Mulitimorbidity is common among young workers and related to increased work absenteeism and presenteeism: results from the population-based Raine Study cohort¹

by Sigrid A Troelstra, Leon M Straker, Mark Harris, Sarah Brown, Allard J van der Beek, Pieter Coenen, academic degree ²

- 1. Supplementary material
- 2. Correspondence to: Dr. Pieter Coenen, Department of Public and Occupational Health Amsterdam UMC, location VUmc, van der Boechorststraat 7 NL-1081 BT Amsterdam, the Netherlands. (E-mail: p.coenen@amsterdamumc.nl)

Category	%	%	%	Condition	%	%	%
	Total	Females	Males		Total	Females	Males
Allergies and	32.5	35.9	28.5	Asthma	11.6	13.2	9.9
respiratory conditions				Chronic respiratory or breathing	0.5	0.6	0.4
				problems other than asthma			
				Hay fever or some other allergy	19.8	21.1	18.3
				Food allergies	11.6	14.0	8.9
Cancer	0.2	0	0.4	Cancer	0.2	0	0.4
Cardiovascular	1.0	1.3	0.7	Heart condition	1.0	1.3	0.7
conditions							
Gastrointestinal	0.5	0.9	0	Coeliac disease	0.5	0.9	0
conditions							
Mental & neurological	17.8	20.1	15.1	Speech and/or language	0.8	0	1.8
conditions				problems			
				Coordination or clumsiness	1.0	1.3	0.7
				difficulties			
				Attentional problems	4.2	1.3	7.4
				Anxiety problems	10	14.2	5.3
				Behavioural problems	1.2	0.3	2.1
				Intellectual disability	0.3	0	0.7
				Learning problems	1.7	1.6	1.8
				Depression	8.5	11	5.6
Metabolic &	15.7	19.1	12	Diabetes	0.2	0	0.4
endocrine conditions	Thyroid		Thyroid problem	1	1.6	0.4	
				Eating disorder/weight problems	2.7	4.7	0.4
				Obesity	14.1	16.6	11.3
Musculoskeletal	31.2	39.5	21.8	Arthritis or joint problems	4.2	5.0	3.2
conditions				Chronic neck/shoulder pain	13.5	18.4	5.5
				Chronic back pain	11.7	15.1	7.3
				Current other pain	22.5	27.5	16.9
Other medical	30.1	40.9	18.0	Migraine or severe headache	6.3	9.7	2.5
conditions				Menstrual problems	6.0	11.3	0
				Hemochromatosis	0.3	0	0.7
				Bladder control problems	0.5	0.6	0.4
				Acne	10	12.6	7.0
				Other medical condition	13.8	17.4	9.9
Sensory conditions	29.1	34.3	23.2	Vision problems	28.4	34	22.2
				Hearing impairment or deafness	0.8	0.6	1.1
Sleep conditions	25.8	28.4	22.9	Sleep disturbance	3.5	5.4	1.4
				Indicator of sleep apnoea	10.0	9.7	10.2
				Insomnia disorder	18.2	21.6	13.9
				Sleepiness	4.5	5.7	3.2
				Restless legs	2.5	2.8	2.1

Supplementary file 1. Prevalence of multimorbidity categories and individual conditions

	Count individual conditions			Count condition categories			
	% Total	% Females	% Males	% Total	% Females	% Males	
0	19.1	12.9	26.1	19.7	13.4	26.8	
1	21.3	17.9	25.0	27.2	23.1	31.7	
2	20.6	19.2	22.2	23.5	25.3	21.5	
3	14.5	16.7	12.0	17.9	20.9	14.4	
4	10.5	12.9	7.7	5.8	7.5	3.9	
5	5.1	6.6	3.5	3.8	5.9	1.4	
6	3.5	5.0	1.8	1.7	2.8	0.4	
7	2.3	3.5	1.1	0.5	0.9	0.0	
8	0.7	1.3	0.0	0.0	0.0	0.0	
9	0.3	0.6	0.0	0.0	0.0	0.0	
10	0.7	1.3	0.0	0.0	0.0	0.0	
11	0.7	0.6	0.7	0.0	0.0	0.0	
12	0.7	1.3	0.0	0.0	0.0	0.0	
17	0.2	0.3	0.0	0.0	0.0	0.0	

Supplementary file 2. Multimorbidity count for individual conditions and condition categories.

		Excess total	Relative burden of total productivity loss ² (hours/1000
	Prevalence %	(hours/year) ¹	workers/year)
Total		· · · ·	
Allergies and respiratory conditions	32.5	35.1	11403.0
Cancer	0.2	-167.3	-279.2
Cardiovascular conditions	1.0	232.9	2329.3
Gastrointestinal conditions	0.5	-61.7	-308.7
Mental and neurological conditions	17.8	88.1	15650.1
Metabolic and endocrine conditions	15.7	35.1	5516.0
Musculoskeletal conditions	31.2	137.1	42744.3
Other medical conditions	30.1	74.9	22519.8
Sensory conditions	29.1	44.4	12915.7
Sleep conditions	25.8	130.0	33581.3
Females			
Allergies and respiratory conditions	35.9	-3.7	-1311.7
Cancer	0.0	-175.6	0.0
Cardiovascular conditions	1.3	-12.8	-161.6
Gastrointestinal conditions	1.0	-69.4	-658.4
Mental and neurological conditions	20.1	157.2	31645.8
Metabolic and endocrine conditions	19.1	81.3	15495.9
Musculoskeletal conditions	39.5	115.3	45521.9
Other medical conditions	40.9	102.7	41963.8
Sensory conditions	34.3	83.1	28494.2
Sleep conditions	28.4	109.7	31198.8
Males			
Allergies and respiratory conditions	28.5	25.0	7127.4
Cancer	0.4	-157.6	-560.7
Cardiovascular conditions	0.7	714.0	5028.0
Gastrointestinal conditions	0.0	-156.4	0.0
Mental and neurological conditions	15.1	17.0	2578.5
Metabolic and endocrine conditions	12.0	-18.2	-2180.1
Musculoskeletal conditions	21.8	174.0	37985.9
Other medical conditions	18.0	21.4	3834.0
Sensory conditions	23.2	-17.9	-4148.2
Sleep conditions	22.9	154.0	35239.6

