

## **Substitutions of physical activity, sedentary behaviour and sleep: associations with mental health in middle-aged and elderly persons**

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### **Supplementary material**

- Logistic regression analyses (table A, table C)
- Stratified analyses (table B, table D)
- Sensitivity analyses (table E – H)

## Supplementary material: Depressive symptoms

**Table A. Age- and sex adjusted and confounder adjusted results of isothermal substitution analyses for clinically relevant depressive symptoms (CES-D  $\geq 16$ ) based on logistic regression analyses**

		30 minutes more..							
		Sleep	Sedentary behaviour		Light PA	Moderate-to-vigorous PA			
<b>Age- and sex adjusted model</b>									
Replacing..	Sleep			1.02	0.94, 1.09	0.97	0.76, 1.23	0.82	0.61, 1.08
	Sedentary behaviour	0.98	0.92, 1.05			0.96	0.74, 1.21	0.81	0.61, 1.05
	Light PA	1.05	0.77, 1.38	1.07	0.79, 1.40			0.88	0.48, 1.44
	Moderate-to-vigorous PA	1.36	0.89, 1.96	1.38	0.92, 1.98	1.35	0.70, 2.29		
<b>Confounder adjusted model</b>									
Replacing..	Sleep			0.99	0.91, 1.07	0.99	0.74, 1.29	0.89	0.63, 1.21
	Sedentary behaviour	1.01	0.93, 1.09			1.00	0.75, 1.30	0.90	0.65, 1.21
	Light PA	1.03	0.73, 1.42	1.02	0.72, 1.40			0.94	0.48, 1.65
	Moderate-to-vigorous PA	1.24	0.75, 1.92	1.23	0.75, 1.89	1.26	0.60, 2.36		

Values represent the estimated odds ratios between the mean composition of the study population and a new composition, e.g. in which 30 minutes more times were spent in sleep and 30 minutes less in sedentary behaviour (while light and moderate-to-vigorous physical activity were unchanged). The confounder adjusted model was adjusted for age, sex, living situation, educational level, employment, body mass index, history of cancer, coronary heart disease, stroke and diabetes, use of psycholeptics and psychoanaleptics, smoking status and alcohol use. PA = Physical Activity, Bold indicates a significant association ( $p < 0.05$ ).

**Table B. Confounder adjusted results of isotemporal substitution analyses for depressive symptoms in men and women separately**

		30 minutes more..							
		Sleep	Sedentary behaviour		Light PA	Moderate-to-vigorous PA			
		<b>Men</b>							
Replacing..	Sleep			0.05	-0.09, 0.20	0.19	-0.29, 0.67	<b>-0.61</b>	<b>-1.19, -0.02</b>
	Sedentary behaviour	-0.05	-0.19, 0.09			0.14	-0.35, 0.63	<b>-0.66</b>	<b>-1.21, -0.11</b>
	Light PA	-0.23	-0.81, 0.35	-0.18	-0.77, 0.41			-0.84	-1.93, 0.25
	Moderate-to-vigorous PA	<b>0.90</b>	<b>0.05, 1.75</b>	<b>0.96</b>	<b>0.13, 1.78</b>	1.09	-0.16, 2.35		
		<b>Women</b>							
Replacing..	Sleep			-0.02	-0.23, 0.19	0.02	-0.67, 0.71	-0.47	-1.26, 0.32
	Sedentary behaviour	0.02	-0.18, 0.22			0.04	-0.64, 0.73	-0.45	-1.22, 0.32
	Light PA	-0.04	-0.87, 0.79	-0.06	-0.89, 0.77			-0.50	-2.03, 1.03
	Moderate-to-vigorous PA	0.67	-0.49, 1.83	0.65	-0.49, 1.80	0.70	-1.06, 2.45		

Values represent the estimated differences in the outcome between the mean composition of the study population and a new composition, e.g. in which 30 minutes more times were spent in sleep and 30 minutes less in sedentary behaviour (while light and moderate-to-vigorous physical activity were unchanged). The confounder adjusted model was adjusted for age, sex, living situation, educational level, employment, body mass index, history of cancer, coronary heart disease, stroke and diabetes, use of psycholeptics and psychoanaleptics, smoking status and alcohol use. PA = Physical Activity, Bold indicates a significant association ( $p < 0.05$ ).

