

# Respiratory symptoms and ventilatory function in confectionery workers

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## Abstract

Respiratory symptoms and ventilatory capacity were studied in a group of 288 workers (259 women and 29 men) employed in a confectionery plant. A group of workers (96 women and 31 men) not exposed to confectionery manufacture were also studied as controls. The prevalence of chronic respiratory symptoms was higher in exposed than in control workers, being greatest for confectionery workers exposed to the dust of flour, talc, and starch and the vapours of alcohol. Chronic bronchitis was reported by 7% of the women and 21% of the men, and chest tightness was reported by 27% of women and 66% of men. There was a high prevalence of acute irritative symptoms during the workshift in all groups of confectionery workers, especially for cough, dyspnoea, burning and dryness of the throat, and eye irritation. For all groups of confectionery workers there were statistically significant across shift reductions in ventilatory capacity, being most pronounced for maximum flow rate at 50% of the control vital capacity (FEF<sub>50</sub>; range 4.6-13.0%) and at 25% of the control vital capacity (FEF<sub>25</sub>; range 4.7-22.3%). Preshift values of FEF<sub>50</sub> and FEF<sub>25</sub> were significantly lower than predicted values. The data suggest that some workers employed in confectionery plants may develop acute and chronic respiratory symptoms associated with changes in lung function.

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Work in confectionery plants involves the use of different foods for making sweets and pastries. As a result, confectioners are often exposed to the dusts of flour, talc, starch, walnut, peanut, cacao, cocoa, chocolate, coffee, spices, cinnamon, and other food products. Although the respiratory problems of confectionery workers have not been extensively studied, related data exist for bakery workers.<sup>1-8</sup> Symptoms among bakers may occur often as noted by Hartman *et al* who studied 314 workers in an industrial bakery and found that 74% had respiratory allergy to flour (rhinitis and/or asthma).<sup>9</sup>

As well as studies of bakery workers findings on sensitivity to specific food products are relevant to the study of confectionery

workers. Allergy to nuts and beans is widespread in the general population commonly resulting in upper respiratory symptoms. Multiple allergies to common foods including chocolate, walnut, peanut, and other products have been described by Speer.<sup>10</sup> Nuts, in particular, have been associated with allergic reactions. Hypersensitivity to pine nuts was reported by Fine<sup>11</sup> and Nielsen,<sup>12</sup> to pinon nuts by Armentia *et al*,<sup>13</sup> and to pignolia nuts by Santos and Unger.<sup>14</sup> Allergic and other untoward reactions of the upper respiratory tract due to peanuts have been described by Fries<sup>15</sup> and Yunginger *et al*.<sup>16</sup> A case of asthma due to central American walnut was reported by Bush and Clayton.<sup>17</sup> Allergy to chocolate and cocoa bean are also well recognised and have been reported by Fries.<sup>18,19</sup> Wutrich<sup>20</sup> described an allergic reaction after the consumption of malt-containing chocolate drinks and snack products. Asthma and other symptoms in cinnamon workers have been reported after exposure to cinnamon dust.<sup>21</sup>

The current study was designed to examine the respiratory function of workers employed in a confectionery plant exposed to many of these substances.

## Workers and methods

### WORKERS

Our study examined 288 workers (259 women and 29 men) in one confectionery plant in Zagreb, Croatia. They represented 85% of all workers in the plant. Additionally a group of control workers (65 women and 31 men) of similar age and smoking habit employed as transport workers in the same plant served as a control for respiratory symptoms and baseline lung function. All subjects were volunteers. Table 1 presents the

Table 1 Demographic data of confectionery and control workers

Group	No	Age (y)	Height (cm)	Exposure (y)	Smokers (%)
Confectionery:					
Women	259	33 (16-57)	162 (152-177)	11 (1-35)	15
Men	29	31 (18-56)	174 (158-179)	10 (1-28)	85
Control:					
Women	65	31 (18-58)	161 (151-176)	10 (1-34)	16
Men	31	36 (18-57)	174 (156-180)	8 (1-26)	87

Data are presented as means (range).

