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The Correlation Between Symptoms, Frequent Use of Dental Polymers, and Evaluation of Health Risk

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Dental personnel are at risk as they manually handle polymer products containing monomers and additives that cause irritation and induce allergy. Gloves and face masks can be easily penetrated by monomers. A total of 587 dental personnel and a referent group (585) in the 2 most northern regions of Sweden were included in a questionnaire study (response rate 76%). Questions were asked regarding symptoms of atopy, asthma, conjunctivitis, atopic dermatitis, hand dermatitis, and hay fever/rhinitis. The dental personnel were asked to give the name of polymer products used in their practice and the frequency of use. They were also asked to risk evaluate 5 different types of polymer materials on a scale from 1 to 5. Analysis was done to find if the occurrence of a symptom was associated with a high risk evaluation of a polymer material, or with frequent use of a certain polymer product. Significantly more dentists reported symptoms of atopic dermatitis and conjunctivitis compared to referents and chair assistants. Results show that dental personnel with symptoms risk evaluated most materials significantly higher than dental personnel without symptoms. Further, the occurrence of some symptoms was associated with frequent use of 8 polymer products.

dental personnel correlation analysis self-reported symptoms
dental polymer use health risk evaluation

1. INTRODUCTION

Dentistry uses a variety of different polymer materials. Most dental polymer materials are based on methyl methacrylate and its polymers,

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for example, dentures, crowns, bridges, artificial teeth, orthodontic appliances, temporary constructions, tooth coloured restorative materials, adhesives, pit and fissure sealant. Some, that is, glass ionomers, polyether, and silicone are based on polyelectrolytes, for example, poly (acrylic) acid (Ruyter & Oysaed, 1988). The polymerisation is initiated chemically by mixing two components, or by light (visible or UV light). Polymerisation of crowns, bridges, and dentures is initiated by heat. Initiators and accelerators are added to trigger the polymerisation, inhibitors and antioxidants to improve stability during storage, and cross-linking agents to improve mechanical properties. Apart from additives, many polymers also contain fillers of, for example, glass, quartz, and silica. In contrast to industrial use, dental use of acrylates requires manual handling.

Many studies have shown that methyl methacrylate can irritate skin, eyes, and the respiratory tract. Stevenson (1941) and Moody (1941) were the first reporting about hypersensitivity to methacrylate. Stoy (1952) reported about dental technicians who developed hand dermatitis due to handling methyl methacrylate. Several studies later on documented that methyl methacrylate, and its polymers, can cause skin irritation like contact dermatitis (Hensten-Pettersen & Jacobsen, 1991; Kanerva, Estlander, Jolanki, & Tarvainen, 1993; Munksgaard & Knutsen, 1990). Respiratory and eye-related symptoms have also been reported (Estlander, Kanerva, Kari, Jolanki, & Mölsö, 1996; Savonius, Keskinen, Tupparainen, & Kanerva, 1993). External primary irritants produce an acute inflammatory response, self-limiting once the irritant has been removed (Milne, 1976). The most serious aspect is the sensitisation capacity of chemicals. Once sensitisation is induced it is self-perpetuating. Important factors for sensitisation capacity are, for example, the ability to react with skin proteins, and the ability to penetrate the skin. Methyl methacrylate and its polymers have been shown to induce sensitisation in humans (Estlander et al., 1996, Kanerva, Estlander, Jolanki, & Henriks-Eckerman, 1995a; Kanerva et al., 1993; Kanerva, Estlander, Jolanki, & Tarvainen, 1995b; Koppula, Fellman, & Storrs, 1995; Munksgaard & Knutsen, 1990; Savonius et al., 1993). Also, many additives in dental polymers are shown to cause sensitisation (Arisu, Hayakawa, Ogino, Matsunga, & Kaniwa, 1992; Kanerva et al., 1993; Torres, Mano-Azul, Correia, & Soares, 1993; Tosti, Bardazzi, Piancastelli, & Braisle, 1990; Vershueren & Bruynzeel, 1991). Latex gloves give better protection than vinyl gloves but all are easily penetrated by acrylate monomers (Munksgaard, 1992). Studies