## Supplementary material: Anxiety symptoms

Table C. Age- and sex adjusted and confounder adjusted results of isothermal substitution analyses for clinically relevant anxiety symptoms (HADS-A score  $\geq 8$ ) based on logistic regression analyses

		30 minutes more..							
		Sleep	Sedentary behaviour		Light PA	Moderate-to-vigorous PA			
<b>Age- and sex adjusted model</b>									
Replacing..	Sleep			1.01	0.93, 1.09	1.20	0.92, 1.53	<b>0.74</b>	<b>0.54, 0.98</b>
	Sedentary behaviour	0.99	0.92, 1.07			1.19	0.91, 1.51	<b>0.73</b>	<b>0.54, 0.97</b>
	Light PA	0.82	0.59, 1.10	0.82	0.59, 1.11			0.61	0.32, 1.04
	Moderate-to-vigorous PA	<b>1.60</b>	<b>1.03, 2.34</b>	<b>1.61</b>	<b>1.05, 2.34</b>	1.92	0.99, 3.26		
<b>Confounder adjusted model</b>									
Replacing..	Sleep			1.00	0.93, 1.08	1.26	0.96, 1.63	0.77	0.55, 1.04
	Sedentary behaviour	1.00	0.93, 1.08			1.26	0.95, 1.63	0.77	0.55, 1.03
	Light PA	0.77	0.54, 1.05	0.77	0.54, 1.06			0.60	0.31, 1.06
	Moderate-to-vigorous PA	1.53	0.95, 2.31	1.53	0.95, 2.30	1.94	0.94, 3.44		

Values represent the estimated odds ratios between the mean composition of the study population and a new composition, e.g. in which 30 minutes more times were spent in sleep and 30 minutes less in sedentary behaviour (while light and moderate-to-vigorous physical activity were unchanged). The confounder adjusted model was adjusted for age, sex, living situation, educational level, employment, body mass index, history of cancer, coronary heart disease, stroke and diabetes, use of psycholeptics and psychoanaleptics, smoking status and alcohol use. PA = Physical Activity, Bold indicates a significant association ( $p < 0.05$ ).

**Table D. Confounder adjusted results of isotemporal substitution analyses for anxiety symptoms in men and women separately**

		30 minutes more..							
		Sleep	Sedentary behaviour		Light PA	Moderate-to-vigorous PA			
		<b>Men</b>							
Replacing..	Sleep			0.01	-0.07, 0.08	0.09	-0.15, 0.32	-0.07	-0.35, 0.21
	Sedentary behaviour	0.00	-0.07, 0.06			0.08	-0.16, 0.32	-0.08	-0.34, 0.19
	Light PA	-0.10	-0.39, 0.18	-0.10	-0.39, 0.19			-0.17	-0.70, 0.36
	Moderate-to-vigorous PA	0.11	-0.31, 0.52	0.11	-0.29, 0.51	0.19	-0.42, 0.81		
		<b>Women</b>							
Replacing..	Sleep			-0.04	-0.14, 0.05	0.22	-0.10, 0.54	-0.20	-0.56, 0.17
	Sedentary behaviour	0.04	-0.05, 0.13			0.26	-0.06, 0.58	-0.15	-0.51, 0.21
	Light PA	-0.27	-0.66, 0.12	-0.31	-0.70, 0.07			-0.46	-1.18, 0.25
	Moderate-to-vigorous PA	0.28	-0.26, 0.82	0.24	-0.29, 0.77	0.50	-0.32, 1.32		

Values represent the estimated differences in the outcome between the mean composition of the study population and a new composition, e.g. in which 30 minutes more times were spent in sleep and 30 minutes less in sedentary behaviour (while light and moderate-to-vigorous physical activity were unchanged). The confounder adjusted model was adjusted for age, sex, living situation, educational level, employment, body mass index, history of cancer, coronary heart disease, stroke and diabetes, use of psycholeptics and psychoanaleptics, smoking status and alcohol use. PA = Physical Activity, Bold indicates a significant association ( $p < 0.05$ ).

