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Kauppinen *et al.* (2002) described the prevalence of exposure to talc among workers in the on-machine coating of paper. In total, 25 departments were assessed: in 60% of the departments, more than 5% of the workers were exposed to talc, with a median prevalence of exposure of 51–90%. The median level of exposure was assessed as medium ($0.6\text{--}2\text{ mg/m}^3$) by a team of occupational hygienists.

Pooley and Rowlands (1975) examined talc imported into the United Kingdom. These talcs were used in a variety of industries, including cosmetics. Only one of the samples examined contained tremolite (>30%). [The number of samples examined and their use were not given. The electron micrograph of the sample identified as tremolite and the concentration of tremolite are consistent with the Gouverneur District New York State talc, which is unlikely to have been used in cosmetics.] All other elongated particles detected in the samples were identified as laths or rolled sheets of talc, chlorite or sepiolite (several samples).

1.3.3 Consumer exposure

(a) Mineralogical characterization

Two studies that were conducted between 1968 and 1977 examined the mineralogy of consumer talc in the USA.

Cralley *et al.* (1968) examined 22 cosmetic talc products that were purchased off the shelf for particles $>5\text{ }\mu\text{m}$ with a 3:1 or greater aspect ratio (diameter:length) and found that on average 19% of the particles met these dimensional criteria. [No additional information was provided on the source of the talc products, but the Working Group noted that the authors were located in Cincinnati, OH, USA.] The authors concluded that these 'fibres' were predominantly talc, but suggested that some may have been anthophyllite, tremolite, pyrophyllite or chrysotile. [The Working Group noted that no data were provided to support this statement. The statement was based only on the fact that these minerals have been reported to occur in some talc deposits.] Using X-ray diffraction, quartz was found at a level of 0.2–53.4% in these samples. No limit of detection was given, but the lowest concentration reported was 0.2 wt%. Analysis for other minerals was not carried out.

Rohl *et al.* (1976) examined 20 body powders, baby powders and facial talcums and one pharmaceutical talc, all of which were purchased at retail stores in New York City between 1971 and 1975. Based on X-ray diffraction, optical microscopy and transmission electron microscopy, the concentration of tremolite, anthophyllite and quartz was estimated and the presence of several other minerals was established (see Tables 1.14 and 1.15). One of the 21 samples was composed entirely of cornstarch and one contained primarily pyrophyllite and only a small amount of talc. Quartz was present in nine of the 21 samples, tremolite was reported in nine, anthophyllite in seven and serpentine in two samples. Chrysotile was confirmed by transmission electron microscopy in these samples, but no estimates of the concentrations were provided. Krause (1977), in a review of this study, pointed out that the overlap of the X-ray diffraction patterns of tremolite and

anthophyllite makes accurate estimation of their concentration by this method impossible. A similar problem was pointed out for estimates of the concentration of quartz because of overlap with several talc peaks. [The Working Group believed that these criticisms were reasonable and that little reliance can be placed on the reported concentration of tremolite or anthophyllite. The Working Group also noted that Rohl *et al.* (1976) stated that their methodology did not distinguish between asbestos and non-asbestiform mineral fragments. In addition, the representativeness of these samples for other countries or for other areas of the USA is unclear.]

Table 1.14. Concentrations of minerals in 20 samples of body powders, baby powders and facial talcums and one sample of pharmaceutical talc

Mineral	No. of samples	Concentration range (wt%)
Quartz	9	1.6–35.1
Tremolite ^a	9	0.1–10.3
Anthophyllite ^a	7	2.1–11.4
Chrysotile	2	<0.5 ^b

From Rohl *et al.* (1976)

^a Six samples contained both minerals, which resulted in uncertainty about the absolute concentrations given for each mineral.

^b Visual estimates by transmission electron microscopy were given as 0.25–0.5%, but no methodology was provided

Table 1.15. Qualitative measurements of minerals other than anthophyllite, chrysotile, quartz or tremolite in 20 samples of body powders, baby powders and facial talcums and one sample of pharmaceutical talc

Mineral	No. of samples in which the mineral was present
Talc	20 ^a
Chlorite	16 ^b
Calcite	8 ^b
Phlogopite	3 ^b
Pyrophyllite	2 ^b
Dolomite	1 ^b
Kaolin	1 ^b

From Rohl *et al.* (1976)

^a Talc was the major mineral in 19 of the 20 samples.

^b Present in quantities above trace amounts

Paoletti *et al.* (1984) examined talc powders that were used in pharmaceutical and cosmetic preparations. Tremolite was identified in two of six cosmetic talcs on the Italian market. Six of 14 samples provided by the European Pharmacopoeia contained either tremolite, anthophyllite or chrysotile. [No information was provided on the concentration of minerals, including tremolite and quartz, or on the time of purchase.]