have shown that frequent use of latex gloves increases the risk of sensitisation to latex (Tarlo, Sussman, & Holness, 1997). A typical worn dental facemask retains less than 42% of respirable particles (Collard, Vogel, & Ladd, 1991). Further, from an observation study in dental clinics, it was shown that a large number of dental personnel wore their facemask under the nose or chin, and removed gloves before treatment was over (Lönnroth & Shahnavaz, 1997).

The increasing use of different polymer materials in dentistry is a cause of great concern among dental personnel, because they handle the non-reacted polymer products manually, and personal protective devices do not give enough protection.

2. AIM

The aim of this study was to analyse (a) if there was a correlation between occurrence of a self-reported symptom from skin, eyes, or the respiratory tract, with higher health risk evaluation of different types of polymer materials; (b) if frequent use of certain dental polymer material was correlated with occurrence of a self-reported symptom; (c) if use of a certain dental polymer material was correlated with higher health risk evaluation for that type of material.

3. PARTICIPANTS AND METHOD

Two questionnaires (one for the dentist and one for the chair assistant) were sent to the office of all general dental practitioners working in private and public dental care in the two northern regions of Sweden. As referent group, teachers, researchers, and secretaries from university and high schools in the same geographical area were selected. One reminder was sent to non-respondents. Questions were asked regarding age, sex, profession, symptoms of atopy (shortness of breath, cough, a runny nose, eye irritation, skin eruptions, and skin irritation upon exposure to, e.g., pollen, dust, animals, foodstuffs, tobacco, smoke, automobile exhaust, cleaning agents, and dental materials), asthma, hay fever/rhinitis, conjunctivitis, atopic dermatitis, and hand dermatitis.

Dental personnel were asked to give the name of the composite, glass ionomer, bonding, primer, fissure sealant, and cold cured acrylate materials used in their clinic, and mark if they used them daily, usually, or occasionally. Further, they were asked to evaluate five different types

of polymer materials (composite, glass ionomer, bonding, fissure sealant, and cold cured acrylate) with respect to health risk for dental personnel, on a scale from 1 to 5 (1—no risk, 5—very high risk).

For each product name given by dental personnel, frequency of use, that is, total, daily, usual, and occasional use were calculated. All products used by more than 5.6% of dental personnel (22 products) were chosen for analysis. Frequency of use was given scores: 0—do not use, 1—occasionally use, 2—usually use, and 3—use daily.

Logistic regression analysis was used to find if occurrence of a self-reported symptom (atopy, atopic dermatitis, asthma, conjunctivitis, hand dermatitis, and hay fever/rhinitis) was associated with higher health risk evaluation for different types of polymer products (fissure sealant, composite, glass ionomer, bonding, cold cured acrylate). Correlation analysis was also done to find if occurrence of a self-reported symptom was associated with frequent use of any of the 22 polymer products. Further, correlation analysis was done to find if use of any of the 22 polymer products was associated with a higher evaluation of health risk for that type of material. All analyses were done for dental personnel as a group and with regard to age, sex, and profession.

4. RESULTS

A total of 587 dental personnel were included in this study. The response rate was 76% for dental teams. Analysis of non-respondents showed no differences with regard to age and sex. Dental personnel were on average 40–44 years old, ranging from 25 to 65 years. Frequency of symptoms was compared between dental personnel and the referent group which is presented in Lönnroth and Shahnavaz (1998). Prevalence of self-reported symptoms is shown in Table 1. Significant differences between dental personnel and referents are marked with an asterisk (*).

As shown in Table 1, only dentists reported a significantly higher prevalence of eye and skin problems (conjunctivitis and atopic dermatitis), and male dentists—of hand dermatitis.