Supplementary file 3. Prevalence, excess in total productivity loss and relative burden of total productivity loss for multimorbidity categories in young workers

¹ Excess in total productivity loss is the difference in average total absenteeism and presenteeism hours per year between individuals that do and do not report morbidity in a certain category. If - on average - individuals without the condition have higher total productivity loss compared to individuals with the condition (as is the case with cancer and gastrointestinal disorders) the scores are negative.

² Relative burden of total productivity loss for a certain condition category is excess productivity loss multiplied by % prevalence of a certain condition category multiplied by 10. If - on average - individuals without the condition have higher relative burden of productivity loss compared to individuals with the condition (as is the case with cancer and gastrointestinal disorders) the scores are negative.

Supplementary file 4. Model characteristics of the models presented in table 2.

Among females:

- For the association of condition categories with total absence: Number of condition groups contributed significantly (p<0.05) to the zero inflated part of the ZINB model, hence this variable and the constant term were retained. Alpha showing the added value of ZINB (compared to ZIP): 0.77 [0.63-0.95]. Vuong test showing that a ZINB model is preferred over a NB model: Z=9.79 (p<0.05).
- For the association of condition categories with sickness absence: Number of condition groups contributed significantly (p<0.05) to the zero inflated part of the ZINB model, hence this variable and the constant term were retained. Alpha showing the added value of ZINB (compared to ZIP): 0.72 [0.58-0.89]. Vuong test showing that a ZINB model is preferred over a NB model: Z=9.73 (p<0.05).
- For the association of condition categories with total presenteeism: Number of condition groups contributed significantly (p<0.05) to the zero inflated part of the ZINB model, hence this variable and the constant term were retained. Alpha showing the added value of ZINB (compared to ZIP): 0.72 [0.60-0.88]. Vuong test showing that a ZINB model is preferred over a NB model: Z=15.32 (p<0.05).

Among males:

- For the association of condition categories with total absence: Number of condition groups contributed significantly (p<0.05) to the zero inflated part of the ZINB model, hence this variable and the constant term were retained. Alpha showing the added value of ZINB (compared to ZIP): 0.83 [0.65-1.08], however, this was not statistically significant. However, to keep the analysis consistent with the other models, we elected to conduct the ZINB analysis. Vuong test showing that a ZINB model is preferred over a NB model: Z=5.20 (p<0.05).
- For the association of condition categories with sickness absence: Number of condition groups contributed significantly (p<0.05) to the zero inflated part of the ZINB model, hence this variable and the constant term were retained. Alpha showing the added value of ZINB (compared to ZIP): 0.94 [0.71-1.25]. Vuong test showing that a ZINB model is preferred over a NB model: Z=7.03 (p<0.05).
- For the association of condition categories with total presenteeism: Number of condition groups contributed significantly (p<0.05) to the zero inflated part of the ZINB model, hence this variable and the constant term were retained. Alpha showing the added value of ZINB (compared to ZIP): 0.74 [0.58-0.94]. Vuong test showing that a ZINB model is preferred over a NB model: Z=8.59 (p<0.05).

		Females		Males		
		Included (N=320)	Not included (N=287)	Included (N=284)	Not included (N=255)	
		%	%	%	%	
Condition categories	Allergies and respiratory conditions	35.9	36.6	28.5	28.6	
	Cancer	0	0.3	0.4	0.8	
	Cardiovascular conditions	1.3	2.1	0.7	2.4	
	Gastrointestinal conditions	0.9	0.7	0	0.0	
	Mental and neurological conditions	20.1	22.7	15.1	22.2	
	Metabolic and endocrine conditions	19.1	19.2	12.0	12.5	
	Musculoskeletal conditions	39.5	32.4	21.8	24.8	
	Other medical conditions	40.9	41.6	18.0	24.5	
	Sensory conditions	34.3	30.8	23.2	18.0	
	Sleep conditions	28.4	30.7	22.9	23.1	
Multimorbidity (N condition	0	13.4	17.1	26.8	27.8	
categories)	1	23.1	25.4	31.7	23.5	
	2	25.3	19.9	21.5	28.6	
	3	20.9	16.4	14.4	10.2	
	4	7.5	11.1	3.9	6.3	
	5	5.9	4.5	1.4	3.1	
	6	2.8	3.8	0.4	0.4	
	7	0.9	1.7	0.0	0.0	
Occupation	Managers	3.5	2.6	3.9	1.3	
	Professionals	17.0	10.0	12.3	13.8	
	Technicians and trades workers	6.3	5.8	24.3	31.6	
	Community and personal service workers	21.1	25.8	14.4	13.2	
	Clerical and administrative workers	24.8	25.8	9.5	3.9	
	Sales workers	20.8	23.7	15.1	11.8	
	Machinery operators and drivers	0.9	1.6	5.2	7.9	
	Labourers	5.7	4.7	15.1	16.4	

Supplementary file 5. Comparison of Raine Study Gen2-22 participants who either did or did not have sufficient data to be included in current analysis.