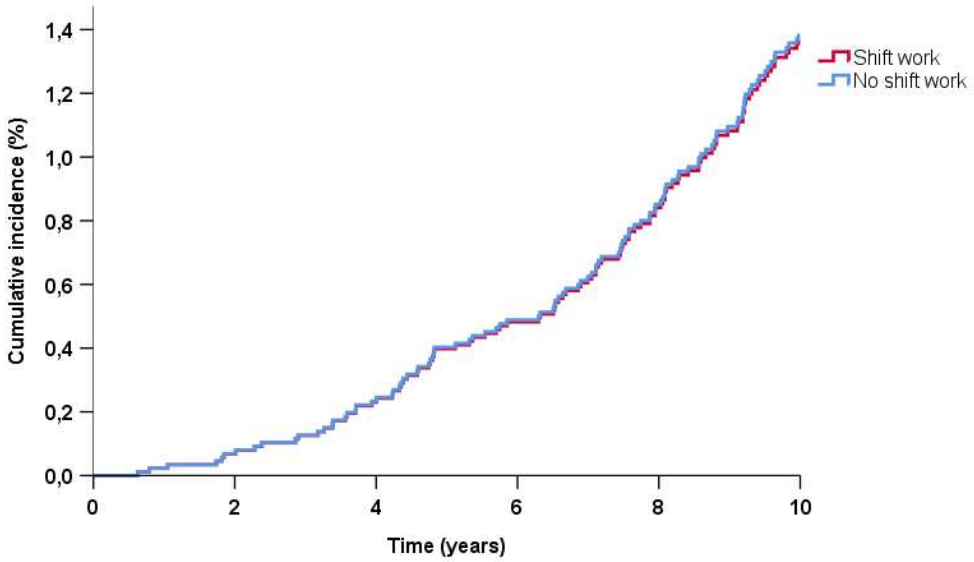


**Figure S1b:** Propensity score-adjusted Kaplan-Meier cumulative incidence plot for incident atrial fibrillation in participants ≥40 years with and without shift work

**Table S2a: Clinical characteristics of participants <40 years with and without shift work. The Tromsø Study**

| Characteristic | Shift work | | p-value |
|---|---|---|---|
| | No (n = 10 491) | Yes (n = 3220) | |
| Age (years) | 30.7 ± 5.3 | 30.3 ± 5.0 | <0.001 |
| Female sex | 5271 (50%) | 1680 (52%) | 0.055 |
| BMI (kg/m$^2$) | 23.5 ± 3.2 | 23.8 ± 3.5 | <0.001 |
| Overweight | 2393 (23%) | 779 (24%) | 0.106 |
| Obesity | 434 (4%) | 186 (6%) | <0.001 |
| SBP (mmHg) | 125.0 ± 12.9 | 123.8 ± 12.7 | <0.001 |
| DBP (mmHg) | 72.6 ± 9.4 | 71.6 ± 9.3 | <0.001 |
| Antihypertensive drug use | 52 (0.5%) | 10 (0.3%) | 0.171 |
| Hypertension | 1499 (14%) | 369 (11%) | <0.001 |
| Resting heart rate (bpm) | 71.7 ± 13.1 | 71.5 ± 12.6 | 0.334 |
| Total cholesterol (mmol/L) | 5.3 ± 1.0 | 5.3 ± 1.1 | 0.035 |
| Diabetes | 31 (0.3%) | 9 (0.3%) | 0.882 |
| History of MI | 3 (0.0%) | 4 (0.1%) | 0.057 |
| History of stroke | 11 (0.1%) | 4 (0.1%) | 0.763 |
| Current smoking | 4300 (41%) | 1541 (48%) | <0.001 |
| Sedentary lifestyle | 2536 (24%) | 840 (26%) | 0.025 |
| Highly active lifestyle | 2277 (22%) | 613 (19%) | 0.001 |
| Primary education only | 1705 (16%) | 640 (20%) | <0.001 |
| Higher education | 4929 (47%) | 1299 (40%) | <0.001 |

*Data presented as mean ± standard deviation or count (%). P-values represent the difference between participants with and without shift work at baseline. Overweight was defined as BMI 25-30 kg/m$^2$, obesity as BMI ≥ 30 kg/m$^2$, and hypertension as SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg and/or use of antihypertensive drugs. BMI, body mass index; bpm, beats per minute; DBP, diastolic blood pressure; MI, myocardial infarction; SBP, systolic blood pressure.*

