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Industrial Hygiene Aspects of Swimming Pool Service Workers

A thesis submitted in partial satisfaction of the

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by

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ABSTRACT OF THE THESIS

Industrial Hygiene Aspects of Worker Hazards

During Swimming Pool Activities

by

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Master of Science in Environmental Health Sciences

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Professor Shane S. Que Hee, Chair

Swimming pool cleaners are a common sight for swimming pool users across the U.S. These workers do a variety of jobs surrounding pools and spas. Unfortunately, pool worker occupational hazards are not well researched in existing literature. This thesis presents pilot study findings on pool worker hazards. It features two sections: a review of data on the pool industry and a survey of pool service workers in Southern California. The goal was to gather information on workplace hazards for future research. The survey involved 10 respondents and revealed a variety of hazards, including the role of varied work processes, which translated to exposure to different types of hazards. Additionally, workers and their bosses often faced similar

hazards, potentially due to the common occurrence of small businesses. The study serves as a blueprint for further research and recommends partnering with pool supply companies to recruit pool workers.

The thesis of Thomas Rafael Mackey is approved.

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Dedicated to my father, mother, and family.

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1.0. Introduction

The pool service industry is a relatively small niche industry related to the cleaning and maintenance of swimming pools and spas. Residential and commercial swimming facilities require regular cleaning and chemical treatment in order to both stay fit for recreational swimming and to prevent biological hazards to swimmers from microbes. In addition, equipment of all sizes and complexity are installed to ensure cleanliness via water movement through pumps, filtration, and debris collection. As a result, the industry focuses on cleaning of water and maintenance/repair of equipment. Cleaning involves often weekly manual cleaning with chemical maintenance of pool water to prevent biological growth. Maintenance includes the installation and maintenance of the various pool equipment. The unit processes of both will be covered in Section 1.1. The pool service industry consists primarily of small businesses or individuals doing local pool routes rather than larger companies. These small businesses typically involve one or a few workers driving throughout local areas in trucks with pool cleaning equipment in the truck bed to do weekly pool cleaning, often to residential properties.

The pool industry is small with an estimated 50,000 workers in the U.S. (IBISWorld, 2023). In addition, having many businesses with fewer than 10 employees limits the amount of injury data that are reported to federal and state governments in the U.S. Finally, the varied nature of pool service involves a variety of work activities including cleaning, chemical maintenance, plumbing, mechanical repairs, and general maintenance work. This makes it hard to categorize pool work unlike other related industries like landscaping, housecleaning, or plumbing. For example, pool service professionals do not have a Bureau of Labor and Statistics (BLS) job category for tracking, unlike landscapers (NAICS Association, 2023). As a result of these factors, there are very limited data on pool worker hazard exposures and injuries. There is

also limited government oversight due to the nature of the industry. These circumstances mean that there is a research gap on pool service occupational hazards and injuries that could be remedied with further studies. The current research aims to help fill this gap through a pilot study surveying pool service workers throughout Southern California about the hazards that they face throughout their work. The thesis also includes a description of the unit processes of the pool industry as well as a short review of the existing data. Overall, this thesis aims to be a useful starting point for larger, more in depth research to protect pool service workers better from their occupational hazards.

1.1. Unit Processes

Before identifying the occupational hazards that exist with regard to the pool service industry, the unit processes of the different pool occupations need to be examined and specified. In addition, many of the pool workers do many different jobs surrounding pool service. One major way to organize the disparate jobs pool workers may do is by defining the various pool jobs and what they may entail.

Pool workers can have many different job titles. These include pool cleaners, pool boys, pool maintenance technicians, pool equipment repairmen, and pool chemical delivery drivers. Despite not having spa in the name, many or most workers who work on pools in the above categories also work on spas. Pools or spas that are worked on can vary in size and can be either indoors or outdoors. Pools and spas also can be in low-density single-family residential, higher density apartment complexes, and commercial facilities like hotels and motels. In addition, pool workers are often “jacks-of-all trades” regarding pool work which may result in work outside

what their job titles or descriptions entail. For example, many pool cleaners also do work on pool equipment. Major work categories for these jobs include pool cleaning, pool chemical management, pool equipment repair, pool equipment installation, pool chemical delivery, customer service, and administrative work. The current section will discuss the unit processes for each category and will note what pool jobs do what unit processes. Major pool chemicals and pool equipment types will also be covered in the chemical adjustment and equipment repair sections.

Pool cleaning involves the maintenance of pools for health and appearances. Customers want pools both safe to swim in and looking pristine. Pool cleaning also involves sanitization using pool chemicals as part of the process, but not always. The first major process for pool cleaning involves preparing tools for a day of pool cleaning work. These include adjustable steel/plastic pool poles to attach equipment to, pool nets (for surface and underwater debris), pool vacuums for fine debris on the pool floor, pool hoses to connect pool vacuums to pool equipment, pool brushes, and various pool cleaning chemicals. Pool equipment is detailed in Table 1. Preparing pool equipment can be as simple as gathering the equipment and walking to the pool if a pool worker is on-site. However, in a day of work, most pool workers drive to multiple residential and commercial pools using motor vehicles. Preparing to clean pools then may require lifting of pool cleaning equipment and cases of pool chemicals into trucks or other vehicles. Pool cleaners will then drive to pools they need to clean on highways and neighborhood streets. Pools often take about 30 minutes to an hour to clean, so pool cleaners may drive to many pools throughout the workday. Additionally, many pool workers clean pools once a week or month and have weekly/monthly routes like some delivery drivers have.

