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A screening questionnaire for occupational and hobby exposures during pregnancy

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Background	Occupational and environmental exposures during the prenatal period may be associated with adverse pregnancy outcomes and lifelong health effects. Yet, identification and evaluation of these potential hazards is lacking in routine obstetric care.
Aims	To assess the feasibility of incorporating a self-administered occupational and environmental exposure questionnaire into obstetric clinics.
Methods	A cross-sectional survey assessed prenatal clinic patients at a public hospital who were currently employed and <20 weeks gestation. Questionnaires evaluated job characteristics, workplace and hobby exposures, protective equipment use and symptoms during pregnancy.
Results	Of 69 participants (96% response rate), 46% were predominantly Spanish-speaking. Primary occupations were caregiver (16%), cleaner (14%) and administrative assistant (14%). Overall, 93% were exposed to a workplace hazard, with most participants reporting physical stressors (82%) or organic solvent exposure (78%). Most women (74%) used some personal protective equipment. Nearly half (54%) reported at least one non-pregnancy symptom, and 52% were referred for follow-up with an occupational medicine practitioner. Household and hobby-related chemical exposures were common in our sample (91%). We observed moderate consistency between job task and chemical use responses: 67–99% of intentionally redundant questions were fully or partially matched. Closed- compared to open-ended activity questions identified a higher proportion of physical stressors (82% versus 12%) and cleaning product (76% versus 30%) exposures.
Conclusions	A self-administered questionnaire is an effective screening tool for identifying women with occupational and hobby-related exposures during pregnancy. Consistent incorporation of exposure assessment into prenatal care can improve clinical communications and early interventions for at-risk pregnant women.
Key words	Chemical exposures; occupational health; pregnancy; questionnaire; screening; workplace hazards.

Introduction

There is increasing concern regarding the effects of environmental toxins on human reproduction and development [1,2]. Preconception and prenatal exposures to environmental toxins are pervasive and can have lifelong detrimental effects [3,4]. Occupational exposures to reproductive and developmental toxins are of particular concern, as workers may be exposed to higher concentrations than the general public [5,6]. Work-related exposures including pesticides, heavy metals, solvents, ionizing radiation, anaesthetic gases and physical hazards have been associated with adverse pregnancy and developmental outcomes such as spontaneous abortion, pre-term birth, reduced birth weight and impaired neurological development [5,7–9].

The public health implications of these exposures are significant, as the proportion of children born to working mothers has been steadily increasing in recent decades [2]. Under US regulations, rigorous pre-market testing of environmental chemicals remains limited particularly compared to European new chemicals management

Key learning points

What is already known about this subject:

- Occupational and environmental exposures during preconception and prenatal periods can be associated with adverse health outcomes.
- The current regulatory structure may not protect pregnant workers from reproductive and developmental toxins.
- Healthcare providers face barriers to addressing reproductive environmental health topics, and reliable methods to screen pregnant women for potentially harmful exposures are needed.

What this study adds:

- Self-administered questionnaires can be a feasible and effective screening tool for occupational and environmental exposures in prenatal care settings.
- Occupational and household exposures, particularly to physical stressors and organic solvents, during pregnancy were highly prevalent in our study population.
- Closed-ended questions performed better than open-ended questions at identifying job activities associated with common physical and chemical hazards.

What impact this may have on practice or policy:

- Future research and public health interventions are needed to better identify household and hobby-related exposures during pregnancy.
- Women's health practitioners adopting our self-administered questionnaire may overcome barriers to communicating with patients about potential environmental health risks.
- Population-level policy changes are needed to reduce the burden of occupational and environmental hazards, particularly among low-income pregnant women.

programs [10]. Furthermore, occupational exposure standards do not routinely consider reproductive and developmental outcomes [2,11]. Safety Data Sheets (formerly called Material Safety Data Sheets) can inform workers and healthcare providers about workplace chemical hazards. However, Safety Data Sheets are not required to report reproductive effects, frequently lack information on sub-acute and chronic exposures and can be inaccessible to workers with limited education or English-language abilities [12,13].