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demographic characteristics of the workers and their controls.

#### WORK ENVIRONMENT AND PROCESSES

The studied workers were employed in processing various confectionery products such as biscuits, sweets, chocolate, chewing gum, candied fruits, and snack products. We classified workers by specific exposures into five different groups. Group 1 was exposed to aerosols of flour, sugar, starch, talc, and egg powder; group 2 was exposed to the vapours of ethyl alcohol in preparing candied fruits (such as cherry); group 3 was employed in the processing of nuts, almonds, cocoa, cacao, and chocolate; group 4 processed butter, honey, aromatic oil, yeast, and different food colourings; group 5 packed the confectionery products in a cold room. Workers in this plant occasionally rotated their jobs and moved from one working station to another; these areas were completely separated physically. By and large however, workers remained in one area.

#### RESPIRATORY SYMPTOMS

Chronic respiratory symptoms were recorded for confectionery workers and control workers with the British Medical Research Council Committee questionnaire on respiratory symptoms<sup>22</sup> with additional questions on occupational asthma.<sup>23</sup> For all workers a detailed occupational history as well as questions about their smoking habit were recorded.

The workers were also asked about acute work related symptoms such as cough, dyspnoea, chest tightness, irritation or dryness of the throat, secretion, dryness or bleeding of the nose, and headache. The following definitions were used:

*Chronic cough or phlegm*—Cough or phlegm production for at least three months a year;

*Chronic bronchitis*—Cough and phlegm for a minimum of three months a year and for not less than two successive years;

*Dyspnoea grade 3*—Shortness of breath when walking with other people at an ordinary pace on level ground.

*Dyspnoea grade 4*—Shortness of breath when walking at their own pace on level ground;

*Occupational asthma*—recurring attacks of dyspnoea, chest tightness, and impairment of pulmonary function of the obstructive type associated with or after the workshift. The diagnosis was confirmed by medical records from the employee health centre. Symptoms began or were exacerbated after the start of employment.

#### VENTILATORY CAPACITY

Ventilatory capacity was measured in all confectionery and control workers by recording maximum expiratory flow-volume (MEFV) curves with a portable flow-volume spirometer (Pneumoscreen, Jaeger, Germany). Measurements were performed on the first working day of the week (Monday) after two days away from work. All employees were working on the day shift. The forced vital

capacity (FVC), forced expiratory volume in one second (FEV<sub>1</sub>), and maximum flow rates at 50% and the last 25% of the control vital capacity (FEF<sub>50</sub>, FEF<sub>25</sub>) were measured on these curves. At least three MEFV curves were recorded and the highest value was used as the result of the test; MEFV curves in confectionery workers were measured before and after the workshift. The measured Monday preshift values for ventilatory capacity were compared with the predicted normal values defined by Quanjer<sup>24</sup> and with the control group. The spirometer was calibrated for volume on a daily basis. Both measurements and calibration were performed in accordance with the American Thoracic Society standards for spirometric measurements.<sup>25</sup>

#### ENVIRONMENTAL DUST MEASUREMENTS

Airborne dust samples in the confectionery plant were collected with Hexhlet horizontal two stage samplers during the eight hour work shift. Twenty dust samples were collected in the areas where workers were examined. Dust concentrations were expressed separately as the total and the respirable dust fractions in mg/m<sup>3</sup>. Vapours of ethyl alcohol were collected in tubes filled with activated charcoal and subsequently analysed by gas chromatography. Vapour concentrations were expressed as parts per million (ppm).

#### STATISTICAL ANALYSIS

The results of ventilatory capacity measurements were analysed by paired *t* test for matched differences (across shift changes and the comparison of baseline to predicted normal values). The unpaired *t* test was used for measuring differences between exposed and control workers. The  $\chi^2$  test or when appropriate Fisher's exact test were used for testing differences in the prevalence of respiratory symptoms. Values of *p* < 0.05 were considered statistically significant.

