

## Compilation of Research on Occupational Exposure to Chemicals in Salons

Produced by the National Healthy Nail Salon Alliance

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**Blount, B.C., et al., “Levels of Seven Urinary Phthalate Metabolites in a Human Reference Population,” Environmental Health Perspectives. (2000); 108.**

Using a novel and highly selective technique, we measured monoester metabolites of seven commonly used phthalates in urine samples from a reference population of 289 adult humans. This analytical approach allowed us to directly measure the individual phthalate metabolites responsible for the animal reproductive and developmental toxicity while avoiding contamination from the ubiquitous parent compounds. The monoesters with the highest urinary levels found were monoethyl phthalate (95th percentile, 3,750 ppb, 2,610 microg/g creatinine), monobutyl phthalate (95th percentile, 294 ppb, 162 microg/g creatinine), and monobenzyl phthalate (95th percentile, 137 ppb, 92 microg/g creatinine), reflecting exposure to diethyl phthalate, dibutyl phthalate, and benzyl butyl phthalate. Women of reproductive age (20-40 years) were found to have significantly higher levels of monobutyl phthalate, a reproductive and developmental toxicant in rodents, than other age/gender groups ( $p < 0.005$ ). Current scientific and regulatory attention on phthalates has focused almost exclusively on health risks from exposure to only two phthalates, di-(2-ethylhexyl) phthalate and di-isononyl phthalate. Our findings strongly suggest that health-risk assessments for phthalate exposure in humans should include diethyl, dibutyl, and benzyl butyl phthalates.

**Brown, Nellie. “Health Hazard Manual for Cosmetologists, Hairdressers, Beauticians, and Barbers.” Manuals and User Guides, Cornell University (1987).**

**<http://digitalcommons.ilr.cornell.edu/manuals/6>**

**Brown, JJ and Nanayakkara, C. “Acetone-Free Nail Polish Removers: Are They Safe.” Clinical Toxicology. (2005); (43)4: 297-299.**

The following case report highlights the dangers of acetone-free nail polish remover products which are widely regarded as safe. *Case Report*. A 15-month-old presented with coma and cardiorespiratory collapse after sucking on Boots Conditioning Nail Polish Remover Pads®, which was complicated by features of upper airway obstruction, bilateral pneumothoraces, and pneumomediastinum. The child required intubation and ventilation for 5 days along with full supportive management before making a complete recovery. The clinical features in this case resemble those of poisoning due to gamma butyrolactone, the principal component of this nail polish remover. Gamma butyrolactone is rapidly metabolized to gamma hydroxybutyrate on ingestion, a compound whose toxicity is well recognized. Package labeling gave no indication of the potential toxicity of its components. *Conclusion*. We wish to draw attention to the potential toxicity of gamma butyrolactone containing nail polish removers and the need for appropriate labeling of product packaging. Since alternative products are available, these products should be removed from the market.

**Epstein, Samuel. Toxic Beauty: How Cosmetics and Personal Care Products Endanger Your Health: And What You Can Do About It. New York, NY: BenBella Books, 2009.**

**Federman MN, Harrington DE, Krynski K. "Vietnamese Manicurists: Are Immigrants Displacing Natives or Finding New Nails to Polish?" Industrial and Labor Relations Review (2006); 59:302-18.**

Although many people believe that immigrants displace native workers, most economic research finds that immigration has little or no adverse effect on natives' employment outcomes. An unusual opportunity to explore this question in the context of a narrowly defined labor market is afforded by the influx of Vietnamese immigrants into California's market for manicurists. Over the years 1987–2002, the number of these new entrants (35,700) slightly exceeded the total number of manicurists in California in 1987 (35,500). Using data for 34 metropolitan areas over the 16-year period, the authors estimate that for every five Vietnamese who entered the market, two non-Vietnamese were displaced. This displacement appears to have been primarily due to a reduction in the number of non-Vietnamese entering the occupation rather than to an increase in the number of current manicurists leaving it.

**Flaws, Jodi. "Reproductive Outcomes In Salon Employees." Grant 1R01OH008579-01 from National Institute For Occupational Safety And Health, IRG: ZOH1**

Cosmetologists are primarily defined as hairdressers who work in retail or home-based salons. They constitute a major occupational group of female workers who sustain chemical exposures during their reproductive lifespan. In fact, it is estimated that there are between 500,000 and 750,000 cosmetologists in the United States alone, and that 80-85% of these workers are women. In general, cosmetologists are exposed to a variety of chemicals on a daily basis, including bleaches, hair dyes, non-lye relaxers, alcohols, methacrylate, ethylene glycol, and phthalates. Although several of these chemicals are known to cause reproductive dysfunction in animal models, few studies have examined whether they are associated with reproductive dysfunction in humans. In addition, no studies have examined the underlying mechanisms by which chemical exposures in cosmetology businesses are associated with reproductive dysfunction in women. Thus, the proposed work will test the hypothesis that exposure to chemicals used in cosmetology businesses is associated with reproductive abnormalities in women through mechanisms involving destruction of ovarian follicles. To test this hypothesis, this work will 1) determine whether cosmetologists have an increased risk of reproductive abnormalities compared to women who are not cosmetologists and 2) investigate whether cosmetologists have reduced ovarian volume and follicle numbers compared to women who are not cosmetologists. To complete the proposed work, a cross-sectional study will be conducted in 1500 female cosmetologists and 500 women not exposed to chemicals used in hair/nail salons (i.e., retail sales clerks). Each participant will complete a self-administered questionnaire that assesses demographics, reproductive functioning, medical and lifestyle history, and chemical exposures. A subset of women from the cross-sectional study (30 infertile cosmetologists, 30 fertile cosmetologists, and 30 retail sales clerks) will have a transvaginal ultrasound to measure ovarian volume and follicle numbers. Data from the questionnaires will be used to compare reproductive function in cosmetologists and retail sales clerks. Data from the transvaginal ultrasounds will be used to compare ovarian volume and follicle numbers in cosmetologists and sales clerks. The results of this study will help determine whether exposures in cosmetology businesses are associated with reproductive dysfunction in women.