Home-based and craft activities (e.g. jewellery making, gardening, ceramics and silk-screening) can contribute additional risk for chemical exposures, including exposures to chemicals with reproductive effects like heavy metals, solvents and pesticides [14]. Compared to the occupational setting, home and hobby exposures often lack adequate controls [15]. Families may also undertake home renovation projects during the prenatal period that can increase the potential for hazardous chemical exposures, particularly in areas with older housing [15].

The lack of robust safety information leads many pregnant women to consult their obstetric providers for advice regarding environmental and occupational risks [13]. Healthcare providers are uniquely positioned to obtain exposure histories, communicate current research, raise awareness of potential hazards and provide guidance regarding protective measures [5]. However, a survey of obstetricians found significant barriers to addressing reproductive environmental health topics including uncertainty about environmental health data, concerns about raising patient anxiety and ability to reduce harmful exposures [16].

To bridge this gap, we implemented a self-administered questionnaire to assess the feasibility of incorporating chemical exposure questions into routine obstetric care. The Pregnancy and Work Questionnaire was developed in collaboration with the Hazard Evaluation System and Information Service (HESIS) of the California Department of Public Health, the University of California Berkeley, and the University of California San Francisco (UCSF) Program on Reproductive Health and the Environment (PRHE). This cross-sectional analysis describes the prevalence of chemical exposures, associated symptoms and protective measures for occupational and hobby activities among prenatal clinic patients at Zuckerberg San Francisco General Hospital (ZSFG).

Methods

Participants receiving prenatal care from ZSFG Women's Health Centre were recruited between March and August 2011. ZSFG is a public hospital, whose prenatal clinic serves predominantly low-income and minority women. Women were invited to participate if they were over 18 years old, English or Spanish-speaking, <20 weeks gestation and currently working. Eligibility was restricted to early gestation to capture potential exposures during organogenesis, a critical window for foetal development [1,17]. Only employed women were included so

that appropriate interventions or workplace adjustments could be made, if necessary.

Eligible women were selected by convenience sampling. All participants were given information leaflets on protection from chemical exposures and the HESIS toll-free workplace hazard helpline. Qualified PRHE staff reviewed questionnaires within 24 h of completion, and referred selected participants to the UCSF occupational and environmental medicine (OEM) clinic for additional follow-up. Participants qualified for referral if they reported a combination of occupational or hobby chemical exposures (or employment in an industry, occupation or job task associated with chemical exposures) and non-pregnancy-related symptoms. Additional criteria considered were symptom remission at home and the participant's belief that symptoms were work-related [18]. Obstetric providers were notified of all occupational medicine referrals. Written informed consent was obtained from all participants, and the study was approved by the institutional review board at UCSF.

The Pregnancy and Work Questionnaire was designed to screen pregnant women at risk of hazardous occupational or hobby-based exposures. The questionnaire assessed the following during pregnancy: industry, workplace activities, physical stressors, chemical exposure and frequency of use, symptoms, use of personal protective equipment (PPE), and hobby activities and chemicals used (Pregnancy and Work Questionnaire, available as Supplementary data at *Occupational Medicine* Online). The instrument incorporated assessment of exposures for which there is strong evidence of adverse reproductive and developmental outcomes, determined by literature review and consultation with HESIS.

We used intentionally repetitive questions to ascertain which formats yielded the most complete exposure information. The instrument was translated into Spanish, and used simple language and illustrations to increase accessibility for a low-literacy audience. The questionnaire was pre-tested with six women recruited from ZSFG to evaluate the ease of use, comprehension and congruence with occupations and exposures. Minor modifications were made in question wording, but did not result in substantive changes to the instrument.

We defined exposures to physical stressors to include frequent heavy lifting, prolonged standing and heavy physical work. Organic solvents included cleaners, degreasers, glues, nail polish remover, paint, paint stripper and photography processing chemicals. Exposure to X-rays, computerized tomography scans, nuclear medicine and radiotherapy were categorized as ionizing radiation. Heavy metals included mercury, cadmium and lead. We evaluated symptoms of itchy or teary eyes, bloody nose, sneezing, coughing and sore throat. Although nausea, vomiting, headaches, dizziness and skin rashes were also assessed, we considered these symptoms as pregnancy-related and excluded them from the symptom analysis.

