

## **SUPPLEMENTARY MATERIAL**

### **The effect of long-term poor sleep quality on risk of back-related disability and the modifying role of physical activity**

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**Supplementary table 1.** Risk of chronic back pain and back-related disability at follow-up in 2017-19 associated with changes in sleep quality from 1995-97 to 2006-08 and adherence to physical activity recommendations in 2006-08. People reporting use of pain medication in 1995-97 and/or 2006-08 were excluded from the analysis.

Risk of back pain and change in sleep quality from 1995-97 to 2006-08	Meeting physical activity guidelines				Not meeting physical activity guidelines			
	No. of persons	No. of cases	Age-adjusted, RR <sup>a</sup>	Multi-adjusted RR (95% CI) <sup>b</sup>	No. of persons	No. of cases	Age-adjusted, RR <sup>a</sup>	Multi-adjusted RR (95% CI) <sup>b</sup>
<b>Chronic back pain</b>								
Remained good sleep	2,742	474	1.00	1.00 (reference)	2,350	432	1.08	1.03 (0.91-1.17)
Poor sleep to good sleep	158	35	1.35	1.29 (0.93-1.79)	206	49	1.36	1.27 (0.94-1.70)
Good sleep to poor sleep	412	91	1.30	1.27 (1.03-1.57)	462	106	1.44	1.31 (1.07-1.60)
Remained poor sleep	148	35	1.57	1.40 (1.00-1.96)	182	50	1.88	1.66 (1.29-2.14)
<b>Back-related disability</b>								
Remained good sleep	2,742	178	1.00	1.00 (reference)	2,350	178	1.19	1.18 (0.95-1.46)
Poor sleep to good sleep	158	16	1.71	1.63 (0.96-2.76)	206	28	1.86	1.82 (1.18-2.82)
Good sleep to poor sleep	412	47	1.63	1.80 (1.31-2.49)	462	49	1.81	1.64 (1.18-2.28)
Remained poor sleep	148	17	1.79	1.79 (1.05-3.06)	182	28	2.35	2.18 (1.42-3.34)

Abbreviations: CI, confidence interval; RR, risk ratio

<sup>a</sup>Adjusted for age (continuous)

<sup>b</sup>Adjusted for age (continuous), sex (women, men), education (primary school, high school, college ≤4 years, college >4 years), body mass index (continuous), relative change in body weight (continuous), and smoking (never smoked, former smoker, current low-intensity smoker [ $<10$  cigarettes per day], medium-intensity smoker [10-19 cigarettes per day], high-intensity smoker [20 or more cigarettes per day])

**Supplementary table 2.** Risk of chronic back pain and back-related disability at follow-up in 2017-19 associated with changes in sleep quality from 1995-97 to 2006-08 and adherence to physical activity recommendations in 2006-08. People reporting sleep apnea and/or restless legs syndrome in 1995-97 and/or 2006-08 were excluded from the analysis.

Risk of back pain and change in sleep quality from 1995-97 to 2006-08	Meeting physical activity guidelines				Not meeting physical activity guidelines			
	No. of persons	No. of cases	Age-adjusted, RR <sup>a</sup>	Multi-adjusted RR (95% CI) <sup>b</sup>	No. of persons	No. of cases	Age-adjusted, RR <sup>a</sup>	Multi-adjusted RR (95% CI) <sup>b</sup>
<b>Chronic back pain</b>								
Remained good sleep	3,363	597	1.00	1.00 (reference)	2,861	533	1.08	1.00 (0.90-1.12)
Poor sleep to good sleep	194	46	1.35	1.34 (1.00-1.78)	250	59	1.36	1.21 (0.92-1.59)
Good sleep to poor sleep	501	112	1.30	1.23 (1.01-1.49)	560	128	1.44	1.29 (1.07-1.55)
Remained poor sleep	187	50	1.57	1.53 (1.18-2.00)	224	62	1.88	1.60 (1.28-2.01)
<b>Back-related disability</b>								
Remained good sleep	3,486	229	1.00	1.00 (reference)	3,004	218	1.19	1.09 (0.90-1.32)
Poor sleep to good sleep	207	21	1.71	1.65 (1.06-2.60)	270	32	1.86	1.75 (1.20-2.57)
Good sleep to poor sleep	557	53	1.63	1.52 (1.12-2.06)	614	58	1.81	1.55 (1.15-2.10)
Remained poor sleep	208	19	1.79	1.48 (0.90-2.44)	255	30	2.35	1.80 (1.19-2.74)