**Table S2b: Clinical characteristics of participants ≥40 years with and without shift work. The Tromsø Study**

| Characteristic | Shift work | | p-value |
|---|---|---|---|
| | No (n = 7132) | Yes (n = 1496) | |
| Age (years) | 47.3 ± 6.1 | 46.9 ± 5.9 | 0.019 |
| Female sex | 3273 (46%) | 656 (44%) | 0.149 |
| BMI (kg/m$^2$) | 25.0 ± 3.5 | 25.4 ± 3.8 | <0.001 |
| Overweight | 2660 (37%) | 599 (40%) | 0.049 |
| Obesity | 589 (8%) | 160 (11%) | 0.002 |
| SBP (mmHg) | 130.5 ± 16.8 | 130.1 ± 16.7 | 0.422 |
| DBP (mmHg) | 80.0 ± 10.7 | 79.4 ± 10.7 | 0.096 |
| Antihypertensive drug use | 337 (5%) | 66 (4%) | 0.599 |
| Hypertension | 2267 (32%) | 461 (31%) | 0.437 |
| Resting heart rate (bpm) | 71.1 ± 13.4 | 71.4 ± 12.9 | 0.314 |
| Total cholesterol (mmol/L) | 6.1 ± 1.2 | 6.3 ± 1.3 | <0.001 |
| Diabetes | 65 (1%) | 12 (1%) | 0.678 |
| History of MI | 77 (1%) | 17 (1%) | 0.854 |
| History of stroke | 21 (0.3%) | 1 (0.1%) | 0.157 |
| Current smoking | 2560 (36%) | 679 (45%) | <0.001 |
| Sedentary lifestyle | 1698 (24%) | 415 (28%) | 0.001 |
| Highly active lifestyle | 1232 (17%) | 240 (16%) | 0.255 |
| Primary education only | 2621 (37%) | 674 (45%) | <0.001 |
| Higher education | 1580 (36%) | 356 (24%) | <0.001 |

*Data presented as mean ± standard deviation or count (%). P-values represent the difference between participants with and without shift work at baseline. Overweight was defined as BMI 25-30 kg/m$^2$, obesity as BMI ≥ 30 kg/m$^2$, and hypertension as SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg and/or use of antihypertensive drugs. BMI, body mass index; bpm, beats per minute; DBP, diastolic blood pressure; MI, myocardial infarction; SBP, systolic blood pressure.*

**Table S3: Hazard ratios for the association between shift work and 10-year incidence of atrial fibrillation, stratified by age category. The Tromsø Study**

| Determinant and age group | HR (95% CI) | p-value |
|---|---|---|
| *Model 1: unadjusted* | | |
| Age < 40 years | 2.65 (1.05-6.71) | 0.040 |
| Age 40-49 years | 1.07 (0.50-2.30) | 0.860 |
| Age 50-59 years | 0.98 (0.46-2.10) | 0.956 |
| Age 60-69 years | 0.33 (0.04-2.44) | 0.277 |
| *Model 2: adjusted for age and sex* | | |
| Age < 40 years | 2.90 (1.14-7.34) | 0.025 |
| Age 40-49 years | 1.03 (0.48-2.22) | 0.940 |
| Age 50-59 years | 1.06 (0.50-2.28) | 0.874 |
| Age 60-69 years | 0.36 (0.05-2.70) | 0.321 |
| *Model 3: adjusted for age, sex, and CHARGE-AF risk model* | | |
| Age < 40 years | 2.90 (1.12-7.49) | 0.028 |
| Age 40-49 years | 0.99 (0.45-2.14) | 0.971 |
| Age 50-59 years | 1.01 (0.47-2.19) | 0.973 |
| Age 60-69 years | 0.43 (0.06-3.24) | 0.411 |
| *Model 4: adjusted for age, sex, CHARGE-AF risk model, education level, and physical activity* | | |
| Age < 40 years | 2.64 (0.99-7.00) | 0.051 |
| Age 40-49 years | 0.97 (0.44-2.13) | 0.943 |
| Age 50-59 years | 1.07 (0.49-2.34) | 0.873 |
| Age 60-69 years | 0.44 (0.06-3.39) | 0.432 |

*Hazard ratios and p-values represent the association between shift work and 10-year AF in participants aged <40 years (n = 13 711, number of AF cases = 18, crude incidence = 0.1%), 40-49 years (n = 5818, number of AF cases = 44, crude incidence = 0.8%), 50-59 years (n = 2429, number of AF cases = 46, crude incidence = 1.9%), and 60-69 years (n = 378, number of AF cases = 21, crude incidence = 5.6%). Components of the CHARGE-AF risk model were weight, height, systolic and diastolic blood pressure, antihypertensive drug use, diabetes, smoking, and history of myocardial infarction. AF, atrial fibrillation; CI, confidence interval; HR, hazard ratio.*