Questionnaire responses were entered and managed using REDCap electronic data capture tools hosted at UCSF [19]. For participants with multiple jobs, we used the job with the highest reported hours for our analysis by primary occupation. We conducted descriptive statistics on the study population, job types and chemical exposures. Chi-squared and Fisher's exact tests were used for comparisons of categorical variables.

We analysed intentionally redundant questions for workplace activities and chemicals used. Responses were classified as fully matched if the activity and chemical use frequencies were the same, possibly matched if frequencies only varied by a response of some days versus every day and not matched if frequencies did not correspond. Questions with one missing response were categorized as possibly matched; two missing responses were excluded. Cronbach's alpha was calculated to assess internal consistency of job activity and chemical use questions. Responses to open- and closed-ended questions of two common job tasks (heavy lifting/prolonged standing and cleaning) were also compared for agreement. Analysis of less-common job tasks was not performed due to limited sample size. Data were analysed using R (version 3.3.1).

Results

Of 72 eligible women who were invited to participate, 69 enrolled (96% response rate). Most participants (87%) completed the entire questionnaire, and 97% of questionnaires were more than three-quarters complete. During pilot testing, questionnaires were completed in ~10 min. For questions that allowed open-ended responses, 98% were fully complete. Approximately half of the study population (54%) were predominantly English-speaking, and had a median (interquartile range [IQR]) gestational age of 13.6 (10.6, 16.4) weeks at recruitment. Additional demographics were not collected; however, 89% of the ZSFG clinic population in 2011 self-identified as a racial/ethnic minority and 72% were covered by public insurance.

Participants worked an average of 1.2 jobs during pregnancy, with a range of 1 to 4. Median (IQR) hours worked per week was 25 (15, 37.5). The most common occupations were caregiver/babysitter (16%), cleaner/janitor (14%) and administrative assistant (14%). There were significant differences in job type by primary language spoken ($P < 0.001$). Spanish-speaking participants more likely to work as cleaners/janitors (28% versus 3%) or cooks (22% versus 0%), while administrative assistant (22% versus 6%) and teacher (11% versus 0%) were more common occupations for English-speaking participants. Thirty-six women (52%) were referred to the OEM clinic for additional consultation. Administrative

assistant was the most common occupation referred (19% of referrals), followed by cashier (17%) and caregiver (14%) (Table 1). Among those referred, symptoms included sneezing or bloody nose (36%), coughing or sore throat (36%) and itchy or watery eyes (33%).

Overall, 93% reported exposure to at least one workplace hazard (including chemicals and physical stressors), and 83% reported occupational chemical exposure at least some days. The highest reported workplace hazards were physical stressors, with 82% of participants reporting exposure to frequent heavy lifting or prolonged standing either every day or some days. Organic solvents were the most common workplace chemical exposures (78% reporting exposure at least some days). Most solvent exposures were from cleaning products (65%), nail polish remover (28%) and degreasers (18%) (Table 2).

Table 1. Primary occupations during pregnancy

	Total, *n* (%)	English-speaking, *n* (%)	Spanish-speaking, *n* (%)	Referred for follow-up, *n* (%)
Total	69	37 (54)	32 (46)	36 (52)
Occupation				
Caregiver/babysitter	11 (16)	8 (22)	3 (9)	5 (14)
Cleaner/janitor	10 (14)	1 (3)	9 (28)	4 (11)
Administrative assistant	10 (14)	8 (22)	2 (6)	7 (19)
Cashier	8 (12)	4 (11)	4 (12)	6 (17)
Waitress	8 (12)	5 (14)	3 (9)	4 (11)
Cook	7 (10)	0	7 (22)	2 (6)
Teacher	4 (6)	4 (11)	0	1 (3)
Manicurist/stylist	3 (4)	2 (5)	1 (3)	2 (6)
Retail manager	3 (4)	1 (3)	2 (6)	2 (6)
Artist	3 (4)	3 (8)	0	3 (8)
Delivery person	2 (3)	1 (3)	1 (3)	0