## Results

#### RESPIRATORY SYMPTOMS

Table 2 presents the prevalence of chronic respiratory symptoms for workers of all groups (men and women) and their controls. Most of the chronic respiratory symptoms occurred significantly more often in confectionery workers than in control workers.

Table 3 shows the prevalence of chronic respiratory symptoms in the five different occupational groups of confectionery workers compared with control workers. Male confectionery workers were employed exclusively in group one jobs. Chronic phlegm, chronic bronchitis, chest tightness, and nasal catarrh were particularly frequent in group 2 women confectioners exposed to ethyl alcohol compared with the other groups of women confectioners. Occupational asthma was reported by seven (2.7%) of 259 women confectionery workers. These workers stated that their symptoms of asthma were not present before starting employment in the confectionery plant but developed after working for three to

Table 2 Prevalence of chronic symptoms for workers of all groups and controls

Group	Mean age (y)	Mean exposure (y)	Chronic cough	Chronic phlegm	Chronic bronchitis	Dyspnoea	Occupational asthma	Chest tightness	Nasal catarrh	Sinusitis
<b>Women:</b>										
Confectionery (n = 259)	32	11	62 (23.9) p < 0.001	24 (9.3) NS	19 (7.3) NS	33 (12.7) p < 0.001	7 (2.7) NS	68 (26.6) p < 0.001	54 (20.8) p < 0.001	61 (23.6) p < 0.001
Control (n = 65)	31	10	4 (6.2)	2 (3.1)	2 (3.1)	0 (0)	0 (0)	0 (0)	1 (1.5)	1 (1.5)
<b>Men:</b>										
Confectionery (n = 29)	31	10	8 (27.5) NS	6 (20.7) NS	6 (20.7) NS	8 (27.6) p < 0.001	0 (0) NS	19 (65.5) p < 0.001	7 (24.1) p < 0.001	7 (24.1) p < 0.001
Control (n = 31)	36	8	6 (19.4)	5 (16.1)	5 (16.1)	2 (2.5)	0 (0)	0 (0)	0 (0)	0 (0)

Numbers in parentheses are percentages.

Table 3 Prevalence of chronic respiratory symptoms in confectionery workers (groups 1-5) and in control workers

Group	Sex	No	Mean age (y)	Mean exposure (y)	Chronic cough	Chronic phlegm	Chronic bronchitis	Dyspnoea	Occupational asthma	Chest tightness	Nasal catarrh	Sinusitis
1	Women	78	32	10	29** (37.2)	9* (11.5)	4 (5.1)	14** (17.9)	3 (3.8)	21** (26.9)	15** (19.2)	19** (24.4)
1	Men	29	31	10	8 (27.5)	6 (20.7)	6** (20.7)	8* (27.6)	0 (0)	19** (65.5)	7** (24.1)	7** (24.1)
2	Women	19	28	8	5** (26.3)	5** (26.3)	5** (26.3)	2 (10.5)	0 (0)	12** (53.2)	5** (26.3)	5** (26.3)
3	Women	22	33	9	2** (9.0)	2 (9.0)	2 (9.0)	3 (13.6)	1 (4.5)	10** (45.4)	3* (13.6)	7** (31.6)
4	Women	67	33	12	9 (13.4)	3 (4.5)	3 (4.5)	2 (2.9)	1 (1.5)	20** (29.9)	15** (22.4)	15** (22.4)
5	Women	73	35	15	17** (23.3)	5 (6.8)	5 (6.8)	12** (16.4)	2 (2.7)	6 (8.2)	16** (21.9)	15** (20.5)
Control	Women	65	31	10	4 (6.2)	3 (3.1)	2 (3.1)	0 (0)	0 (0)	0 (0)	1 (1.5)	1 (1.5)
	Men	31	36	8	6 (19.4)	5 (16.1)	5 (16.1)	2 (2.5)	0 (0)	0 (0)	0 (0)	0 (0)

\*p < 0.05; \*\*p < 0.01; confectionery v control workers. Numbers in parentheses are percentages.

five years in confectionery and were most pronounced during exposure in the workplace.