**Table S4: Propensity score-adjusted hazard ratios for the association between shift work and 10-year incidence of atrial fibrillation, stratified by age. The Tromsø Study**

| Determinant and age group | HR (95% CI) | p-value |
|---|---|---|
| *Model 1: unadjusted* | | |
| Shift work (age < 40 years) | 2.65 (1.05-6.71) | 0.040 |
| Shift work (age ≥ 40 years) | 0.87 (0.52-1.46) | 0.601 |
| *Model 2: adjusted for propensity score* | | |
| Shift work (age < 40 years) | 2.64 (1.03-6.74) | 0.043 |
| Shift work (age ≥ 40 years) | 0.99 (0.57-1.66) | 0.962 |
| *Model 3: adjusted for propensity score and additionally adjusted for age and sex* | | |
| Shift work (age < 40 years) | 2.59 (1.00-6.73) | 0.050 |
| Shift work (age ≥ 40 years) | 0.92 (0.54-1.55) | 0.754 |

*Hazard ratios and p-values represent the association between shift work and 10-year AF in participants aged <40 years (n = 13 711, number of AF cases = 18, crude incidence = 0.1%) or participants aged ≥40 years (n = 8628, number of AF cases = 111, crude incidence = 1.3%). The propensity score was calculated using relevant clinical characteristics as included in Table 1 (age, sex, weight, height, systolic and diastolic blood pressure, antihypertensive drug use, resting heart rate, total cholesterol, diabetes, history of myocardial infarction, history of stroke, smoking, physical activity, and education level). AF, atrial fibrillation; CI, confidence interval; HR, hazard ratio.*

**Table S5: Hazard ratios for the association between shift work status at the 1st and 2nd attended survey and 10-year incidence of atrial fibrillation. The Tromsø Study**

| Determinant | HR (95% CI) | p-value |
|---|---|---|
| *Model 1: unadjusted* | | |
| No shift work at either survey | Ref. | Ref. |
| Shift work at 1st survey only | 0.81 (0.41-1.60) | 0.550 |
| Shift work at 2nd survey only | 0.45 (0.21-0.96) | 0.039 |
| Shift work at both surveys | 0.65 (0.38-1.11) | 0.111 |
| *Model 2: adjusted for age and sex* | | |
| No shift work at either survey | Ref. | Ref. |
| Shift work at 1st survey only | 1.18 (0.60-2.33) | 0.627 |
| Shift work at 2nd survey only | 0.67 (0.31-1.44) | 0.307 |
| Shift work at both surveys | 0.77 (0.45-1.31) | 0.327 |
| *Model 3: adjusted for age, sex, and CHARGE-AF risk model* | | |
| No shift work at either survey | Ref. | Ref. |
| Shift work at 1st survey only | 1.10 (0.56-2.18) | 0.780 |
| Shift work at 2nd survey only | 0.69 (0.32-1.48) | 0.344 |
| Shift work at both surveys | 0.76 (0.44-1.33) | 0.342 |
| *Model 4: adjusted for age, sex, CHARGE-AF risk model, education level, and physical activity* | | |
| No shift work at either survey | Ref. | Ref. |
| Shift work at 1st survey only | 1.10 (0.56-2.19) | 0.780 |
| Shift work at 2nd survey only | 0.72 (0.34-1.55) | 0.404 |
| Shift work at both surveys | 0.81 (0.47-1.42) | 0.468 |
| *Model 5: adjusted for propensity score* | | |
| No shift work at either survey | Ref. | Ref. |
| Shift work at 1st survey only | 1.11 (0.56-2.19) | 0.764 |
| Shift work at 2nd survey only | 0.52 (0.23-1.18) | 0.116 |
| Shift work at both surveys | 0.90 (0.53-1.55) | 0.706 |

*Hazard ratios and p-values represent the association between shift work status and 10-year incident AF (starting from the 2nd attended survey). Results are shown for participants with no shift work at either survey (reference group, n = 7731, number of AF cases = 135, crude incidence = 1.7%), with shift work at the 1st survey only (n = 670, number of AF cases = 9, crude incidence = 1.3%), with shift work at the 2nd survey only (n = 885, number of AF cases = 7, crude incidence = 0.8%), and with shift work at both surveys (n = 1306, number of AF cases = 15, crude incidence = 1.1%). Components of the CHARGE-AF risk model were weight, height, systolic and diastolic blood pressure, antihypertensive drug use, diabetes, smoking, and history of myocardial infarction. AF, atrial fibrillation; CI, confidence interval; HR, hazard ratio.*