Dental personnel were asked to give the names of different polymer roducts used in their clinic, and also mark if the materials were used daily or occasionally. Dental personnel reported total use (daily + usually + occasionally) of 1 to 24 different polymer materials with mean 8.4, and *SD* 3.5. Materials used by more than 5.6% of respondents (33 persons)

TABLE 1. Prevalence (in %) of Self-Reported Symptoms Among Dentists, Chair Assistants, and Referents With Regard to Sex ($n = 1172$)

	Dentists		Chair Assistants	Referents	
Symptom	Male $n = 178$%	Female $n = 125$%	Female $n = 284$%	Male $n = 160$%	Female $n = 425$%
Atopy	55.8	62.5	59.3	44.9	56.3
Asthma	12.9	12.0	8.8*	8.8	13.6
Atopic dermatitis	20.2**	24.8***	11.6	9.4	9.6
Conjunctivitis	15.7***	18.4***	3.5	1.3	3.3
Hay fever/rhinitis	30.9	27.2	21.8	24.8	28.2
Hand eczema	15.2*	27.0	19.3	7.5	20.0

Notes. * $p < .05$ compared to female referents; ** $p < .001$ compared to male referents; *** $p < .0001$ male dentists compared to male referents, and female dentists to female referents.

TABLE 2. The 22 Most Commonly Used Dental Polymers, Ranked According to Total Use, as Reported by Dental Personnel ($n = 587$). Content Information Is From Material Safety Data Sheets

		Use			
Product Name	Type of Material	Total (%)	Daily (%)	Occasional (%)	Content Given (%)
Swedon	cold cured acrylate	55.3	6.0	49.3	32–100
Prisma Fil	composite	42.7	30.3	12.4	60–100
Scotchbond	bonding	40.8	31.0	9.8	54
Fuji LC	glass ionomer	37.7	22.6	9.7	30–100
Ketac-Silver	glass ionomer	35.2	19.7	15.5	0
Delton	pit, fissure sealant	33.5	7.1	26.4	5
Fuji I, II	glass ionomer	32.4	19.5	12.9	5–30*, 30–100**
Dyract	compomer	30.6	13.1	17.5	10–30
Prismabond	bonding	23.5	10.2	13.3	30–100
All bond	bonding	23.3	10.5	12.8	61–100
Z100	composite	22.0	17.8	4.2	100
Vitrebond	glass ionomer	22.8	10.2	12.6	100
Prisma Ful-Fil	composite	20.5	14.3	6.2	23.5
Ketac-Fil	glass ionomer	20.2	12.6	7.6	0
Vitremer	glass ionomer	19.0	5.9	13.1	100
Ana-Norm	composite	18.1	12.1	6.0	100
Heliomolar	composite	18.1	9.7	8.4	100
Prisma TP.H	composite	17.9	14.1	3.8	30–90
Prisma AP.H	composite	16.7	13.6	3.1	15–30
ChemFil	glass ionomer	14.0	6.9	7.1	10–30
Heliobond	composite	10.5	5.9	4.6	100
Metabond	bonding	5.6	1.6	4.0	?

Notes. *—powder, **—liquid, ?—no information available.

were analysed and are listed according to total use in Table 2. Product information on physical and chemical properties with regard to, for example, strength, dimensional stability, solubility, and water absorption, including brief information on composition, is enclosed in dental polymer products. Available is also product information on safety data sheets giving, for example, the list of content and precaution information. Information regarding composition was taken from safety data sheets of the materials.

According to Table 2, information in safety data sheets is far from comprehensive. Total composition is not given for many products. Some give, for example, acrylic monomer but not which type, how much, or what else? Further, different products with the same composition give diverse information regarding health risk and precautions. According to the manufacturer, Prisma Fil and Prisma Ful-Fil have now been removed from the market as they do not fulfil the requirements for the European Standard (CE mark).