**Froines, J, and Garabrant, D. "Quantitative evaluation of manicurists exposure to methyl, ethyl and isobutyl methacrylates during production of synthetic fingernails." Applied Industrial Hygiene. (1986); 2: 70-74.**

**F. Gallagher, D. Gaubert and M. Hale. "Respiratory hazards of nail sculpture." British Medical Journal. (2003); 327(74220): 1050.**

**Gallicchio L, Miller S, Greene T, Zacur H, Flaws JA. "Cosmetologists and reproductive outcomes." Obstet Gynecol. (2009)May; 113(5): 1018-26.**

**OBJECTIVE:** To test the hypothesis that cosmetologists are at increased risk of poor pregnancy outcomes compared with women of the same age who are not cosmetologists. **METHODS:** Participants were recruited through mass mailing of questionnaires. To be included in the study, respondents to the survey had to be aged between 21 and 55 years and not have had a hysterectomy or oophorectomy. This analysis focused on 350 cosmetologists and 397 women in other occupations who met these inclusion criteria and who reported five or fewer singleton pregnancies. The main outcome measures were miscarriage, stillbirth, the occurrence of maternal health conditions during pregnancy (preeclampsia, high blood pressure, diabetes), hospitalization or physician-ordered bed rest during pregnancy, preterm labor, and premature delivery (before 37 weeks at delivery). **RESULTS:** There were no statistically significant associations between occupation and the pregnancy outcomes after adjustment for age, race, education, and smoking and alcohol use at the time of pregnancy. A statistically significant association was found between race and low birth weight such that nonwhite women were at increased risk of reporting a low birth weight neonate compared with white women (odds ratio [OR] 3.35, 95% confidence interval [CI] 1.53-7.26). Similarly, current smoking was found to be positively associated with miscarriage (OR 1.53, CI 1.09-2.16) and miscarriage or stillbirth (OR 1.64, 95% CI 1.18-2.28). **CONCLUSION:** Risk of adverse pregnancy outcomes among cosmetologists is not increased compared with women of the same age working in other occupations.

**Garlantezec, Monfort, Cordier. "Maternal occupational exposure to solvents and congenital malformations: a prospective study in the general population." Occup. Environ. Med. (2009); 66: 456-463**

**OBJECTIVE:** To study the relations between maternal occupational exposure to solvents during pregnancy and the risk of congenital malformations. **METHODS:** A prospective population-based cohort, specifically designed to study the impact of maternal exposure to solvents on the risk of congenital malformations, began in 2002 in three districts of Brittany (France). 3421 pregnant women were recruited until the end of 2005 by physicians before 19 weeks of gestation and followed through birth. Information on pregnancy outcomes was obtained from the hospital. Occupational exposure to solvents at the beginning of pregnancy was assessed from the women's self-reported occupational exposures at inclusion and from a job-exposure matrix (JEM). Sociodemographic characteristics, lifestyle factors, medical history, diseases during pregnancy were obtained at inclusion and from hospital records. Analyses were restricted to working women (n = 3005). Logistic regressions were used to adjust for potential confounders. **RESULTS:** 30.2% of the working women declared regular exposure to at least one product that may contain solvents. 21.3% of them were classified at least in the medium exposure category using the JEM. Occupations mainly classified as exposed by both assessment methods were hairdressers, nurses' aides, nurses and chemists/biologists. Significant associations were found between major congenital malformations and maternal occupational exposure to solvents, assessed by both self-report odds ratio (OR = 2.48, 95% CI 1.4 to 4.4 for regular exposure vs no exposure) and the JEM (OR = 3.48, 95% CI 1.4 to 8.4 for highest level of exposure vs no exposure). A significant dose-response trend was observed with both assessment methods. Several subgroups of major malformations were associated with maternal exposure to solvents (oral clefts, urinary malformations

and male genital malformations). CONCLUSION: This study provides further evidence of an association between exposure to solvents during pregnancy and the risk of major malformations.

**Gjolstad M, Thorud S, Molander P. "Occupational exposure to airborne solvents during nail sculpturing." Journal of Environmental Monitoring. (2006)May; 8(5):537-42.**

This study describes occupational exposure to acrylates and other solvents during nail sculpturing, including comparative measurements of the exposure using four different sculpturing methods: The acrylic method, the UV-gel method, the acrylic powder method and the resin method. Thirty-two nail technicians working in 22 different salons participated in the study. In total, 92 measurements were performed, comprising 70 solvent measurements and 22 measurements of ethyl 2-cyanoacrylate. The solvents most frequently present in all samples were acetone, ethyl acetate, toluene and n-butyl acetate, measured in 96%, 94%, 91% and 81% of the samples, respectively. The study shows that the overall solvent exposure was low, with all measurements calculated as the additive effect (n = 70) below 20% of the OEL (arithmetic mean 0.06 and range 0.01-0.19). No statistically significant difference between sculpturing methods were observed (p = 0.05).

**Gray, E.L. et al., "Perinatal Exposure to the Phthalates DEHP, BBP, and DINP, but not DEP, DMP, or DOTP, Alters Sexual Differentiation of the Male Rat," Toxicological Sciences. (2000); 58, 350-365.**

In mammals, exposure to antiandrogenic chemicals during sexual differentiation can produce malformations of the reproductive tract. Perinatal administration of AR antagonists like vinclozolin and procymidone or chemicals like di(2-ethylhexyl) phthalate (DEHP) that inhibit fetal testicular testosterone production demasculinize the males such that they display reduced anogenital distance (AGD), retained nipples, cleft phallus with hypospadias, undescended testes, a vaginal pouch, epididymal agenesis, and small to absent sex accessory glands as adults. In addition to DEHP, di-n-butyl (DBP) also has been shown to display antiandrogenic activity and induce malformations in male rats. In the current investigation, we examined several phthalate esters to determine if they altered sexual differentiation in an antiandrogenic manner. We hypothesized that the phthalate esters that altered testis function in the pubertal male rat would also alter testis function in the fetal male and produce malformations of androgen-dependent tissues. In this regard, we expected that benzyl butyl (BBP) and diethylhexyl (DEHP) phthalate would alter sexual differentiation, while dioctyl tere- (DOTP or DEHT), diethyl (DEP), and dimethyl (DMP) phthalate would not. We expected that the phthalate mixture diisononyl phthalate (DINP) would be weakly active due to the presence of some phthalates with a 6-7 ester group. DEHP, BBP, DINP, DEP, DMP, or DOTP were administered orally to the dam at 0.75 g/kg from gestational day (GD) 14 to postnatal day (PND) 3. None of the treatments induced overt maternal toxicity or reduced litter sizes. While only DEHP treatment reduced maternal weight gain during the entire dosing period by about 15 g, both DEHP and DINP reduced pregnancy weight gain to GD 21 by 24 g and 14 g, respectively. DEHP and BBP treatments reduced pup weight at birth (15%). Male (but not female) pups from the DEHP and BBP groups displayed shortened AGDs (about 30%) and reduced testis weights (about 35%). As infants, males in the DEHP, BBP, and DINP groups displayed femalelike areolas/nipples (87, 70, and 22% (p < 0.01), respectively, versus 0% in other groups). All three of the phthalate treatments that induced areolas also induced a significant incidence of reproductive malformations. The percentages of males with malformations were 82% (p < 0.0001) for DEHP, 84% (p < 0.0001) for BBP, and 7.7% (p < 0.04) in the DINP group. In summary, DEHP, BBP, and DINP all altered sexual differentiation, whereas DOTP, DEP, and DMP were ineffective at this dose. Whereas DEHP and BBP were of equivalent potency, DINP was about an order of magnitude less active.