Table 2. Frequency of self-reported workplace and hobby-based exposures during pregnancy

	Every day, *n* (%)	Some days, *n* (%)	Never, *n* (%)
Workplace exposures			
Any workplace hazard (*N* = 69)	30 (44)	34 (49)	5 (7)
Any workplace chemical (*N* = 64)	14 (22)	41 (61)	9 (14)
Physical stressors (*N* = 69)	27 (39)	29 (42)	13 (19)
Organic solvents (*N* = 68)	11 (16)	42 (62)	15 (22)
Cleaners (*N* = 68)	10 (15)	34 (50)	24 (35)
Nail polish remover (*N* = 68)	0	19 (28)	49 (72)
Degreasers (*N* = 66)	4 (6)	8 (12)	54 (82)
Glues or adhesives (*N* = 67)	1 (2)	10 (15)	56 (84)
Paint or paint stripper (*N* = 66)	0	5 (8)	61 (92)
Ionizing radiation (*N* = 66)	0	2 (3)	64 (97)
Ethylene oxide (*N* = 66)	1 (2)	0	65 (98)
Heavy metals (*N* = 66)	0	1 (2)	65 (98)
Pesticides (*N* = 66)	0	1 (2)	65 (98)
Other chemical (*N* = 53)	2 (4)	3 (6)	48 (91)
Hobby-based exposures			
Any hobby exposure (*N* = 67)	9 (13)	52 (78)	6 (9)
Organic solvents (*N* = 67)	9 (13)	52 (78)	6 (9)
Cleaners (*N* = 67)	7 (10)	49 (73)	11 (16)
Nail polish or remover (*N* = 67)	0	31 (46)	36 (54)
Degreasers (*N* = 66)	1 (2)	8 (12)	57 (86)
Glues or adhesives (*N* = 67)	1 (2)	4 (6)	62 (92)
Paint or paint stripper (*N* = 67)	0	3 (4)	64 (96)
Photography chemicals (*N* = 67)	0	1 (2)	66 (98)
Heavy metals (*N* = 62)	0	2 (3)	60 (97)
Pesticides (*N* = 67)	0	2 (3)	65 (97)

Household chemical exposures were also common in our sample, with 13% of women reporting daily exposure and 78% reporting exposure on some days. As with occupational exposures, organic solvents were the most common chemical exposure during hobby activities (91% reporting exposure at least some days). Cleaning products (84%) and nail polish/remover (46%) accounted for the majority of solvent exposures in the home environment (Table 2). Craft activities such as furniture remodelling and painting were reported by 4% and 3% of participants, respectively. English-speaking participants were more likely to report hobby exposures (97% versus 84%), although this result was not statistically significant. There were no significant differences in OEM referrals by household exposures (93% referred versus 88% not referred).

Almost half (49%) of participants reported either direct contact with chemicals or smelling chemicals in the workplace. Overall, 75% of participants reported using at least one type of PPE (Table 3). When this was stratified by referral status, those referred to the OEM clinic had higher use of PPE (86% versus 64%, P = NS). Over half (54%) reported at least one non-pregnancy symptom (i.e. itchy eyes, sneezing, bloody nose, coughing or sore throat). Of these, 27% reported symptom remission outside of work, and 19% expressed a belief that their symptoms were related to the work environment. These proportions were 24 and 26%, respectively, among women referred to the OEM clinic. Only 7% of all participants expressed concerns about connections between workplace safety and their overall health (Table 3).

Table 3. Self-reported chemical contact, PPE use and symptoms experienced at the workplace during pregnancy

	n (%)
Chemical contact and knowledge	
Direct chemical contact (N = 67)	24 (36)
Chemicals smelled (N = 68)	31 (46)
Can find Safety Data Sheet (N = 67)	33 (49)
PPE	
Any type	52 (75)
Gloves	49 (71)
Mask	12 (17)
Fan	32 (46)
Protective clothing	15 (22)
Lab hood	4 (6)
Other	1 (1)
Non-pregnancy symptoms	
Any non-pregnancy symptom	37 (54)
Itchy/teary eyes	15 (22)
Sneezing/bloody nose	16 (23)
Coughing/sore throat	21 (30)
Symptoms related to work (N = 36)	7 (19)
Symptoms remit at home (N = 33)	9 (27)
Coworkers with similar symptoms (N = 37)	2 (5)
Concern about workplace chemicals affecting health (N = 68)	5 (7)