Table 4 shows the prevalence of acute symptoms. There was a high prevalence in all groups of confectionery workers, particularly for cough, dyspnoea, burning or dryness of the throat, and eye irritation. These prevalences were greatest in the women confectioners exposed to alcohol fumes.

#### VENTILATORY CAPACITY

Table 5 shows the mean across shift reductions (before-after shifts) in FVC, FEV<sub>1</sub>, FEF<sub>50</sub>, and FEF<sub>25</sub>. There were statistically significant across shift reductions in all ventilatory capacity tests, most pronounced for

FEF<sub>50</sub> (range 4.6-13.0%) and for FEF<sub>25</sub> (range 4.7-22.3%).

Table 6 shows the mean measured ventilatory capacity data in confectionery workers compared with predicted and control values. Most of the preshift values were significantly lower than expected; in particular, FEF<sub>50</sub> and FEF<sub>25</sub> were greatly reduced. Among the group of workers in confectionery as a whole 28% had an FEF<sub>50</sub> and 35% had an FEF<sub>25</sub> below 80% of predicted.

#### ENVIRONMENTAL DUST MEASUREMENT

The mean total dust concentration in our studied confectionery mill was 31.2 (range 4.1-95.5) mg/m<sup>3</sup> with a respirable fraction of

Table 4 Prevalence of acute symptoms during the work shift in confectionery workers

Group	Sex	No	Cough	Dyspnoea	Throat		Eye Irritation	Nose			Headache
					Burning	Dryness		Secretion	Dryness	Bleeding	
1	Women	78	20 (25.5) NS†	32 (41.0) NS	30*† (38.5) NS	47* (60.3) NS	40 (51.3) < 0.05	11 (14.1) < 0.02	37 (47.4) 0.01	16* (20.5) NS	36† (46.2) NS
1	Men	29	13 (44.8)	15 (51.7)	6 (20.7)	17 (58.6)	9 (31.0)	5 (34.5)	5 (17.2)	3 (10.3)	12 (41.4)
2	Women	19	6 (31.6)	10 (52.6)	13* (68.4)	15 (78.9)	10 (52.6)	3 (15.8)	13 (68.4)	8* (42.1)	9 (47.4)
3	Women	22	5 (22.7)	9 (40.9)	8 (36.4)	18* (81.8)	13 (59.1)	4 (18.2)	6 (27.3)	6 (27.3)	12 (54.5)
4	Women	67	24 (35.8)	30 (44.8)	36† (53.7)	44 (65.7)	37 (55.2)	9 (13.4)	35 (52.2)	16 (23.9)	45† (67.2)
5	Women	73	19 (26.0)	14 (19.2)	27 (36.9)	28 (38.4)	17 (23.3)	4 (5.5)	21 (28.8)	6 (8.2)	29 (39.7)

\*†p < 0.01; groups significantly different from one another have the same superscripts. †Indicates significant difference between men and women in group 1.

Table 5 Mean across shift (before-after shift) reductions in lung function in confectionery workers

Group	Sex	No	FVC		FEV <sub>1</sub>		FEF <sub>50</sub>		FEF <sub>25</sub>	
			%	p Value*	%	p Value	%	p Value	%	p Value
1	Women	78	-1.6	< 0.01	-1.9	< 0.01	-6.1	< 0.01	-19.4	< 0.01
1	Men	29	-1.4	< 0.01	-1.7	NS	-4.6	< 0.01	-4.7	< 0.01
2	Women	19	-3.7	< 0.05	-2.6	NS	-13.0	< 0.01	-4.7	< 0.01
3	Women	22	-2.2	< 0.01	-2.4	< 0.05	-8.8	< 0.01	-14.7	< 0.01
4	Women	67	-1.7	< 0.01	-2.6	< 0.01	-7.3	< 0.01	-22.3	< 0.01
5	Women	73	0	NS	0	NS	-11.5	< 0.01	-22.3	< 0.01

\*Average before value significantly greater than after value.