Dental personnel evaluated—on a scale from 1 to 5—the health risk for themselves when handling fissure sealant, composite, glass ionomer, bonding, and cold cured acrylate. Mean health risk value for each material was calculated for dentists (male and female) and for chair assistants separately, as presented in Figure 1.

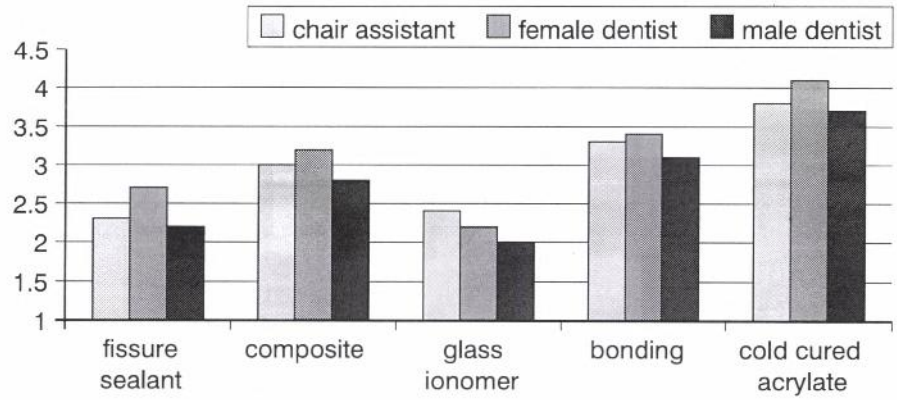

Figure 1. Mean values of risk evaluation for five different types of polymers, as given by 284 chair assistants, 178 male dentists, and 125 female dentists. *Notes.* Scale from 1 to 5 (1—no risk, 5—very high risk).

According to Figure 1, glass ionomer was considered least risky to health, and cold cured acrylate most risky. More than 30% ranked fissure sealant as 1, and bonding as 4 on the risk evaluation scale.

Almost 40% of respondents ranked cold cured acrylate as 5 (very high risk) on the scale. Further, female dentists risk evaluated all materials higher than male dentists and chair assistants.

To find if occurrence of a self-reported symptom correlated with higher risk evaluation of five different types of polymer materials, correlation analysis was done between each symptom and risk evaluation for male dentists, female dentists, and chair assistants as shown in Tables 3, 4, and 5.

TABLE 3. Association Between Self-Reported Symptom and Higher Evaluation of Health Risk for Five Different Types of Polymer Materials as Reported by Male Dentists (n = 178)

Symptom	Fissure Sealant	Composite	Glass Ionomer	Bonding	Cold Cured Acrylate
Atopy	*OR* 1.4 [1.1, 2.0]	*OR* 1.3 [1.0, 1.8]	*ns*	*ns*	*ns*
Atopic dermatitis	*ns*	*OR* 1.6 [1.1, 2.3]	*ns*	*ns*	*ns*
Asthma	*ns*	*ns*	*ns*	*ns*	*ns*
Conjunctivitis	*ns*	*OR* 1.8 [1.2, 2.8]	*ns*	*OR* 1.5 [1.0, 2.2]	*ns*
Hand dermatitis	*OR* 1.8 [1.2, 2.7]	*OR* 1.5 [1.0, 2.3]	*OR* 1.8 [1.1, 3.0]	*OR* 1.5 [1.0, 2.1]	*OR* 1.6 [1.1, 2.5]
Hay fever/ rhinitis	*OR* 1.4 [1.0, 1.9]	*ns*	*ns*	*ns*	*ns*

Notes. *OR*—Odds Ratio and 95% confidence interval, *ns*—nonsignificant.