**Gocki, J., M. Wojciechowska & Z. Bartuzi.. "The prevalence of side effects, hypersensitivity and allergy to chosen ingredients of cosmetics, chrome and nickel among the students of cosmetology."(2007). 325-325. Blackwell Publishing.**

**Guidotti S, Wright WE, Peters JM. "Multiple myeloma in cosmetologists." *American Journal of Industrial Medicine.* (1982); 3(2): 169-171**

In an hypothesis-generating activity, data in a population-based cancer registry were analyzed according to occupation and industry. The number of cases of multiple myeloma was found to be excessive for females in the occupation "cosmetologists, hairdressers and manicurists." Race did not explain the excess. People in this occupation have potential exposure to a number of chemicals that produce mutations in bacteria. Studies should be done to investigate the hypothesis that these chemicals cause multiple myeloma in cosmetologists.

**Halliday-Bell JA, Gissler M, Jaakkola JJ. "Work as a hairdresser and cosmetologist and adverse pregnancy outcomes." (2009)May; 59(3): 180-4.**

**BACKGROUND:** Hairdressers and cosmetologists are commonly exposed to chemicals, poor posture and psychological stress that may increase the risk of adverse pregnancy outcomes. **AIMS:** To assess whether work as a hairdresser and cosmetologist during pregnancy increases the risk of low birth weight, preterm delivery, small for gestational age (SGA) and perinatal death. **METHODS:** The 1990-2004 Finnish Medical Birth Registry was used to identify all singletons of hairdressers (n = 10 622) and cosmetologists (n = 2490) and those of teachers (n = 18 594) as the reference group. The main outcomes were sexual differentiation measured as the probability of female gender, low birth weight, preterm delivery, SGA and perinatal death. Logistic regression analysis was used to estimate odds ratios (ORs) adjusted for maternal age, parity, marital status and maternal smoking during pregnancy. **RESULTS:** In logistic regression, the risk of low birth weight (adjusted OR 1.44, 95% CI 1.23-1.69), preterm delivery (adjusted OR 1.21, 95% CI 1.07-1.38), SGA (adjusted OR 1.65, 95% CI 1.38-2.07) and perinatal death (adjusted OR 1.62, 95% CI 1.01-1.60) was higher in hairdressers than in teachers. In cosmetologists, the risk of SGA (adjusted OR 1.53, 95% CI 1.10-2.12) and perinatal death (adjusted OR 1.36, 95% CI 0.62-2.98) was elevated. There were no substantial differences in the sex distribution. **CONCLUSIONS:** This study provides evidence that work as a hairdresser or cosmetologist may reduce foetal growth. Work as a hairdresser may also increase the risk of preterm delivery and perinatal death.

**Heymann, W. "Nail Cosmetics: Potential Hazards." *Journal of the American Academy of Dermatology.* (2007); 57(6): 1069-1070**

**Herd-Losavio ML, Lin S, Druschel CM, Hwang SA, Mauer MP, Carlson GA. "The risk of having a low birth weight or preterm infant among cosmetologists in New York State." *Maternal Child Health Journal* (2009) Jan;13(1):90-7.**

This study sought to determine if female licensed cosmetologists have a higher risk of low birth weight, small-for-gestational-age, and preterm delivery compared to two different comparison groups. **METHODS:** This retrospective cohort study matched 15,003 licensed cosmetologists and a comparison group of 4,246 licensed realtors to birth records in New York State from 1997 to 2003. A second comparison group from the general population of New York State (n = 12,171) was frequency matched to cosmetologists on child's year

of birth, mother's ethnicity and mother's education. RESULTS: A positive association was found for low birth weight when comparing cosmetologists to realtors (adjusted odds ratio 1.36 (95% confidence interval: 1.09, 1.70)). Associations were stronger in non-whites than in whites in each birth weight comparison. Associations observed for small-for-gestational-age or preterm births with either comparison group were close to the null or had wide confidence intervals that included the null. CONCLUSIONS: We observed a slightly increased risk for having a child born low birth weight among cosmetologists compared to another group of licensed professionals. The risk was greater among non-white races in each comparison.

**Hiipakka, D. and Samimi. "Exposure of acrylic fingernail sculptors to organic vapors and methacrylate dusts." American Industrial Hygiene Association Journal. (1987) Mar; 48:230-237.** Personal and area samples for organic vapors and polymethacrylate dust were collected in six different sculptured nail salons. Self-administered symptom questionnaires were completed by 20 female nail sculptors and 20 matched controls. Mean time-weighted average concentrations (TW ACs) of ethyl methacrylate, isopropyl alcohol, butyl acetate and toluene in 17 personal organic vapors samples collected in these establishments were 4.5, 15.6, 0.4 and 0.8 ppm, respectively. The mean TWACs of polymethacrylate dust in 16 personal samples were 0.9 mg/m<sup>3</sup> and 1.4 mg/m<sup>3</sup> for respirable dust and total dust, respectively. The only statistically significant (p<.05) health effect noted among sculptors was throat irritation. Also, nose and skin irritation, drowsiness, dizzy spells and trembling of the hands were reported consistently more often by sculptors than the control group; however, the difference was not statistically significant.

**Hines, J. Cynthia, et al. "Urinary Phthalate Metabolite Concentrations among Workers in Selected Industries: A Pilot Biomonitoring Study." The Annals of Occupational Hygiene. (2009); 53(1): 1-17.**

Phthalates are used as plasticizers and solvents in industrial, medical and consumer products; however, occupational exposure information is limited. We sought to obtain preliminary information on occupational exposures to diethyl phthalate (DEP), di-*n*-butyl phthalate (DBP) and di(2-ethylhexyl) phthalate (DEHP) by analyzing for their metabolites in urine samples collected from workers in a cross-section of industries. We also obtained data on metabolites of dimethyl phthalate (DMP), benzylbutyl phthalate (BzBP), di-isobutyl phthalate and di-isononyl phthalate. We recruited 156 workers in 2003–2005 from eight industry sectors. We assessed occupational contribution by comparing end-shift metabolite concentrations to the US general population. Evidence of occupational exposure to DEHP was strongest in polyvinyl chloride (PVC) film manufacturing, PVC compounding and rubber boot manufacturing where geometric mean (GM) end-shift concentrations of DEHP metabolites exceeded general population levels by 8-, 6- and 3-fold, respectively. Occupational exposure to DBP was most evident in rubber gasket, phthalate (raw material) and rubber hose manufacturing, with DBP metabolite concentrations exceeding general population levels by 26-, 25- and 10-fold, respectively, whereas DBP exposure in nail-only salons (manicurists) was only 2-fold higher than in the general population. Concentrations of DEP and DMP metabolites in phthalate manufacturing exceeded general population levels by 4- and >1000-fold, respectively. We also found instances where GM end-shift concentrations of some metabolites exceeded general population concentrations even when no workplace use was reported, e.g. BzBP in rubber hose and rubber boot manufacturing. In summary, using urinary metabolites, we successfully identified workplaces with likely occupational phthalate exposure. Additional work is needed to distinguish occupational from non-occupational sources in low-exposure workplaces.