## Supplementary material: Sensitivity analyses

Table E. Age- and sex adjusted and confounder adjusted results of isothermal substitution analyses for depressive symptoms in those moving forward without any type of walking aid

		30 minutes more..							
		Sleep		Sedentary behaviour		Light PA		Moderate-to-vigorous PA	
<b>Age- and sex adjusted model</b>									
Replacing..	Sleep			0.07	-0.06, 0.21	0.02	-0.43, 0.46	<b>-0.65</b>	<b>-1.17, -0.13</b>
	Sedentary behaviour	-0.08	-0.21, 0.05			-0.06	-0.50, 0.38	<b>-0.73</b>	<b>-1.23, -0.23</b>
	Light PA	-0.02	-0.55, 0.52	0.06	-0.48, 0.59			-0.67	-1.66, 0.32
	Moderate-to-vigorous PA	<b>0.97</b>	<b>0.21, 1.73</b>	<b>1.04</b>	<b>0.30, 1.79</b>	0.98	-0.15, 2.12		
<b>Confounder adjusted model</b>									
Replacing..	Sleep			0.03	-0.11, 0.16	0.10	-0.33, 0.52	<b>-0.54</b>	<b>-1.04, -0.04</b>
	Sedentary behaviour	-0.03	-0.15, 0.10			0.07	-0.35, 0.50	<b>-0.56</b>	<b>-1.04, -0.08</b>
	Light PA	-0.12	-0.63, 0.39	-0.10	-0.61, 0.42			-0.66	-1.61, 0.29
	Moderate-to-vigorous PA	<b>0.79</b>	<b>0.06, 1.52</b>	<b>0.82</b>	<b>0.10, 1.53</b>	0.89	-0.20, 1.98		

Values represent the estimated differences in the outcome between the mean composition of the study population and a new composition, e.g. in which 30 minutes more times were spent in sleep and 30 minutes less in sedentary behaviour (while light and moderate-to-vigorous physical activity were unchanged). The confounder adjusted model was adjusted for age, sex, living situation, educational level, employment, body mass index, history of cancer, coronary heart disease, stroke and diabetes, use of psycholeptics and psychoanaleptics, smoking status and alcohol use. PA = Physical Activity, Bold indicates a significant association ( $p < 0.05$ ).

**Table F. Age- and sex adjusted and confounder adjusted results of isothermal substitution analyses for anxiety symptoms in those moving forward without any type of walking aid**

		30 minutes more..							
		Sleep		Sedentary behaviour		Light PA		Moderate-to-vigorous PA	
<b>Age- and sex adjusted model</b>									
Replacing..	Sleep			-0.01	-0.07, 0.05	0.07	-0.13, 0.28	-0.17	-0.40, 0.07
	Sedentary behaviour	0.01	-0.05, 0.07			0.08	-0.12, 0.29	-0.15	-0.38, 0.08
	Light PA	-0.09	-0.34, 0.16	-0.10	-0.35, 0.15			-0.26	-0.71, 0.20
	Moderate-to-vigorous PA	0.24	-0.11, 0.59	0.23	-0.11, 0.57	0.31	-0.21, 0.84		
<b>Confounder adjusted model</b>									
Replacing..	Sleep			-0.02	-0.08, 0.04	0.11	-0.10, 0.31	-0.13	-0.36, 0.11
	Sedentary behaviour	0.02	-0.04, 0.08			0.12	-0.08, 0.33	-0.11	-0.34, 0.12
	Light PA	-0.13	-0.37, 0.11	-0.15	-0.39, 0.09			-0.26	-0.71, 0.19
	Moderate-to-vigorous PA	0.19	-0.16, 0.53	0.17	-0.17, 0.51	0.29	-0.22, 0.81		

Values represent the estimated differences in the outcome between the mean composition of the study population and a new composition, e.g. in which 30 minutes more times were spent in sleep and 30 minutes less in sedentary behaviour (while light and moderate-to-vigorous physical activity were unchanged). The confounder adjusted model was adjusted for age, sex, living situation, educational level, employment, body mass index, history of cancer, coronary heart disease, stroke and diabetes, use of psycholeptics and psychoanaleptics, smoking status and alcohol use. PA = Physical Activity, Bold indicates a significant association ( $p < 0.05$ ).