Abbreviations: CI, confidence interval; RR, risk ratio

<sup>a</sup>Adjusted for age (continuous)

<sup>b</sup>Adjusted for age (continuous), sex (women, men), education (primary school, high school, college ≤4 years, college >4 years), body mass index (continuous), relative change in body weight (continuous), and smoking (never smoked, former smoker, current low-intensity smoker [<10 cigarettes per day], medium-intensity smoker [10-19 cigarettes per day], high-intensity smoker [20 or more cigarettes per day])

**Supplementary table 3.** Risk of chronic back pain and back-related disability at follow-up in 2017-19 associated with changes in sleep quality from 1995-97 to 2006-08 and adherence to physical activity recommendations in 2006-08. Main analysis repeated with additional adjustment for physical work demands and shift work.

Risk of back pain and change in sleep quality from 1995-97 to 2006-08	Meeting physical activity guidelines				Not meeting physical activity guidelines			
	No. of persons	No. of cases	Age-adjusted, RR <sup>a</sup>	Multi-adjusted RR (95% CI) <sup>b</sup>	No. of persons	No. of cases	Age-adjusted, RR <sup>a</sup>	Multi-adjusted RR (95% CI) <sup>b</sup>
<b>Chronic back pain</b>								
Remained good sleep	3,486	636	1.00	1.00 (reference)	3,004	568	1.08	1.01 (0.91-1.13)
Poor sleep to good sleep	207	50	1.35	1.32 (1.00-1.75)	270	66	1.36	1.20 (0.92-1.56)
Good sleep to poor sleep	557	130	1.30	1.27 (1.06-1.52)	614	146	1.44	1.31 (1.10-1.55)
Remained poor sleep	208	56	1.57	1.46 (1.14-1.87)	255	75	1.88	1.66 (1.35-2.04)
<b>Back-related disability</b>								
Remained good sleep	3,486	242	1.00	1.00 (reference)	3,004	239	1.19	1.11 (0.92-1.34)
Poor sleep to good sleep	207	23	1.71	1.69 (1.11-2.60)	270	34	1.86	1.59 (1.08-2.32)
Good sleep to poor sleep	557	62	1.63	1.57 (1.18-2.08)	614	69	1.81	1.60 (1.22-2.10)
Remained poor sleep	208	25	1.79	1.63 (1.06-2.51)	255	39	2.35	2.01 (1.40-2.89)

Abbreviations: CI, confidence interval; RR, risk ratio

<sup>a</sup>Adjusted for age (continuous)

<sup>b</sup>Adjusted for age (continuous), sex (women, men), education (primary school, high school, college ≤4 years, college >4 years), body mass index (continuous), relative change in body weight (continuous), smoking (never smoked, former smoker, current low-intensity smoker [<10 cigarettes per day], medium-intensity smoker [10-19 cigarettes per day], high-intensity smoker [20 or more cigarettes per day]), physical work demands (mostly sedentary, much walking, much walking or lifting, heavy physical work), and shift work (yes, no)

**Supplementary table 4.** Risk of chronic back pain and back-related disability at follow-up in 2017-19 associated with changes in sleep quality from 1995-97 to 2006-08 and adherence to physical activity recommendations in 2006-08. Main analysis repeated with additional adjustment for comorbid condition(s).