**Hines, CJ, Hopf, NB, Deddens, JA, Silva, MJ, Calafat, AM. "Estimated daily intake of phthalates in occupationally exposed groups." Journal of Exposure Science and Environmental Epidemiology. (2009).**

Improved analytical methods for measuring urinary phthalate metabolites have resulted in biomarker-based estimates of phthalate daily intake for the general population, but not for occupationally exposed groups. In 2003-2005, we recruited 156 workers from eight industries where materials containing diethyl phthalate (DEP), dibutyl phthalate (DBP), and/or di(2-ethylhexyl) phthalate (DEHP) were used as part of the worker's regular job duties. Phthalate metabolite concentrations measured in the workers' end-shift urine samples were used in a simple pharmacokinetic model to estimate phthalate daily intake. DEHP intake estimates based on three DEHP metabolites combined were 0.6-850 mug/kg/day, with the two highest geometric mean (GM) intakes in polyvinyl chloride (PVC) film manufacturing (17 mug/kg/day) and PVC compounding (12 mug/kg/day). All industries, except phthalate manufacturing, had some workers whose DEHP exposure exceeded the U.S. reference dose (RfD) of 20 mug/kg/day. A few workers also exceeded the DEHP European tolerable daily intake (TDI) of 50 mug/kg/day. DEP intake estimates were 0.5-170 mug/kg/day, with the highest GM in phthalate manufacturing (27 mug/kg/day). DBP intake estimates were 0.1-76 mug/kg/day, with the highest GMs in rubber gasket and in phthalate manufacturing (17 mug/kg/day, each). No DEP or DBP intake estimates exceeded their respective RfDs. The DBP TDI (10 mug/kg/day) was exceeded in three rubber industries and in phthalate manufacturing. These intake estimates are subject to several uncertainties; however, an occupational contribution to phthalate daily intake is clearly indicated in some industries. *Journal of Exposure Science and Environmental Epidemiology* advance online publication, 16 December 2009; doi:10.1038/jes.2009.62.

**J.E. McNary and E.M. Jackson. "Inhalation exposure to formaldehyde and toluene in the same occupational and consumer setting." *Inhal Toxicol.* (2007); 19: 573-576.**

Formaldehyde, a natural component of all mammalian cells, is metabolized to carbon dioxide. It is a colorless gas used as a preservative and a reactant in chemical processes in a wide variety of commercial and consumer products. Toluene is an organic solvent also used in a wide variety of commercial and consumer products. There is a growing concern that chemical exposure from consumer products including cosmetics adds to the overall toxic exposure bioburden. This study was designed to quantify the actual amount of formaldehyde and toluene exposure to professional nail technicians and their customers during the application of cosmetic nail products containing either formaldehyde or toluene. Formaldehyde concentrations were measured on workers and consumers using treated silica gel absorption tubes. Formaldehyde concentrations varied between 0.0012 and 0.0038 ppm. The results of this study clearly demonstrate that neither workers nor consumers are at any additional risk from exposure to formaldehyde or toluene in cosmetic nail products beyond daily exposure from commercial products in a work setting and in the home.

**John, E., Savitz, D. and Shy, C. "Spontaneous abortions among cosmetologists." *Epidemiology.* (1994) Mar; 5(2): 147-155.**

To examine the relation between adverse pregnancy outcomes and work in cosmetology during pregnancy, we conducted a mail survey in North Carolina among 8,356 licensed female cosmetologists 22-36 years of age. We identified pregnancies between 1983 and 1988 by a brief screening questionnaire, followed by a more detailed mail questionnaire. Seventy-four per cent of eligible cosmetologists responded to each inquiry. We restricted the main analysis to 96 cosmetologists with a spontaneous abortion and 547 cosmetologists with a single live birth who worked full-time in cosmetology or in other jobs during the first trimester of pregnancy. With adjusted odds ratios ranging from 1.4 to 2.0, we found associations between spontaneous abortion and the number of hours worked per day in cosmetology, the number of chemical services performed per week, the use of formaldehyde-based disinfectants, and work in salons where nail sculpturing was performed by other employees. We found no important associations among full-time cosmetologists who performed few chemical services and among cosmetologists who worked less than 35 hours per week.

**Koo, JW, et al. "The association between biomarker-based exposure estimates for phthalates and demographic factors in a human reference population." Environmental health Perspective. (2002) Apr;110(4):405-10.**

Population-based estimates of environmental exposures using biomarkers can be difficult to obtain for a variety of reasons, including problems with limits of detection, undersampling of key strata, time between exposure and sampling, variation across individuals, variation within individuals, and the ability to find and interpret a given biomarker. In this article, we apply statistical likelihoods, weighted sampling, and regression methods for censored data to the analysis of biomarker data. Urinary metabolites for seven phthalates, reported by Blount et al., are analyzed using these methods. In the case of the phthalates data, we assumed the underlying model to be a log-normal distribution with the mean of the distribution defined as a function of a number of demographic variables that might affect phthalate levels in individuals. Included as demographic variables were age, sex, ethnicity, residency, family income, and education level. We conducted two analyses: an unweighted analysis where phthalate distributions were estimated with changes in the means of these distributions as a function of demographic variables, and a weighted prediction for the general population in which weights were assigned for a subset of the population depending on the frequency of their demographic variables in the general U.S. population. We used statistical tests to determine whether any of the demographic variables affected mean phthalate levels. Individuals with only a high school education had higher levels of di-n-butyl phthalate than individuals with education beyond high school. Subjects who had family income less than \$1,500 in the month before sampling and/or only high school education had higher levels of n-butyl benzyl phthalate levels than other groupings. Di(2-ethylhexyl) phthalate was higher in males and/or in urban populations and/or in people who had family income less than \$1,500 per month. Our findings suggest that there may be significant demographic variations in exposure and/or metabolism of phthalates and that health-risk assessments for phthalate exposure in humans should consider different potential risk groups.

**Kreiss, K., R. S. Esfahani, V. C. S. Antao, J. Odenchantz, D. C. Lezotte & R. E. Hoffman. "Risk factors for asthma among cosmetology professionals in Colorado." Journal of Occupational and Environmental Medicine (2006); 48: 1062-1069.**

Problem: After receiving several reports of occupational asthma among cosmetology professionals, we studied the prevalence, work-attributable risk, and tasks associated with asthma in this industry. Methods: We selected a stratified random sample of cosmeticians, manicurists, barbers, and cosmetologists holding licenses in Colorado for a mail survey instrument. Results: The prevalence of physician-diagnosed asthma among the 1883 respondents (68% response rate) was 9.3%. of these, 67 (38%) developed asthma after entering the cosmetology profession. Multivariate analyses showed that hairstyling, application of artificial nails, and shaving and honing were significantly associated with asthma arising in the course of employment ( $P < 0.005$ ) with relative risks of 2.6-2.9. Conclusions: The increased risk of asthma with onset during employment among cosmetologists is probably attributable to their exposure to sensitizers and irritants in tasks demonstrated to be associated with asthma.