TABLE 4. Association Between Self-Reported Symptom and Higher Evaluation of Health Risk for Five Different Types of Polymer Materials as Reported by Female Dentists (n = 125)

Symptom	Fissure Sealant	Composite	Glass Ionomer	Bonding	Cold Cured Acrylate
Atopy	*ns*	*OR* 1.5 [1.0, 2.1]	*ns*	*ns*	*ns*
Atopic dermatitis	*ns*	*ns*	*ns*	*ns*	*OR* 1.7 [1.0, 2.7]
Asthma	*ns*	*ns*	*ns*	*ns*	*ns*
Conjunctivitis	*ns*	*OR* 2.1 [1.3, 3.5]	*ns*	*OR* 2.0 [1.2, 3.2]	*OR* 2.5 [1.2, 5.1]
Hand dermatitis	*ns*	*ns*	*ns*	*ns*	*ns*
Hay fever/ rhinitis	*ns*	*OR* 1.7 [1.2, 2.6]	*ns*	*OR* 1.8 [1.2, 2.8]	*OR* 1.8 [1.0, 2.9]

Notes. *OR*—Odds Ratio and 95% confidence interval, *ns*—nonsignificant.

TABLE 5. Association Between Self-Reported Symptom and Higher Evaluation of Health Risk for Five Different Types of Polymer Materials as Reported by Chair Assistants (n = 284)

Symptom	Fissure Sealant	Composite	Glass Ionomer	Bonding	Cold Cured Acrylate
Atopy	*OR* 1.3 [1.0, 1.6]	*ns*	*ns*	*ns*	*ns*
Atopic dermatitis	*ns*	*ns*	*ns*	*ns*	*ns*
Asthma	*OR* 1.7 [1.1, 2.3]	*OR* 1.5 [1.0, 2.2]	*ns*	*ns*	*OR* 1.7 [1.1, 2.8]
Conjunctivitis	*ns*	*ns*	*ns*	*ns*	*ns*
Hand dermatitis	*ns*	*ns*	*ns*	*ns*	*ns*
Hay fever/ rhinitis	*ns*	*ns*	*ns*	*ns*	*ns*

Notes. *OR*—Odds Ratio and 95% confidence interval, *ns*—nonsignificant.

To find if occurrence of a self-reported symptom was associated with frequent use of a certain polymer product, correlation analyses was done between self-reported symptoms and the 22 most commonly used polymer materials. A history of atopy was reported by 57.9% (340) of dental personnel, asthma by 10.7% (63), hay fever/rhinitis by 25.9% (152), conjunctivitis by 10.2% (60), atopic dermatitis by 17.4% (102), and hand dermatitis by 19.1% (112). Analysis was done for all dental

TABLE 6. Significant Correlation Between Frequent Use of Eight Polymers and Occurrence of Self-Reported Symptom for All Dental Personnel (n = 587), Dentists Male (n = 178) and Female (n = 125), and for Chair Assistants (n = 284)

Product Name	Self-Reported Symptom	All Dental Personnel	Dentists		Chair Assistants
			Male	Female	
Swedon	Atopy	*OR* 1.3 [1.0, 1.6]	*ns*	*ns*	*ns*
Metabond	Asthma	*OR* 1.6 [1.1, 2.5]	*ns*	*ns*	*ns*
Prisma Fil	Atopic dermatitis	*OR* 1.2 [1.0, 1.4]	*ns*	*ns*	*OR* 1.4 [1.1, 1.8]
Prismabond	Atopic dermatitis	*OR* 1.2 [1.0, 1.4]	*ns*	*ns*	*OR* 1.3 [1.0, 2.7]
	Hand dermatitis	*OR* 1.2 [1.0, 1.4]	*ns*	*ns*	*ns*
Ketac Silver	Conjunctivitis	*OR* 1.3 [1.0, 1.6]	*OR* 1.4 [1.0, 1.9]	*OR* 1.5 [1.0, 2.1]	*ns*
Prisma AP.H	Conjunctivitis	*OR* 1.3 [1.0, 2.6]	*ns*	*ns*	*ns*
Fuji I and II	Hay fever/rhinitis	*OR* 1.2 [1.0, 1.4]	*ns*	*ns*	*ns*
Heliomolar	Hay fever/rhinitis	*OR* 1.2 [1.0, 1.5]	*ns*	*ns*	*ns*

Notes. *OR*—Odds Ratio and 95% confidence interval, *ns*—nonsignificant.

personnel as a group and for dentists and chair assistants separately. Frequent use of eight materials was significantly correlated with certain symptoms, for dental personnel as a group as shown in Table 6.

