

Do central vacuum cleaners produce less indoor airborne dust or airborne cat allergen, during and after vacuuming, compared with regular vacuum cleaners?

Abstract Vacuum cleaners with a central exhaust may lead to lower airborne dust and allergen concentrations compared with regular vacuum cleaners. In 12 houses, equipped with a central vacuum cleaning system, a standardized vacuum cleaning protocol was performed comparing airborne dust and allergen concentrations between the central system and a regular cleaner. Airborne dust concentrations during (104 vs. 95 $\mu\text{g}/\text{m}^3$) and after vacuum cleaning (38 vs. 36 $\mu\text{g}/\text{m}^3$) were not significantly different. In houses with a cat, Fel d 1 concentrations were also not significantly different either during (6.12 vs. 5.91 ng/m^3) and after (0.64 vs. 0.91 ng/m^3) use of the vacuum cleaners. Airborne dust and Fel d 1 concentrations increased considerably during use of both vacuum cleaners. Compared with central vacuum cleaning systems, conventional modern vacuum cleaners do not cause higher airborne dust or cat allergen concentrations during and after use.

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Practical Implications

This study shows that the amount of dust or cat allergen in the air during and after vacuum cleaning is similar when comparing a central vacuum cleaner with a regular vacuum cleaner. Therefore, allergen avoidance advice given to reduce exposure of allergic asthmatic patients to allergens, does not necessarily have to include switching to a central vacuum cleaner.

Introduction

Manufacturers of vacuum cleaners sometimes suggest health benefits to asthma patients when using their products. Limited differences between different types of vacuum cleaners have been shown, with regard to their ability to reduce airborne dust levels, airborne mite allergen levels (Hegarty et al., 1995; Kalra et al., 1990) and airborne cat allergen levels in real life (de Blay et al., 1998) and under experimental circumstances (Woodfolk et al., 1991), during vacuum cleaning. These studies compared conventional vacuum cleaners, either with or without filters. Central vacuum cleaner systems consist of one, centrally placed vacuum cleaner, with tubing to rooms of the building. The

presumed advantage is that collected dust is vented directly to the outside. Sly et al. (1985) showed that airborne particle counts were lower during and after the use of central vacuum cleaners, compared with conventional vacuum cleaners. Allergen levels were not measured. Rønborg et al. (1999) compared cat allergen levels in 10 homes after vacuuming with a central vacuum cleaner and a conventional vacuum cleaner. After use of the central vacuum cleaner, cat allergen concentrations were lower (median 2.1 ng/m^3) than after use of the conventional vacuum cleaner (median 5.2 ng/m^3). Each house was vacuumed once with the central and once with the traditional vacuum cleaner.

In this study, the difference between central vacuum cleaners and a conventional vacuum cleaner was

assessed with regard to airborne dust and cat allergen concentrations before, during and after vacuuming.

Methods

Twelve homes in the Netherlands, equipped with a central vacuum cleaner were selected. Each home was visited between six and 10 times. During these visits a standardized vacuum cleaning protocol was followed, either using the central vacuum cleaner or a new conventional cleaner (Electrolux Clario, price about €250) which was equipped with a backup filter (not a high-efficiency particulate air filter). The vacuum cleaner to be used for the cleaning protocol was chosen at random on the day of sampling. The vacuum cleaning protocol took 20 min to complete and consisted of vacuuming the floor of the whole living room and any upholstered furniture present in the room. Home visits were done between April and September 2000, with at least 2 weeks between visits to the same house. Only homes with wall-to-wall carpets or rugs in the living room were included. The residents of the homes were not restricted in any way with regard to their behaviour or cleaning habits between study visits.