**Kwapniewski R, et al. "Occupational exposure to dibutyl phthalate among manicurists." Journal of Occupational and Environmental Medicine. (2008) Jun; 50 (6): 705-11.**

OBJECTIVE: To measure manicurists' exposure to dibutyl phthalate (DBP) at work and to determine whether workplace characteristics influence this exposure. DBP is a reproductive and developmental toxicant in rats and is used in nail polish to hold color and prevent chipping. METHODS: Pre- and post

shift spot urine samples were collected from 40 manicurists. Linear regression compared the relationship between the log of the cross-shift differences in urinary phthalate monoester metabolite concentrations and use of workplace exposure control methods. RESULTS: There was a statistically significant cross-shift increase of 17.4 ng/mL in the urinary concentration of mono-n-butyl phthalate, the major metabolite of DBP. Use of gloves reduced mono-n-butyl phthalate concentrations by 15.1 ng/mL below the pre-shift concentration compared with a 20.5 ng/mL increase if gloves were not worn. CONCLUSIONS: Manicurists are occupationally exposed to DBP and glove use may minimize this exposure.

**Kurt, T.L. "The (internal) dangers of acrylic fingernails." Journal of the American Medical Association, (1990) April; 263(16): 2181**

**Labreche, F., et al. "Characterization of Chemical Exposures in Hairdressing Salons." Applied Occupational and Environmental Hygiene. (2003) Dec; 18 (12): 1014-1021**

Workers in hairdressing salons are exposed to several hundred chemicals, of which a few are possibly detrimental to pregnant workers or their fetuses. In Quebec, a government program provides protective reassignment for exposed pregnant workers. This study was set up to assist public health physicians by describing the exposure levels for ingredients that were measurable (i.e., airborne), selected from a list of possibly detrimental hairdressing ingredients. Twenty-six salons were sampled in Montreal, Canada, between June 1996 and December 1997. At the time of sampling, information on certain work conditions (e.g., chemical services offered, number of clients, average CO(2) level during the day) was also noted. Fifty percent of the salons provided additional services other than hairdressing, such as manicures, pedicures, or beauty treatments. Almost half of the salons were quite small, with less than 5 employees. Average temperature ranged between 17 and 26 degrees C, relative humidity between 18 and 59 percent and average CO(2) concentrations from 583 to 4301 mg/m(3). Duration of samples varied between 15 minutes and 8 hours. The most prevalent chemicals were alcohols: ethanol, at an average personal concentration of 39.9 mg/m(3), and isopropanol at an average personal concentration of 3.1 mg/m(3). Acetone, toluene, and acetates, all related to manicure services, were also measured in small quantities. An empirical mathematical model brought in evidence that CO(2) levels explained 46 percent of variation in the concentration of ethanol; when number of permanent waves done during the day and relative humidity and temperature were added, the resulting model explained 68 percent of the variations in ethanol. Thus, although the measured concentrations of chemicals were fairly low in this study, it appears possible that on very busy days, especially if other chemical services are performed in the salon, the total mixture of airborne chemicals could reach significant concentrations.

**Latini, Giuseppe et al., "In Utero Exposure to Di-(2-ethylhexyl)phthalate and Duration of Human Pregnancy," Curr Med Chem . (2006) ;13(21):2527-34.**

The diesters of benzene-1,2-dicarboxylic (phthalic) acid, commonly known as phthalates, are a family of industrial compounds, primarily used as plasticizers in enormous quantities for a variety of industrial uses in the formulation of plastics. Di-(2-ethylhexyl) phthalate (DEHP) is the most commonly used plasticizer. These plasticizers are not covalently bound to the polymer and leach out into the environment, thus becoming ubiquitous environmental contaminants. Cumulating evidence points out on the adverse effects of phthalate exposure during intrauterine life. Recently, it has been documented that in utero phthalate exposure is associated with a shorter duration of pregnancy. Phthalates induce and activate a subset of peroxisome proliferator-activated receptors (PPARs) and have an intrinsic pro-inflammatory activity, while some natural PPAR agonists induce cyclooxygenase (COX)-2 expression. To this regard, COX-2 is thought to be overexpressed in chorioamnionitis (CA), a fetal systemic inflammatory response syndrome and a leading cause of preterm birth. An adequate maternal dietary

intake of essential fatty acids, well known anti-inflammatory agents, is indispensable to fetal development. Recently, it has been shown that phthalates alter the placental essential fatty acids (EFAs) homeostasis so potentially leading to abnormal fetal development. Likewise, a possible down-regulation of COX-2 by omega-3 fatty acids has been suggested. As a consequence, maternal supplementation with omega 3 during pregnancy could counteract the adverse effects of phthalates exposure in the human fetus. Here, we analyze the existing evidence on the link between antenatal phthalate exposure and abnormal fetal development, as well as on possible therapeutic tools to fight the adverse effect of this exposure.

**Latini, Giuseppe et al., "In Utero Exposure to Di-(2-ethylhexyl)phthalate and Duration of Human Pregnancy," Environmental Health Perspectives. (2003) Nov; 111 (14).**

Di-(2-ethylhexyl)phthalate (DEHP), the most commonly used plasticizer in flexible polyvinylchloride formulations, is a ubiquitous environmental contaminant. To date, no information exists on the potential health hazards from exposure to DEHP and/or its main metabolite, mono-(2-ethylhexyl)phthalate (MEHP), in high-risk conditions, such as pregnancy and during the neonatal period. The aim of this study was to evaluate prenatal exposure to DEHP and/or MEHP and its possible biologic effects. We measured serum DEHP and MEHP concentrations in the cord blood of 84 consecutive newborns by high-performance liquid chromatography. Relationships between DEHP/MEHP and infant characteristics were tested using Fisher's exact test, unpaired t-tests, and univariate linear regression analyses, and significant differences on univariate analysis were evaluated using multiple logistic regression analysis. We found detectable cord blood DEHP and/or MEHP concentrations in 88.1% of the samples. Either DEHP or MEHP was present in 65 of 84 (77.4%) of the examined samples. Mean concentrations of DEHP and MEHP were 1.19 +/- 1.15 microg/mL [95% confidence interval (CI), 0.93-1.44, range = 0-4.71] and 0.52 +/- 0.61 microg/mL (95% CI, 0.39-0.66, range = 0-2.94), respectively. MEHP-positive newborns showed a significantly lower gestational age compared with MEHP-negative infants ( $p = 0.033$ ). Logistic regression analysis results indicated a positive correlation between absence of MEHP in cord blood and gestational age at delivery (odds ratio = 1.50, 95% CI, 1.013-2.21;  $p = 0.043$ ). These findings confirm that human exposure to DEHP can begin in utero and suggest that phthalate exposure is significantly associated with a shorter pregnancy duration.