**Table G. Confounder adjusted results of isothermal substitution analyses for depressive symptoms when the level of moderate-to-vigorous activity in the composition was changed (and the other domains were proportionally distributed)**

		30 minutes more..						
		Sleep	Sedentary behaviour		Light PA	Moderate-to-vigorous PA		
<b>Moderate-to-vigorous physical activity at 25<sup>th</sup> percentile level</b>								
Replacing..	Sleep		0.03	-0.09, 0.16	0.12	-0.29, 0.53	<b>-0.70</b>	<b>-1.33, -0.08</b>
	Sedentary behaviour	-0.04	-0.15, 0.08		0.08	-0.33, 0.49	<b>-0.74</b>	<b>-1.34, -0.13</b>
	Light PA	-0.14	-0.64, 0.35	-0.11	-0.61, 0.39		-0.85	-1.90, 0.21
	Moderate-to-vigorous PA	<b>1.21</b>	<b>0.15, 2.28</b>	<b>1.25</b>	<b>0.19, 2.30</b>	1.33	-0.08, 2.74	
<b>Moderate-to-vigorous physical activity at 75<sup>th</sup> percentile level</b>								
Replacing..	Sleep		0.04	-0.09, 0.16	0.12	-0.30, 0.54	<b>-0.46</b>	<b>-0.87, -0.05</b>
	Sedentary behaviour	-0.04	-0.16, 0.08		0.08	-0.34, 0.50	<b>-0.49</b>	<b>-0.88, -0.10</b>
	Light PA	-0.15	-0.66, 0.36	-0.11	-0.63, 0.40		-0.61	-1.47, 0.25
	Moderate-to-vigorous PA	<b>0.63</b>	<b>0.07, 1.18</b>	<b>0.66</b>	<b>0.12, 1.20</b>	0.75	-0.17, 1.66	

Values represent the estimated differences in the outcome between the mean composition of the study population and a new composition, e.g. in which 30 minutes more times were spent in sleep and 30 minutes less in sedentary behaviour (while light and moderate-to-vigorous physical activity were unchanged). The confounder adjusted model was adjusted for age, sex, living situation, educational level, employment, body mass index, history of cancer, coronary heart disease, stroke and diabetes, use of psycholeptics and psychoanaleptics, smoking status and alcohol use. PA = Physical Activity, Bold indicates a significant association ( $p < 0.05$ ).



**Table H. Confounder adjusted results of isotemporal substitution analyses for anxiety symptoms when the level of moderate-to-vigorous activity in the composition was changed (and the other domains were proportionally distributed)**

		30 minutes more..							
		Sleep		Sedentary behaviour		Light PA		Moderate-to-vigorous PA	
<b>Moderate-to-vigorous physical activity at 25<sup>th</sup> percentile level</b>									
Replacing..	Sleep			-0.01	-0.07, 0.05	0.16	-0.04, 0.35	-0.17	-0.46, 0.13
	Sedentary behaviour	0.01	-0.05, 0.07			0.17	-0.03, 0.36	-0.16	-0.44, 0.13
	Light PA	-0.19	-0.42, 0.04	-0.20	-0.43, 0.03			-0.36	-0.85, 0.14
	Moderate-to-vigorous PA	0.29	-0.21, 0.79	0.28	-0.21, 0.78	0.45	-0.22, 1.11		
<b>Moderate-to-vigorous physical activity at 75<sup>th</sup> percentile level</b>									
Replacing..	Sleep			-0.01	-0.07, 0.05	0.16	-0.04, 0.36	-0.11	-0.30, 0.09
	Sedentary behaviour	0.01	-0.05, 0.07			0.17	-0.03, 0.37	-0.10	-0.28, 0.09
	Light PA	-0.20	-0.44, 0.04	-0.21	-0.45, 0.04			-0.30	-0.71, 0.10
	Moderate-to-vigorous PA	0.15	-0.11, 0.41	0.14	-0.11, 0.39	0.31	-0.12, 0.74		

Values represent the estimated differences in the outcome between the mean composition of the study population and a new composition, e.g. in which 30 minutes more times were spent in sleep and 30 minutes less in sedentary behaviour (while light and moderate-to-vigorous physical activity were unchanged). The confounder adjusted model was adjusted for age, sex, living situation, educational level, employment, body mass index, history of cancer, coronary heart disease, stroke and diabetes, use of psycholeptics and psychoanaleptics, smoking status and alcohol use. PA = Physical Activity, Bold indicates a significant association ( $p < 0.05$ ).