In the next step, materials that were significantly correlated with a certain symptom, were analysed with regard to evaluated health risk for that specific material. Analyses were done for all dental personnel, and for dentists (male and female) and chair assistants separately. Results show that only the use of Fuji I and II was associated with higher risk evaluation of glass ionomer for all dental personnel (*OR* 1.3 [1.1, 1.6]) and for chair assistants (*OR* 1.4 [1.1, 1.8]), and the use of Swedon was associated with higher risk evaluation of cold cured acrylate for chair assistants (*OR* 1.3 [1.1, 1.6]).

5. DISCUSSION

A response rate of 76% was considered acceptable. Further, analysis of non-respondents showed no difference in age and the male-to-female ratio. No information was available on the frequency and the materials used from dental companies, or manufacturers. Thus, people were asked to give the name of different polymer materials used in their clinic. As questionnaires were sent to dental offices, it was assumed to decrease the recall bias. However, time required to answer the questionnaires at work may not have always been available, which may have influenced the information given. Correlation between each symptom and each dental material was done starting from the most frequently used according to Table 2. Thus, correlation between asthma and Metabond, conjunctivitis and Prisma AP.H, and hay fever/rhinitis and Heliomolar could be due to chance, especially with regard to the number of different materials (22 variables) and the small number of dental personnel (and sub-groups) with symptoms, that is, 63 with asthma, 60 with conjunctivitis, and 152 with hay fever/rhinitis. Further, the time of the onset of symptoms was asked about but not for how long the material had been used, or if they had changed to other materials due to health problems.

In general the dental personnel reporting symptoms risk evaluated all dental materials significantly higher than those without symptoms, especially male dentists with hand dermatitis (see Table 3). These results

may reflect that dental personnel consider their symptoms to be work-related and due to handling of dental polymers.

It can not be proved that frequent use of certain materials causes certain symptoms in a case-referent study but the relative risk for an exposed group can be approximated. Results showed a significant correlation between some symptoms and frequent use of some materials. These results can be easily supported from literature. Acrylates, as well as acrylic acid, and additives, have the potential to irritate skin, eyes, and the respiratory tract. Acrylates can also cause allergies. Information regarding allergy and polyacrylic acid is still scanty. As dental personnel use on average about 9 different polymer products, some even up to 24 different products, the additive effect can not be neglected.

The highest evaluation of health risks was given by female dentists, which may reflect a greater concern, as significantly more dentists reported symptoms of conjunctivitis, atopic dermatitis, atopy, and hand dermatitis compared to referents and chair assistants. Dental personnel evaluated glass ionomer as least risky to health. Surprisingly, chair assistants using the glass ionomers Fuji I and II risk evaluated this type of material significantly higher than non-users.

From product information regarding composition of dental polymer materials, one can assume that most materials can cause a variety of symptoms. The question is what differences exist between the materials. Why is frequent use of some materials correlated with symptoms whereas others, with a similar composition, are not? What causes the symptoms? Could this be due to components not in the content list? Could it be due to belief? It is obvious that information in safety data sheets, and product information, is far from comprehensive. There is often no consistency between reported health effects and precautionary information. Access to insufficient information probably causes unnecessary concern among dental personnel, especially for those who experience different symptoms. Due to the scanty and diverse product information on content, health risks, and precautions, dental personnel have fewer possibilities to select a product they feel is safe, or to protect themselves.

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