**LoSasso GL. "Neurocognitive sequelae of exposure to organic solvents and (meth)acrylates among nail studio technicians." Neuropsychiatry, Neuropsychology, & Behavioral Neurology. (2002) Mar; 15(1):44-55.**

**Objective:** To evaluate neuropsychologic performance among women occupationally exposed to products commonly used in nail studios. **Background:** Organic solvents and (meth)acrylates commonly used in nail studios have known neurotoxic properties. Few studies have examined the potential for cognitive and neurosensory effects of occupational exposure to these substances, and none has addressed exposure occurring in the cosmetics industry. **Methods:** Participants in this study included nail-salon technicians ( $n = 33$ ) and demographically similar controls who had no known history of exposure to toxic chemicals ( $n = 35$ ). The groups were administered psychologic, neuropsychologic, and neurosensory tests. Aspects of the workplace environment (e.g., square footage of the salon, adequacy of ventilation, and hours worked) also were assessed. **Results:** Multivariate analysis of variance (MANOVA) revealed that the nail technicians performed more poorly than did controls on tests of

attention and processing speed ( $p \leq 0.015$ ;  $\eta^2 = 0.20$ ). Olfaction among the nail technicians was below expected performance based on normative data ( $p < 0.001$ ). A trend toward poorer performance by the nail technicians was observed on the MANOVA investigating executive functioning; individual tests within that domain may be worthy of future investigation ( $ps \leq 0.03$ – $0.10$ ). No significant group differences were observed in the domains of learning and memory, visuospatial ability, or fine motor coordination, or on measures of depression and anxiety. Multiple regression indicated that level of occupational exposure as measured by time worked in the industry, adequacy of ventilation, and workplace size predicted 29% of the variance of performance on attentional tasks ( $p \leq 0.04$ ).

**Conclusion:** Exposure to low-level neurotoxicants common to nail studios may result in mild cognitive and neurosensory changes similar to those observed among solvent-exposed workers in other settings. (NNBN 2002;15:44–55)

**LoSasso GL. et al. “Neuropsychological Symptoms Associated With Low-Level Exposure to Solvents and (Meth)acrylates Among Nail Technicians.” Neuropsychiatry, Neuropsychology, & Behavioral Neurology. (2001) Jul/Sep; 14(3):183-189.**

**Objective:** To evaluate reports of neuropsychological symptoms among women occupationally exposed to products commonly used in nail studios. **Background:** Typical preparations found in nail studios contain a variety of organic solvents (e.g., toluene, acetone, formaldehyde) and (meth)acrylates with known neurotoxic properties. Little research has focused on the neuropsychological sequelae of exposure to these substances occurring in the cosmetics industry. **Method:** Participants included nail salon technicians ( $n = 150$ ) and controls ( $n = 148$ ). Nail technicians were compared with demographically similar controls using the Neuropsychological Impairment Scale, a self-reported measure of neuropsychological and psychological symptoms. Aspects of the workplace environment (e.g., square footage of the salon, adequacy of ventilation, hours worked) also were assessed. **Results:** A MANOVA revealed small but significant differences in the overall level of symptoms as well as in individual scales measuring neurologic complaints, cognitive efficiency, memory, verbal learning, and academic skills ( $p < 0.001$ ). Moreover, nail technicians were significantly more likely to score above the clinical cutoffs than were controls on four of the seven clinical scales and two of the three summary indices. Multiple regression analysis indicated that the severity of symptoms was associated with level of occupational exposure ( $p < 0.01$ ). The cumulative impact of workplace size and ventilation were most strongly associated with symptom severity. **Conclusions:** Exposure to low-level neurotoxins common to nail studios results in the self-reported experience of cognitive and neurologic symptoms similar to other types of solvent and (meth)acrylate exposure. The profile of reported symptoms is consistent with deficits typically observed in this type of neurotoxic exposure: neurologic complaints as well as perceived problems with cognitive efficiency, memory, and learning. Additionally, the nail technicians reported a higher overall level of complaints and greater severity of symptoms than did the controls.

**Lovekamp-Swan, L. and Davis, Barbara J., “Mechanisms of Phthalate Ester Toxicity in the Female Reproductive System,” Environmental Health Perspectives. 2003 Feb; 111 (2).**

Phthalates are high-production-volume synthetic chemicals with ubiquitous human exposures because of their use in plastics and other common consumer products. Recent epidemiologic evidence suggests that women have a unique exposure profile to phthalates, which raises concern about the potential health hazards posed by such exposures. Research in our laboratory examines how phthalates interact with the female reproductive system in animal models to provide insights into the potential health effects of these chemicals in women. Here we review our work and the work of others studying these mechanisms and propose a model for the ovarian action of di-(2-ethylhexyl) phthalate (DEHP). In vivo, DEHP (2 g/kg) causes decreased serum estradiol levels, prolonged estrous cycles, and no ovulations in adult, cycling rats. In vitro, monoethylhexyl phthalate (MEHP; the active metabolite of DEHP) decreases granulosa cell aromatase RNA message and protein levels in a dose-dependent manner. MEHP is unique

among the phthalates in its suppression of aromatase and in its ability to activate peroxisome proliferator-activated receptors (PPARs). We hypothesize that MEHP activates the PPARs to suppress aromatase in the granulosa cell. MEHP-, PPAR alpha-, and PPAR gamma-specific ligands all similarly decreased estradiol production and RNA message levels of aromatase in vitro. Our model shows that MEHP acts on the granulosa cell by decreasing cAMP stimulated by follicle stimulating hormone and by activating the PPARs, which leads to decreased aromatase transcription. Thus, the environmental contaminant DEHP, through its metabolite MEHP, acts through a receptor-mediated signaling pathway to suppress estradiol production in the ovary, leading to anovulation.

**Parks, Louise G. et al., "The Plasticizer Diethylhexyl Phthalate Induces Malformations by Decreasing Fetal Testosterone Synthesis during Sexual Differentiation in the Male Rat," Toxicological Sciences. (2000) 58, 339-349.**

Phthalate esters (PE) such as DEHP are high production volume plasticizers used in vinyl floors, food wraps, cosmetics, medical products, and toys. In spite of their widespread and long-term use, most PE have not been adequately tested for transgenerational reproductive toxicity. This is cause for concern, because several recent investigations have shown that DEHP, BBP, DBP, and DINP disrupt reproductive tract development of the male rat in an antiandrogenic manner. The present study explored whether the antiandrogenic action of DEHP occurs by (1) inhibiting testosterone (T) production, or by (2) inhibiting androgen action by binding to the androgen receptor (AR). Maternal DEHP treatment at 750 mg/kg/day from gestational day (GD) 14 to postnatal day (PND) 3 caused a reduction in T production, and reduced testicular and whole-body T levels in fetal and neonatal male rats from GD 17 to PND 2. As a consequence, anogenital distance (AGD) on PND 2 was reduced by 36% in exposed male, but not female, offspring. By GD 20, DEHP treatment also reduced testis weight. Histopathological evaluations revealed that testes in the DEHP treatment group displayed enhanced 3ss-HSD staining and increased numbers of multifocal areas of Leydig cell hyperplasia as well as multinucleated gonocytes as compared to controls at GD 20 and PND 3. In contrast to the effects of DEHP on T levels in vivo, neither DEHP nor its metabolite MEHP displayed affinity for the human androgen receptor at concentrations up to 10 microM in vitro. These data indicate that DEHP disrupts male rat sexual differentiation by reducing T to female levels in the fetal male rat during a critical stage of reproductive tract differentiation.