Dust sampling

Airborne dust was sampled using a method described by Janssen et al. (1998). Samples were collected at 20 l/min without the use of a size-selective inlet. Using these adaptations, we tried to collect a large enough quantity of dust to detect allergens. Dust was sampled on preweighed 37 mm Teflon filters, with a pore-size of 2 µm. Filters were conditioned at 40% relative humidity and 23°C for at least 24 h before weighing. During each sampling day the flow was measured at the start and at the end of sampling day, and the average flow and sampling time were used to calculate airborne dust concentrations. During each home visit three samples were taken: (1) directly before the vacuum cleaning

protocol (30 min), (2) during and immediately after vacuuming (30 min), and (3) for an additional 210 min after that to measure the concentration decay with time. The residents of the homes were present, and told to behave as they were used to do without the dust measurement equipment being present.

Analytical methods

Samples from the four houses with cats were extracted by shaking the filters for 2 h in 2 ml of phosphate-buffered saline-Tween (pH 7.2). Aliquots of the extracts were stored at -20°C until analysis. Extracts were analyzed for Fel d 1, using the sandwich enzyme immuno assay (EIA) method of Indoor Biotechnologies (Cardiff, UK). All extracts were tested undiluted and two- and four-fold diluted. The lower limit of detection was 0.28 ng Fel d 1 per milliliter extract. Mite and dog allergen was not measured as the assays were not sensitive enough to measure airborne allergens in the small amounts of dust collected.

Statistical analysis

Statistical analysis was carried out using SAS 6.12 (SAS Institute, Cary, NC, USA). Ln transformed dust and Fel d 1 concentrations were compared before, during and after vacuuming with the two cleaners, for each house separately, using *t*-tests. Combined analyses were done using PROC MIXED, assuming that measurements carried out in different houses were independent, and measurements carried out in the same house were not.

Results

Table 1 shows characteristics of the 12 houses that were sampled.

Table 2 shows geometric mean dust concentrations, for each house separately. In general, there were no differences between the two cleaners before, during and

Table 1 Characteristics of the 12 houses participating in the study

House	Size of living room (m ²)	Living room floor cover	Pets present	Central vacuuming protocol (<i>n</i>)	Conventional vacuuming protocol (<i>n</i>)
1	25	Wall-to-wall	No	4	5
2	40	Wall-to-wall	Dog	5	4
3	28	Wall-to-wall	Cat	5	5
4	31	Wall-to-wall	Cat	5	5
5	25	Wall-to-wall	Dog	5	5
6	27	Smooth + rug	Dog	4	4
7	30	Smooth + rug	Cat and dog	4	4
8	34	Wall-to-wall	Dog	4	4
9	30	Wall-to-wall	No	5	4
10	32	Wall-to-wall	No	3	3
11	70	Smooth + rug	No	5	3
12	50	Smooth + rug	Cat	4	4

Table 2 Geometric mean of total dust concentrations ($\mu\text{g}/\text{m}^3$) and geometric standard deviation, before, during and after the vacuuming protocol in the 12 houses

House	Before vacuuming		During vacuuming		After vacuuming	
	Central protocol	Conventional protocol	Central protocol	Conventional protocol	Central protocol	Conventional protocol
1	61 (1.77)	73 (1.38)	112 (1.30)	101 (1.68)	38 (1.83)	43 (1.47)
2	68 (1.75)	75 (1.70)	64 (1.29)	62 (1.34)	27 (1.19)	30 (1.36)
3	57 (1.45)	57 (1.61)	127 (2.36)	102 (1.73)	71 (1.79)	59 (1.47)
4	70 (1.71)	51 (3.03)	71 (1.14)	58 (1.41)	31 (1.53)	24 (1.85)
5	88 (1.82)	59 (1.66)	102 (1.35)	114 (2.61)	41 (1.33)	23* (1.28)
6	117 (1.38)	110 (1.33)	160 (1.24)	129 (1.35)	68 (1.14)	65 (1.44)
7	72 (1.65)	45 (1.61)	96 (1.65)	89 (1.16)	25 (1.53)	20 (1.39)
8	98 (1.43)	139 (1.85)	122 (1.59)	91 (2.09)	46 (1.49)	44 (1.58)
9	61 (1.96)	70 (2.53)	129 (1.96)	90 (1.89)	49 (1.43)	46 (1.53)
10	52 (1.89)	90 (1.37)	159 (1.28)	109 (1.38)	26 (1.17)	30 (1.43)
11	51 (1.41)	57 (1.26)	80 (1.28)	151 (2.40)	34 (1.24)	27 (1.25)
12	55 (1.26)	67 (1.91)	98 (1.99)	101 (2.75)	29 (1.62)	54** (1.43)

* $P < 0.01$. ** $P < 0.10$ (t -test for difference between central and conventional protocol).