% = per cent across shift reduction (((before-after)/before) × 100).

Table 6 Ventilatory capacity in confectionery workers in relation to predicted normal and to control values

Group	Sex	No	Measurement	FVC		FEV <sub>1</sub>		FEF <sub>50</sub>		FEF <sub>25</sub>	
				Before-Shift (l)	Before-predicted p Value	Before-shift (l)	Before-predicted p Value	Before-shift (l/s)	Before-predicted p Value	Before-shift (l/s)	Before-predicted p Value
1	Women	78	Measured	3.79 (0.48)	NS	3.19 (0.47)	NS	3.94 (0.89)	< 0.01	2.32(0.95)	< 0.01
			% Control	96.7		96.2		80.3		84.8	
			% Predicted	99.5		98.1		82.9		87.9	
1	Men	29	Measured	5.13 (0.91)	< 0.01	4.06 (0.83)	NS	4.63 (1.06)	< 0.01	2.67 (1.21)	< 0.01
			% Control	94.3		93.4		73.4		80.4	
			% Predicted	93.9		95.1		76.9		83.98	
2	Women	19	Measured	3.78 (0.48)	< 0.05	3.06 (0.41)	NS	3.71 (1.10)	< 0.01	2.24 (1.04)	< 0.05
			% Control	91.7		94.1		72.5		75.1	
			% Predicted	93.8		96.2		76.08		80.97	
3	Women	22	Measured	3.62 (0.66)	< 0.01	2.91 (0.59)	< 0.05	3.64 (1.38)	< 0.01	2.30 (0.92)	< 0.05
			% Control	91.3		90.3		72.4		83.5	
			% Predicted	90.3		92.9		76.5		87.5	
4	Women	67	Measured	3.61 (0.80)	NS	3.06 (0.48)	NS	3.98 (1.19)	< 0.01	2.15 (1.00)	< 0.01
			% Control	92.4		93.2		80.0		78.3	
			% Predicted	95.5		96.2		84.5		82.4	
5	Women	73	Measured	3.38 (0.60)	< 0.01	2.53 (0.53)	< 0.01	4.00 (0.26)	< 0.01	1.96 (1.08)	< 0.01
			% Control	90.5		90.5		85.2		79.4	
			% Predicted	91.6		90.0		88.1		83.8	

Ventilatory capacity data are presented as mean (SD). Measured pre-shift baseline measurements are compared with controls; statistical differences were the same when worker values were compared with controls.

2.0 (range 0.3–5.4) mg/m<sup>3</sup>. Group 1 had the highest dust exposure (total dust 30.0–95.5 mg/m<sup>3</sup>; respirable fraction 3.0–5.4 mg/m<sup>3</sup>), then group 3 (total dust 20.0–35.6 mg/m<sup>3</sup>; respirable fraction 1.5–3.2 mg/m<sup>3</sup>) and group 4 (total dust 4.1–12.4 mg/m<sup>3</sup>; respirable fraction 0.3–1.7 mg/m<sup>3</sup>). These values for total dust exceed the maximum allowable concentrations for organic dust (vegetable and animal) prescribed by the Croatian occupational standards (total dust 10 mg/m<sup>3</sup>; respirable fraction 3 mg/m<sup>3</sup>). Concentrations of ethyl alcohol vapours varied from 316 to 3421 ppm, and were also often higher than allowed by the Croatian standard (1000 ppm).

### Discussion

Our data suggest that work in confectionery plants may cause the development of chronic respiratory symptoms accompanied by deterioration in lung function in many workers. These changes are particularly pronounced in those workers exposed to the dust of flour, starch, and sugar as well as in those exposed to alcohol vapours (groups 1 and 2).