Table 4 details the consistency between reported job tasks and chemicals used, with most questions (88%) fully or possibly matched. The lowest-matched category was for janitorial chemicals and cleaning activities (48% fully matched, 19% possibly matched). Questions correlating exposure and activities for radiation, glues and paints showed the highest consistency with standardized alpha scores of 0.90, 0.70 and 0.66, respectively. Janitorial chemicals, pesticides and degreasers yielded lower standardized alpha scores (all <0.5). To assess the sensitivity of these question types, we compared whether job activity or chemical exposure questions produced more 'yes' responses. Activity questions elicited more responses for janitorial cleaners (76% versus 65%), but fewer for degreasers (6% versus 18%). Other exposures were approximately equal between the two question types (Table 4).

Open-ended job activity questions failed to identify exposures to the two most common hazards in our sample: physical stressors and cleaning products. Eight women (12%) identified a physical stressor such as standing or lifting in open-ended job task descriptions, yet 82% reported this exposure in the closed-ended format. These results were similar for cleaning activities (30% open-ended versus 76% closed-ended question identification).

Discussion

The Pregnancy and Work Questionnaire provided an effective, low-cost tool for screening obstetric patients for chemical exposures and physical hazards. Our questionnaire had high participation and completion rates, indicating its acceptability in the clinical setting. Participant occupations varied widely, and we identified a high prevalence of occupational and hobby exposures. Referral to specialized occupational follow-up care was recommended for approximately half of participants, reflecting a need for counselling on chemical exposures and other environmental hazards during pregnancy.

Clinic workflow was minimally disrupted by study implementation. Questionnaires were quickly completed in the waiting room prior to appointments, and participants required very limited assistance with completion (presumably due the questionnaire's accessible format). A previous study found that significantly less time is required to complete self-administered exposure questionnaires compared to clinical occupational health interviews, while maintaining 'substantial' validity [20]. The availability of clinic staff to review questionnaires poses a potential limitation to large-scale implementation. The study team reviewed questionnaires in several minutes, and obstetric providers without occupational medicine training could similarly apply our systematic criteria when evaluating patients for referral. However, future studies are needed to quantify the administrative

Table 4. Comparison of workplace activities with self-reported chemical use during pregnancy

	Fully matched, *n* (%)	Possibly matched, *n* (%)	Not matched, *n* (%)	Activity exposure[a], *n* (%)	Chemical exposure[a], *n* (%)
Activity (clean floors, sinks, counters) and chemical (janitorial), *N* = 69	33 (48)	13 (19)	23 (33)	51 (76)	44 (65)
Activity (make, use or handle pesticides) and chemical (pesticides), *N* = 67	63 (94)	2 (3)	2 (3)	1 (2)	1 (2)
Activity (work with glues/adhesives) and chemical (glues/adhesives), *N* = 68	57 (84)	2 (3)	9 (13)	10 (15)	11 (16)
Activity (degrease tools and machines) and chemical (degreasers), *N* = 67	55 (82)	2 (3)	10 (15)	4 (6)	12 (18)
Activity (x-ray, CT or radiotherapy) and exposure (x-ray), *N* = 67	64 (96)	2 (3)	1 (2)	3 (4)	2 (3)
Activity (mix, thin or apply paint) and chemical (paint), *N* = 67	62 (92)	2 (3)	3 (4)	1 (2)	4 (6)
Total	334 (82)	23 (6)	48 (12)	53 (77)	51 (74)

[a]Combined categories with a response of 'every day' or 'some days'. Totals reflect any activity or chemical exposure among the matched questions listed.

burden and to assess patient and provider satisfaction with the questionnaire process and outcomes.