Jehan (1984) reported on commercial cosmetic-grade talc (baby and body talcum powder) used in Pakistan between 2000 and 2004. Sixty samples were analysed using atomic absorption techniques, X-ray diffraction, polarized light microscopy and scanning electron microscopy, and the presence of asbestiform chrysotile, both asbestiform and non-asbestiform tremolite and anthophyllite was identified. Asbestiform varieties of tremolite and anthophyllite were uncommon, while chrysotile was common. Respirable quartz was also identified in most (80%) of the samples.

Some products listed by the Cosmetic and Toiletries Formulations Database are shown in Table 1.7. Listing is voluntary and may not be representative of products that are on the market. Tables 1.16 and 1.17 present the average mineral composition of commercial products that were sold under the name of talc in North America and Europe, respectively, in the late 1980s.

(b) Use of talc for feminine hygiene

The use of body powder for feminine hygiene can be estimated from the prevalence reported for controls in case-control studies that investigated the association between the use of cosmetic talc for feminine hygiene and the risk for ovarian cancer.

The prevalence of ever use in these studies is summarized in Table 1.18. Higher prevalences were generally reported in studies from Canada, the United Kingdom and the USA (up to 59%), whereas the lowest prevalences were generally reported in studies conducted in other countries, including China, Greece and Israel (2.2–5.6%).

Studies with high prevalences also reported doses in terms of frequency, duration of use, age at first use or cumulative doses. Frequency of use may vary from a few times per month to more than once a day, and a large proportion of use is more or less daily. Duration of use ranges up to more than 40 years. The cumulative exposure to talc by perineal dusting was over 10 000 days in 4% of the users in one study (Cook *et al.*, 1997). The use of talcum powder for feminine hygiene is acquired in young adulthood, since 80% of women who use body powder start before the age of 25 years (Harlow & Weiss, 1989).

The types of application also vary. Body powder can be applied perineally, on napkins or on underwear. Dusting of the perineum after bathing appears to be the most frequent single type of application, but simultaneous uses have also been reported. Alternatively, exposure may occur as a result of storing a diaphragm in body powder or contamination from the male partner who has used body powder. One study in the USA reported that the use of deodorant spray had a prevalence of 24% (Cook *et al.*, 1997).

In several of the studies in Table 1.18, the interviews on powder use occurred before 1988. Of these, all but one were conducted in the USA. Information on the composition

of baby powder, body powder, facial powder and pharmaceutical talcum powder on the market in New York City before 1976 suggests that many of these products were impure and contained anthophyllite, carbonate, chlorite, chrysotile, phlogopite, pyrophyllite, quartz and tremolite (Cralley *et al.*, 1968; Rohl *et al.*, 1976). After 1976, these powders probably did not contain anthophyllite, chrysotile or tremolite but may have contained up to 10% of other minerals including carbonate, chlorite and quartz (Grexa & Parmentier, 1979). In 1994, baby talcum powder available in the USA typically contained 99% talc; body powder typically contained 65–70% talc and the remaining material was cornstarch, sodium bicarbonate and fragrance (Zazenski *et al.*, 1995).

(c) *Other uses of cosmetic talc*

Russell *et al.* (1979) and Aylott *et al.* (1979) reported exposure to respirable dust during the use of talcum powders on the face, body and babies. Russell *et al.* (1979) took 48 measurements during baby dusting operations and 44 measurements during the application of powders to adult bodies. Adult exposure was assessed during normal face/body powdering practices by placing cyclone samplers on shelves at an appropriate height or by positioning a cyclone attached to a headband near the nose (i.e. in the breathing zone). Exposure to respirable dust was $2.03 \pm 1.48 \text{ mg/m}^3$ during adult application and was estimated to be 0.19 mg/m^3 for babies. The estimated duration of the application was 1.23 minute for adults and 0.52 minute for babies.

Aylott *et al.* (1979) measured levels of exposure to respirable dust during the application of loose face powder (24 measurements), adult dusting powder (43 measurements) and baby dusting powder (32 measurements). In the study of baby dusting powder, a doll was used. The exposure to respirable dust during face powdering ranged from <0.1 to 1.7 mg/m^3 (duration, 10–25 seconds), that for adult dusting powder ranged from 0.2 to 3.3 mg/m^3 (duration, 15–80 seconds) and that for baby powders ranged from <0.1 to 0.9 mg/m^3 (duration, 15–60 seconds).

(d) *Other exposures*

Talc is used as a surface lubricant on the majority of condoms manufactured; contact with condoms may also represent a direct means of exposure of the female genital tract to talc (Kasper & Chandler, 1995).

Exposure to talc can also occur during surgical procedures when using powdered gloves. Talc particles were observed in the navels of small children, in the testes, on the vocal cords, in the urinary bladder tract and after removal of varicose veins (Ramelet, 1991; Simşek *et al.*, 1992). During breast implantations, it is possible that talc from surgical gloves can lead to unwanted encapsulation (Chandler & Kasper, 2003).

1.3.4 *Environmental exposure*

Talc is often detected as a common anthropogenic contaminant in suspended sediment, even in remote snowfields in the Alps; this has been ascribed to its emission