**Table S6: Hazard ratios for the association of shift work with incident atrial fibrillation during extensive follow-up, with shift work included as a time-varying covariate. The Tromsø Study**

| Hazard ratio (95% confidence interval) | p-value |
|---|---|
| *Model 1: unadjusted* | |
| 0.70 (0.59-0.84) | <0.001 |
| *Model 2: adjusted for age and sex* | |
| 0.98 (0.82-1.16) | 0.779 |
| *Model 3: adjusted for age, sex, and CHARGE-AF risk model* | |
| 0.94 (0.79-1.12) | 0.482 |
| *Model 4: adjusted for age, sex, CHARGE-AF risk model, education level, and physical activity* | |
| 0.93 (0.78-1.12) | 0.455 |

*Hazard ratios and p-values represent the association of shift work (included as time-varying covariate) with incident AF during extensive follow-up (n = 1244) in the total study population (n = 22 339). In order to account for changes in paid work status after baseline, paid work (included as time-varying covariate) was included in all models. Components of the CHARGE-AF risk model were weight, height, systolic and diastolic blood pressure, antihypertensive drug use, diabetes, smoking, and history of myocardial infarction. AF, atrial fibrillation.*

**Table S7: Hazard ratios for the association between shift work status at the 1st and 2nd attended survey and incident atrial fibrillation during extensive follow-up. The Tromsø Study**

| Determinant | HR (95% CI) | p-value |
|---|---|---|
| *Model 1: unadjusted* | | |
| No shift work at either survey | Ref. | Ref. |
| Shift work at 1st survey only | 0.74 (0.49-1.10) | 0.138 |
| Shift work at 2nd survey only | 0.60 (0.42-0.84) | 0.003 |
| Shift work at both surveys | 0.94 (0.74-1.20) | 0.623 |
| *Model 2: adjusted for age and sex* | | |
| No shift work at either survey | Ref. | Ref. |
| Shift work at 1st survey only | 1.07 (0.71-1.60) | 0.755 |
| Shift work at 2nd survey only | 0.83 (0.59-1.17) | 0.294 |
| Shift work at both surveys | 1.07 (0.84-1.35) | 0.604 |
| *Model 3: adjusted for age, sex, and CHARGE-AF risk model* | | |
| No shift work at either survey | Ref. | Ref. |
| Shift work at 1st survey only | 0.95 (0.63-1.44) | 0.807 |
| Shift work at 2nd survey only | 0.80 (0.56-1.14) | 0.223 |
| Shift work at both surveys | 1.07 (0.84-1.37) | 0.570 |
| *Model 4: adjusted for age, sex, CHARGE-AF risk model, education level, and physical activity* | | |
| No shift work at either survey | Ref. | Ref. |
| Shift work at 1st survey only | 0.94 (0.62-1.42) | 0.752 |
| Shift work at 2nd survey only | 0.81 (0.57-1.16) | 0.248 |
| Shift work at both surveys | 1.08 (0.85-1.38) | 0.538 |
| *Model 5: adjusted for propensity score* | | |
| No shift work at either survey | Ref. | Ref. |
| Shift work at 1st survey only | 0.89 (0.59-1.34) | 0.567 |
| Shift work at 2nd survey only | 0.72 (0.51-1.02) | 0.063 |
| Shift work at both surveys | 1.18 (0.93-1.50) | 0.180 |

*Hazard ratios and p-values represent the association between shift work status and incident AF during extensive follow-up (starting from the 2nd attended survey). Results are shown for participants with no shift work at either survey (reference group, n = 7731, number of AF cases = 482, crude incidence = 6.2%), with shift work at the 1st survey only (n = 670, number of AF cases = 25, crude incidence = 3.7%), with shift work at the 2nd survey only (n = 885, number of AF cases = 35, crude incidence = 4.0%) and with shift work at both surveys (n = 1306, number of AF cases = 79, crude incidence = 6.0%). Components of the CHARGE-AF risk model were weight, height, systolic and diastolic blood pressure, antihypertensive drug use, diabetes, smoking, and history of myocardial infarction. AF, atrial fibrillation; CI, confidence interval; HR, hazard ratio.*