Baur *et al*<sup>26</sup> suggested that various baking components, especially mould enzymes play a significant part in the causation of baker's asthma. In their study 5% to 24% of bakers were sensitive to several carbohydrate splitting enzymes as well as to soy flour. Our previous study of soy bean workers showed that working

with soy flour is associated with the development of respiratory symptoms and changes in lung function.<sup>27</sup>

Taytard *et al*<sup>28</sup> showed that in flour mill workers there was a significantly higher prevalence of chronic cough, chronic phlegm, and airway hyper-reactivity than in control workers ( $p < 0.01$ ) but no differences were noted in prevalences of asthma or allergy. Debelic and Sarvan found considerably higher prevalences of asthma and rhinitis (58%) in bakers than we found in our group 1 workers (nasal catarrh: 19.2–24.1%; asthma 3.8%).<sup>5</sup> Recently Musk *et al*<sup>4</sup> recorded that 35% of workers in a British bakery reported chest tightness and 38% complained of nasal catarrh, which is similar to the findings in our present study of confectionery workers. The same authors demonstrated that the standardised FEV<sub>1</sub>/FVC ratio tends to decrease with increasing duration of exposure. One third of their workers had measurable bronchial hyper-reactivity (PD<sub>20</sub> < 120 μmol). DeZotti *et al* studied bakers, confectioners, and pizza makers and found that 25% to 26% of exposed workers complained of chronic respiratory symptoms. They also described upper respiratory symptoms such as eye and nose irritation and chest tightness with prevalences of 16.6% to 21.4% respectively.<sup>29</sup> Jarvinen *et al* found that among 234 bakery workers 23% had allergic rhinitis and 9% had asthma.<sup>30</sup> These data for rhinitis are similar to those



obtained in our workers (nasal catarrh 13.6—26.3%). We found a somewhat lower prevalence of asthma, however, (range 1.5—4.5%), which is most likely due to a healthy worker effect. None of our seven subjects with occupational asthma had a history or signs of prior atopic disease before starting work in this confectionery.

Nuts and chocolate have often been reported as a cause of allergic reactions. Settupane described "restaurant syndrome" caused by food allergens such as peanuts, walnuts, and other foods.<sup>31</sup> Allergy to chocolate was reported by Maslansky and Wein who found clinical symptoms of allergy in 38% of their subjects, which were reproduced after ingestion of cocoa capsules.<sup>32</sup>

Workers in confectionery are also exposed to egg powder. Langeland has reported that egg white may provoke various symptoms in hypersensitive people and may act as an allergen by inhalation as well as by ingestion.<sup>32</sup> Edwards *et al.*<sup>33</sup> described the development of asthmatic symptoms in eight of 13 workers exposed to the spray of an egg solution used to coat meat balls. In our study one woman in group 1 complained of chest tightness, difficulty in breathing, and itchy skin when exposed to an egg powder.

In our study many of the confectionery workers complained of acute headache during the workshift (range 39.7—54.5%). Similar results have been obtained in our previous studies of workers exposed to coffee,<sup>34</sup> tea,<sup>35</sup> soy,<sup>27</sup> and spices.<sup>36</sup> Frequent headache due to exposure to wheat, orange, eggs, tea, coffee, chocolate, milk, corn, cane sugar, and yeast were also reported by Grant.<sup>37</sup> Migraine due to exposure to chocolate has been reported by Blamoutier.<sup>38</sup>

Our data indicate that working in a confectionery plant may result in acute and chronic changes in lung function. Such changes were particularly pronounced for flow rates at low lung volumes (FEF<sub>50</sub> and FEF<sub>25</sub>) suggesting obstructive changes in the smaller airways.

Prevention of the potential airway effects from occupational exposures in confectionery plants requires the environmental control of dust levels. Also, medical surveillance may identify and protect sensitive workers from developing chronic obstructive respiratory disease once respiratory symptoms begin. Lung function tests should be performed before and after the workshift by recording MEFV curves to identify sensitive workers. Those with pre-existing lung disease and smokers may be at particular risk for working in those areas of confectionery manufacture that induce respiratory allergy and acute or chronic respiratory disease.

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