**Peretz J, Gallicchio L, Miller S, Greene T, Zacur H, Flaws JA. "Infertility among cosmetologists." Reproductive Toxicology. (2009) Nov; 28(3):359-64.**

Although chemicals used in hair salons have been linked to infertility in animal models, little is known about whether exposures in hair salons are associated with infertility in women. Thus, a survey-based study was performed to investigate infertility in 448 cosmetologists and 508 non-cosmetologists working in Baltimore, Maryland and its surrounding counties. Infertility was assessed with questions addressing time-to-pregnancy (TTP) length ( $\geq 12$  months), consulting a medical professional about fertility problems, and taking medication to become or maintain a pregnancy. Occupational exposure was assessed by job tasks and customers served per week. There were no statistically significant associations between working as a cosmetologist and the odds of TTP  $\geq 12$  months, consulting a medical professional about infertility, or taking medication to either become or maintain a pregnancy. The data suggest that cosmetologists are not at increased risk for infertility compared to women of the same age working in other occupations.

**Kwapniewski, R, et al. "Occupational Exposure to Dibutyl Phthalate Among Manicurists." Journal of Occupational and Environmental Medicine. (2008) June; 50(6): 705-711.**

**Objective:** To measure manicurists' exposure to dibutyl phthalate (DBP) at work and to determine whether workplace characteristics influence this exposure. DBP is a reproductive and developmental toxicant in rats and is used in nail polish to hold color and prevent chipping. **Methods:** Pre- and post-shift spot urine samples were collected from 40 manicurists. Linear regression compared the relationship between the log of the cross-shift differences in urinary phthalate monoester metabolite concentrations and use of workplace exposure control methods. **Results:** There was a statistically significant cross-shift increase of 17.4 ng/mL in the urinary concentration of mono-n-butyl phthalate, the major metabolite of DBP. Use of gloves reduced mono-n-butyl phthalate concentrations by 15.1 ng/mL below the pre-shift concentration compared with a 20.5 ng/mL increase if gloves were not worn. **Conclusions:** Manicurists are occupationally exposed to DBP and glove use may minimize this exposure.

**Malkan, Stacy. Not Just a Pretty Face. BC, Canada: New Society Publishers, 2007.**

**Manori, J. Silva et al., "Urinary Levels of Seven Phthalate Metabolites in the U.S. Population from the National Health and Nutrition Examination Survey (NHANES) 1999-2000," Environmental Health Perspectives. (2004) Mar; 112 (3).**

We measured the urinary monoester metabolites of seven commonly used phthalates in approximately 2,540 samples collected from participants of the National Health and Nutrition Examination Survey (NHANES), 1999-2000, who were greater than or equal to 6 years of age. We found detectable levels of metabolites monoethyl phthalate (MEP), monobutyl phthalate (MBP), monobenzyl phthalate (MBzP), and mono-(2-ethylhexyl) phthalate (MEHP) in > 75% of the samples, suggesting widespread exposure in the United States to diethyl phthalate, dibutyl phthalate or diisobutylphthalate, benzylbutyl phthalate, and di-(2-ethylhexyl) phthalate, respectively. We infrequently detected monoisononyl phthalate, mono-cyclohexyl phthalate, and mono-n-octyl phthalate, suggesting that human exposures to di-isononyl phthalate, dioctylphthalate, and dicyclohexyl phthalate, respectively, are lower than those listed above, or the pathways, routes of exposure, or pharmacokinetic factors such as absorption, distribution, metabolism, and elimination are different. Non-Hispanic blacks had significantly higher concentrations of MEP than did Mexican Americans and non-Hispanic whites. Compared with adolescents and adults, children had significantly higher levels of MBP, MBzP, and MEHP but had significantly lower concentrations of MEP. Females had significantly higher concentrations of MEP and MBzP than did males, but similar MEHP levels. Of particular interest, females of all ages had significantly higher concentrations of the reproductive toxicant MBP than did males of all ages; however, women of reproductive age (i.e., 20-39 years of age) had concentrations similar to adolescent girls and women 40 years of age. These population data on exposure to phthalates will serve an important role in public health by helping to set research priorities and by establishing a nationally representative baseline of exposure with which population levels can be compared.

**Maxfield R, Howe HL. Silica Exposure in Artificial Nail Application Salons. Epidemiologic Report Series 97:8. Springfield, Il: Illinois Department of Public Health, November 1997.**  
Abstract unavailable

**NAILS Magazine Statistics - 2008-2009 Industry Statistics.**  
<http://www.nailsmag.com/resources/industryStats.aspx?Interstitial=1>

**"First Study of Vietnamese Salon Industry." *NAILS Magazine*. March, 2007, 76-88.**

[http://www.nailsmag.com/pdfs/features/NA0307\\_Study.pdf](http://www.nailsmag.com/pdfs/features/NA0307_Study.pdf)

**"Industry Outlook." *Nails Magazine*. Nails 2007-2008 The Big Book.**

<http://www.nailsmag.com/pdfView.aspx?pdfName=NAI20072008stats.pdf>

**NailPro Magazine (2007) Salon Survey State of the Industry (Gold Book 2007)**

<http://www.nailpro.com/goldbook/survey07.pdf>

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This study describes occupational exposure to acrylates and other solvents during nail sculpturing, including comparative measurements of the exposure using four different sculpturing methods: The acrylic method, the UV-gel method, the acrylic powder method and the resin method. Thirty-two nail technicians working in 22 different salons participated in the study. In total, 92 measurements were performed, comprising 70 solvent measurements and 22 measurements of ethyl 2-cyanoacrylate. The solvents most frequently present in all samples were acetone, ethyl acetate, toluene and n-butyl acetate, measured in 96%, 94%, 91% and 81% of the samples, respectively. The study shows that the overall solvent exposure was low, with all measurements calculated as the additive effect (n = 70) below 20% of the OEL (arithmetic mean 0.06 and range 0.01-0.19). No statistically significant difference between sculpturing methods were observed (p = 0.05).