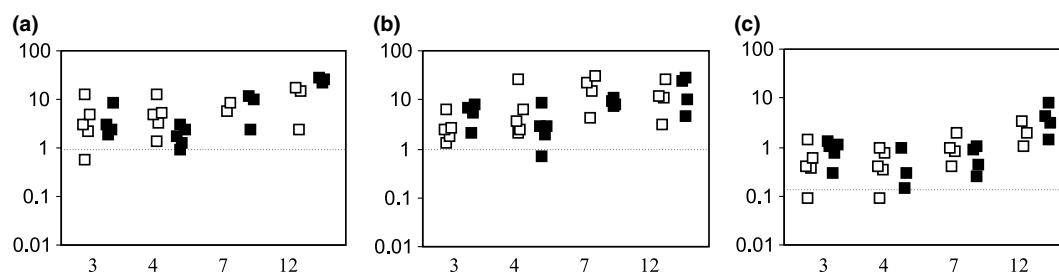


Fig. 1 Comparison of the air Fel d 1 concentration (ng/m^3) (a) before, (b) during and (c) after completion of central and conventional vacuuming protocol in four houses, of which the owners had a cat (---, limit of detection; $\square$, central vacuum cleaner; $\blacksquare$, standard vacuum cleaner)

after cleaning. Average dust concentrations before, during and after cleaning were 67 vs. 70, 104 vs. 95 and 38 vs. 36 $\mu\text{g}/\text{m}^3$, respectively, for the central cleaner vs. the conventional cleaner.

Figure 1 shows airborne cat allergen (Fel d 1) levels before, during and after vacuuming. No differences were found between the two types of vacuum cleaners in any of the four homes. When all data were combined geometric mean of Fel d 1 concentrations were 0.64 and 0.91 ng/m^3 , respectively, after vacuuming with the central vacuum cleaner and the conventional vacuum cleaner. In two of the houses, however, the use of a conventional vacuum cleaner led to higher Fel d 1 concentrations and in the two other houses the central vacuum cleaner did. In the 30 min before and the 30 min during vacuuming, Fel d 1 concentrations were considerably higher but also not different between cleaners.

Discussion

Airborne dust and cat allergen concentrations were not different during and after use of a central vacuum cleaner and a conventional vacuum cleaner.

Sly et al. (1985) found lower particle counts after use of a central vacuum cleaner, compared with a conventional vacuum cleaner. However, there is no relation between particle count and mass so that the two studies are not directly comparable.

In our study, dust concentrations were much lower than the concentrations found by Rønborg et al. (1999) of about 850 $\mu\text{g}/\text{m}^3$ in a similar study. Fel d 1 concentrations were comparable, however, at 2–5 ng/m^3 . The difference can possibly be explained by the differences in sampling methods (high volume vs. low volume in our study), which may lead to more collection of very large particles, which do not contain cat allergen (Rønborg et al., 1999).

Of interest is the difference between dust and Fel d 1 concentrations in samples taken before, during and after vacuuming: concentrations were high both before and during, but not after vacuuming. This is probably related to disturbances generated by entering the homes and setting up equipment. A small study by Durrell et al. (2001) showed that cat allergen concentrations went up by a factor three to five during vacuuming, which is comparable with the differences we found.

In conclusion, we did not find differences in airborne dust and Fel d 1 concentrations comparing central with a new conventional vacuum cleaner. We did observe that airborne dust and Fel d 1 concentrations were much higher before and during vacuuming, which can be explained by activities disturbing settled dust.

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