Another potential challenge is that timely occupational health advice may not be widely available [21]. However, referral networks like the Paediatric Environmental Health Specialty Units can expand the accessibility of environmental health consultation [22]. Additional capacity-building among obstetricians, which has been recommended by numerous professional organizations, is also warranted to address the multitude of environmental exposures pregnant women experience [5,23,24].

Following questionnaire implementation, tracking outcomes for women referred to OEM providers may provide useful information on whether harmful exposures were reduced. Clinics could conduct follow-up assessments to determine if women made workplace modifications, increased PPE use or discontinued hobbies during pregnancy. Pregnancy outcome data could also be gathered, although demonstrating the effectiveness of interventions would be difficult without more robust exposure assessment, particularly given that PPE may not be effective in all situations [25]. Regardless of clinical outcomes, information on environmental exposures can help inform population-level approaches to reducing risk. Pregnant workers, particularly disadvantaged women, may not have the option to leave a polluted workplace or feel empowered to request modifications. Therefore, meaningful policy changes to promote occupational health during pregnancy are essential.

A substantial proportion of pregnant women reported exposure to workplace hazards in our sample, with 36% reporting direct chemical contact and 83% reporting any chemical exposure at work. Similar international studies among pregnant women have found the prevalence of direct contact with toxic chemicals ranging from 17 to 22% [26,27]. Comparisons across studies can be difficult due to measurement differences. Still, workplace janitorial chemical use was substantially more prevalent among pregnant women in our study (65%) compared to international cohorts (8–14%) [26,27]. Exposure to physical load in our population was also greater than a report of pregnant workers in Spain (82% versus 56%) [27]. Notably, these other study samples were more socioeconomically advantaged and included few foreign-born women. Immigrant, seasonal and low-wage workers often face disproportionate risks from occupational hazards [28]. Therefore, our elevated prevalence may be explained by our likely underserved study population. Our study supports broader findings that disadvantaged women are more likely to experience environmental and other hardships, and efforts are needed to address this health disparity [5].

Our study screened pregnant women for hobby exposures, which to the best of our knowledge, has not been described in the literature. The high proportion of women exposed to chemicals, particularly cleaners and nail polish/remover, through household activities warrants additional research and public health programs targeting these specific risks. While we did not observe significant differences in referral patterns for hobby exposures, the relative contribution of these activities to symptoms or other adverse health consequences remains unclear. Future studies elaborating time spent in hobby activities, PPE used and associated symptoms are recommended to comprehensively characterize hobby exposures during pregnancy.

Our questionnaire assessed exposure information through a variety of methods, including a combination of self-reported exposures, job title and industry and job tasks to more fully capture occupational risk [29,30]. We found that the closed-ended format identified more potential exposures to cleaning products and physical stressors, and we recommend incorporating

closed-ended questions about these activities to increase the sensitivity of identifying common exposures. Closed-ended questions about job activities may also identify at-risk women who are unable to recall specific chemical names [18,30]. Overall, our data did not reveal a consistent pattern favouring job activity over chemical exposure questions. As such, it may be more accurate to ask about job activities and chemical use separately to maximize characterization of all relevant exposures.

Our study had several limitations; the study population and convenience sampling potentially limit generalizability to women of different socioeconomic strata. Including only currently working women may have excluded those who left more hazardous occupations after becoming pregnant and those exposed exclusively through hobby activities. Our sample may be skewed towards lower-income individuals who needed to maintain a source of income during pregnancy. Future studies could explore the questionnaire's validity among more socioeconomically and geographically diverse populations. The timing of questionnaire administration may have occurred too late to capture hazardous exposures occurring during organogenesis, and additional research should investigate adaptation of the instrument to preconception or primary care visits. In addition, the questionnaire was not validated with biological or environmental monitoring. While these metrics would enhance exposure assessment, they may be cost-prohibitive for routine clinical use. Furthermore, the primary aim of the questionnaire was to screen potentially at-risk women for additional referrals or educational interventions, and not for diagnostic purposes.

In conclusion, more robust and consistent incorporation of environmental exposure questions during prenatal visits is needed and feasible. Adoption of our screening tool (or its components) into prenatal intake forms would allow clinicians to better understand their patient population and tailor services to meet these needs.

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Competing interests

None declared.

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