**National Toxicology Program Center for the Evaluation of Risks to Human Reproduction,  
Monograph on Di-n-butyl Phthalate (DBP). Brief, March 2003.**

The National Toxicology Program (NTP) Center for the Evaluation of Risks to Human Reproduction (CERHR) conducted an evaluation of the potential for di-n-butyl phthalate (DBP) to cause adverse effects on reproduction and development in humans. DBP is one of 7 phthalate chemicals evaluated by the NTP CERHR Phthalates Expert Panel. These phthalates were selected for evaluation because of high production volume, extent of human exposures, use in children's products, and/or published evidence of reproductive or developmental toxicity. Unlike many phthalates, DBP is not currently used as a plasticizer in polyvinyl chloride plastics. DBP is a component of latex adhesives and is used in cosmetics and other personal care products, as a plasticizer in cellulose plastics, and as a solvent for dyes. The results of this evaluation on DBP are published in a NTP-CERHR monograph which includes: 1) the NTP Brief, 2) the Expert Panel Report on the Reproductive and Developmental Toxicity of Di-n-Butyl Phthalate, and 3) public comments received on the Expert Panel Report. As stated in the NTP Brief, the NTP reached the following conclusions regarding the possible effects of exposure to DBP on human development and reproduction. First, although DBP could possibly affect human reproduction and development if exposures are sufficiently high, the NTP concludes that there is negligible concern for reproductive toxicity in exposed adults. Second, the NTP concludes that there is minimal concern for developmental effects when pregnant women are exposed to DBP levels estimated by the panel (2-10 mg/kg body weight/day). There is no direct evidence that exposure of people to DBP adversely affects reproduction or development, but studies reviewed by the expert panel show that oral exposure to high doses of DBP ( $\geq 100$  mg/kg body weight/day) may adversely affect the prenatal and early postnatal development in rodents. Finally, based on exposure estimates in women of reproductive age, the NTP concludes that there is some concern for DBP causing adverse effects to human development, particularly development of the male reproductive system. NTP-CERHR monographs are transmitted to federal and state agencies, interested parties, and the public and are available electronically in PDF

format on the CERHR web site (<http://cerhr.niehs.nih.gov>) and in printed text or CD-ROM from the CERHR (National Institute of Environmental Health Sciences, P.O. Box 12233, MD EC-32, Research Triangle Park, NC; fax: 919-316-4511).

**Quach, T, et al. "A Preliminary Survey of Vietnamese Nail Salon Workers in Alameda County, California." Journal of Community Health. (2008); 33: 336-343.**

Abstract In recent decades, the nail salon industry has been one of the fastest growing in the U.S. California has over 300,000 workers licensed to perform nail care services. Though little is known about their health, these workers routinely handle cosmetic products containing carcinogens and endocrine disruptors that may increase a woman's breast cancer risk. Additionally, an estimated 59–80% of California nail salons are run by Vietnamese women who face socio-cultural barriers that may compromise their workplace safety and health care access. In a pilot project designed to characterize Vietnamese nail salon workers in Alameda County, California in order to inform future health interventions and reduce occupational exposures, we conducted face-to-face surveys with a convenience sample of 201 Vietnamese nail salon workers at 74 salons. Of the workers surveyed, a majority reported that they are concerned about their health from exposure to workplace chemicals. Additionally, a sizeable proportion reported having experienced some health problem after they began working in the industry, particularly acute health problems that may be associated with solvent exposure (e.g. skin and eye irritation, breathing difficulties and headaches). Our findings highlight a critical need for further investigation into the breast cancer risk of nail salon workers, underscored by the workers' routine use of carcinogenic and endocrine-disrupting chemicals, their prevalent health concerns about such chemicals, and their high level of acute health problems. Moreover, the predominance of Vietnamese immigrant women in this workforce makes it an important target group for further research and health interventions.

**Robinson, CF., Walker, JT. "Cancer Mortality Among Women Employed in Fast-Growing U.S. Occupations." American Journal of Industrial Medicine. (1999); 36(1):186-92.**

Our study examined cancer mortality before the age of 65 for women employed in the fastest growing and/or traditionally female occupations. Analysis of mortality data from 28 U.S. states for 1984-1995 revealed elevated proportionate cancer mortality ratios (PCMRs). The highest PCMRs observed were thyroid cancer among health aides, lymphatic and multiple myeloma among computer programmers, and brain cancer among actresses and directresses. Some of the excess mortality occurred for occupations that have been previously cited. These included elevated breast and ovarian cancer among teachers, Hodgkin's disease among hairdressers and cosmetologists, and thyroid cancer among health aides and therapists. A few of the associations were new, i.e., had not been previously observed. These included cancer of the connective tissue and lymphatic system among computer programmers, ovarian cancer and leukemia among secretaries, and lymphatic cancer and multiple myeloma among child care workers. These findings should be further investigated with epidemiologic and environmental studies.

**Roelofs, C. et al (2006) Nail Salons: Health Effects and Work Environment Characteristics. Presented at the American Industrial Hygiene Conference, Chicago, IL May 17, 2006. <http://www.aiha.org/aihce06/handouts/po125roelofs.pdf>**

**Roelofs, C. et al (2007) Indoor Air Quality in Nail Salons Presented at the American Industrial Hygiene Conference, Philadelphia, PA June 6, 2007. <http://www.aiha.org/aihce07/handouts/po124roelofs.pdf>**

**Roelofs, C. , Azaroff, L. , Holcroft, C., Nguyen, H., and Doan, T. "Results from a Community-based**

**Occupational Health Survey of Vietnamese-American Nail Salon Workers.” *Journal of Immigrant and Minority Health.* (2008) Aug; (10)4: 353-361.**

A community-university collaborative partnership assessed self-reported work-related health effects and environmental factors in Boston's Vietnamese immigrant community via an interviewer-assisted survey. Seventy-one nail technicians responded. Musculoskeletal disorders, skin problems, respiratory irritation and headaches were commonly reported as work-related, as were poor air quality, dusts and offensive odors. The reporting of a work-related respiratory symptom was significantly associated with the reporting of exposure factors such as poorer air quality. Absence of skin disorders was associated with glove use and musculoskeletal symptoms were associated with years worked as a nail technician. Work-related health effects may be common in nail salon work. Chemical and musculoskeletal hazards should be reduced through product and equipment redesign.

**Spencer A., et al. “Control of ethyl methacrylate exposures during the application of artificial fingernails.” *American Industrial Hygiene Association Journal.* (1997) Mar; 58(3):214-8 1997.**

**Spinelli, Gallagher, Band, Threlfall. “Multiple myeloma, leukemia, and cancer of the ovary in cosmetologists and hairdressers.” *American Journal of Industrial Medicine.*(1984) 6(2):97-102.**

In order to evaluate occupational mortality, age standardized proportional mortality ratios (PMR) were calculated for 160 female cosmetologists and hairdressers and 1,001 male barbers and hairdressers utilizing cause of death and occupation statements from British Columbia death registrations collected from 1950 to 1978. Female cosmetologists had elevated risks of death from multiple myeloma (PMR = 619,  $p = .03$ ) and ovarian cancer (PMR = 204,  $p = .09$ ). Male barbers and hairdressers had no corresponding elevated risk of myeloma but had a significantly high risk of death from leukemia (PMR = 188,  $p = .05$ ). Further detailed studies of these occupations would be worthwhile to confirm and extend these findings.