Risk of back pain and change in sleep quality from 1995-97 to 2006-08	Meeting physical activity guidelines				Not meeting physical activity guidelines			
	No. of persons	No. of cases	Age-adjusted, RR <sup>a</sup>	Multi-adjusted RR (95% CI) <sup>b</sup>	No. of persons	No. of cases	Age-adjusted, RR <sup>a</sup>	Multi-adjusted RR (95% CI) <sup>b</sup>
<b>Chronic back pain</b>								
Remained good sleep	3,486	636	1.00	1.00 (reference)	3,004	568	1.08	1.01 (0.90-1.12)
Poor sleep to good sleep	207	50	1.35	1.30 (0.98-1.71)	270	66	1.36	1.19 (0.91-1.55)
Good sleep to poor sleep	557	130	1.30	1.27 (1.06-1.51)	614	146	1.44	1.26 (1.06-1.50)
Remained poor sleep	208	56	1.57	1.47 (1.15-1.88)	255	75	1.88	1.65 (1.34-2.01)
<b>Back-related disability</b>								
Remained good sleep	3,486	242	1.00	1.00 (reference)	3,004	239	1.19	1.10 (0.91-1.33)
Poor sleep to good sleep	207	23	1.71	1.65 (1.08-2.54)	270	34	1.86	1.57 (1.07-2.31)
Good sleep to poor sleep	557	62	1.63	1.56 (1.18-2.07)	614	69	1.81	1.52 (1.16-2.00)
Remained poor sleep	208	25	1.79	1.64 (1.07-2.51)	255	39	2.35	1.98 (1.38-2.84)

Abbreviations: CI, confidence interval; RR, risk ratio

<sup>a</sup>Adjusted for age (continuous)

<sup>b</sup>Adjusted for age (continuous), sex (women, men), education (primary school, high school, college ≤4 years, college >4 years), body mass index (continuous), relative change in body weight (continuous), smoking (never smoked, former smoker, current low-intensity smoker [ $<10$  cigarettes per day], medium-intensity smoker [10-19 cigarettes per day], high-intensity smoker [20 or more cigarettes per day]), and comorbid condition(s) (yes, no)

**Supplementary table 5.** Risk of chronic back pain and back-related disability at follow-up in 2017-19 associated with changes in sleep quality from 1995-97 to 2006-08 and adherence to physical activity recommendations in 2006-08. Main analysis repeated with additional adjustment for anxiety and/or depression.

Risk of back pain and change in sleep quality from 1995-97 to 2006-08	Meeting physical activity guidelines				Not meeting physical activity guidelines			
	No. of persons	No. of cases	Age-adjusted, RR <sup>a</sup>	Multi-adjusted RR (95% CI) <sup>b</sup>	No. of persons	No. of cases	Age-adjusted, RR <sup>a</sup>	Multi-adjusted RR (95% CI) <sup>b</sup>
<b>Chronic back pain</b>								
Remained good sleep	3,486	636	1.00	1.00 (reference)	3,004	568	1.08	1.00 (0.90-1.12)
Poor sleep to good sleep	207	50	1.35	1.30 (0.99-1.72)	270	66	1.36	1.19 (0.92-1.55)
Good sleep to poor sleep	557	130	1.30	1.23 (1.03-1.47)	614	146	1.44	1.26 (1.06-1.50)
Remained poor sleep	208	56	1.57	1.44 (1.12-1.84)	255	75	1.88	1.57 (1.27-1.94)
<b>Back-related disability</b>								
Remained good sleep	3,486	242	1.00	1.00 (reference)	3,004	239	1.19	1.10 (0.91-1.33)
Poor sleep to good sleep	207	23	1.71	1.67 (1.09-2.56)	270	34	1.86	1.59 (1.08-2.33)
Good sleep to poor sleep	557	62	1.63	1.53 (1.15-2.03)	614	69	1.81	1.55 (1.18-2.05)
Remained poor sleep	208	25	1.79	1.65 (1.07-2.52)	255	39	2.35	1.94 (1.33-2.82)

Abbreviations: CI, confidence interval; RR, risk ratio

<sup>a</sup>Adjusted for age (continuous)

<sup>b</sup>Adjusted for age (continuous), sex (women, men), education (primary school, high school, college ≤4 years, college >4 years), body mass index (continuous), relative change in body weight (continuous), smoking (never smoked, former smoker, current low-intensity smoker [ $<10$  cigarettes per day], medium-intensity smoker [10-19 cigarettes per day], high-intensity smoker [20 or more cigarettes per day]), and anxiety and/or depression (yes, no)