Table 1. Some Common Pool Cleaning Equipment Names, Use and Types (modified from Hayward Pool Products, 2023)

Pool Cleaning Equipment Name	Use in Pool Cleaning	Types
Pool Pole	Attaches to other pool equipment to increase worker reach	Plastic or metal poles (extending and non-extending for both)
Pool Brush	Brushes stains and algae on pool walls and floor	Plastic or metal brushes
Pool Net	Captures non-fine debris on pool surfaces and floors	Metal or plastic frame nets (shallow, deep, or fine net versions)
Pool Vacuum	Vacuums fine debris on pool floors	Suction side and pressure side vacuums
Pool Hoses	Connect pool vacuums to pool suction or water pressure	Plastic pool hoses or common garden hoses
Soap Bottles	Clear visible matter on pool surfaces	Usually use dish soap
Pool Chemicals	Have many uses including sanitation, pH balancing/ control, water hardness balancing/control, and more	Have a large variety of chemicals including liquid chlorine, muriatic acid, soda ash, and more

Upon reaching the pool or spa needing cleaning, pool workers clean various parts of the pool using their set of tools. One of the most common ways of cleaning is netting. Pool/spa netting involves attaching a pool net to a pool pole and using the extended net to collect debris without going into pool/spa water. The tool allows manual removal of surface debris and underwater debris. Heavier objects are often collected with the pool net before moving to other types of cleaning. Debris collected in the net is then emptied into trash cans. Plant debris can be emptied onto or near close-by plants.

Pool vacuuming is a process that uses the suction from a pool pump or water pressure from a garden hose to "vacuum" (remove) debris at the bottom of the pool or spa. Long plastic pool hoses are attached to connect the pool equipment system (usually at a pool skimmer) to gain suction at the vacuum head, and the pool worker then attaches the vacuum to the long pool pole to reach the bottom of the pool/spa from outside the water. Debris goes straight to the pool filtration system and pump basket with this method. Other vacuums include garden hose versions that use the water pressure from the hose to push debris into a net rather than a negative pressure system. Both types of vacuums are moved slowly on a pool floor, but garden hose vacuums require net emptying.

Another major process of pool cleaning is brushing. Sides of the pool, especially pool tiles, can have debris collected on them that needs to be brushed off. Additionally, green or black algae may collect on the sides or bottom of the pool and need to be removed manually. Plastic or metal brushes are attached to the pool pole, letting pool workers brush from outside the pool water. Tiles are gently bushed using plastic brushes to release debris into the pool, which can then be netted or vacuumed. Algae can be brushed using plastic brushes or steel brushes when not on tile. Algae removal often requires vigorous brushing into the pool water. Algae are then

automatically collected by the pool filtration system into the pool filters. Pool cleaners will often also test pool water and adjust pool chemical levels.

Pool chemicals are typically seen as part of the pool cleaning process. Some common pool chemicals are listed in Table 2. Pool chemical maintenance is one of the most important parts of the pool maintenance process and is a crucial part of keeping swimmers safe from algae, bacteria, and other microbes causing waterborne illnesses. First, pool or spa water are tested for a variety of factors. These include levels of chlorine, pH, and water hardness (California Department of Public Health, 2020). Testing methods include using pool water test strips that change color based on chemical level to adding chemical reagents to pool water samples to check chemical level by color change. For example, pool water pH can be tested by using pH test strips that will change to various levels of orange based on varying pH levels. Pool workers will then add chemicals to pool systems based on pool tests and visual inspection. In this section, major pool chemicals will be listed alongside when and how pool workers use those chemicals.

Before using pool chemicals, pool workers buy and transport chemicals for their own businesses making exposure hazards potentially multichemical and not just to those associated with pool chemicals, because of the multi- small business scenario. After buying pool chemicals from pool warehouses or other stores, pool workers usually choose to pick up chemicals themselves or get chemicals delivered to their businesses. Both activities involve the pool worker lifting of cases of chemicals, with the most common chemical being plastic boxes with individual chlorine gallons inside. After picking up pool chemicals, workers either drive to work or drive to the business to offload chemicals where more ergonomic hazards may occur in addition to the potential chemical ones.

Table 2. Some Common Pool Chemical Names, Uses and Types (modified from Centers for Disease Control, 2023)

Pool Chemical Name	Pool Chemical Use	Types
Chlorine (Sodium Hypochlorite, Di-chlor, Tri-chlor, etc.)	Sanitizes pool and kills waterborne bacteria	Liquid (gallons) and solid (tablets, powder, and granules)
Muriatic Acid (Hydrochloric Acid)	Lowers pH and cleans some pool equipment	Liquid
Soda Ash (Sodium Carbonate)	Raises pH	Solid powder/granules
Pool Stabilizer (Cyanuric Acid)	Keeps chlorine levels in pool elevated for longer	Liquid
Pool Shock (Unstabilized Chlorine-commonly 73%)	Quickly raises pool chlorine level	Solid powders and granules
Non-Chlorine Cleansers	Sanitizes pool without the use of chlorine	Biguanide, bromine, iodine, and mineral cleansers
Algaecide	Raises chlorine effectiveness to kill algae growths	Solid powders and granules
Pool Clarifier	Clears pool water	Powders
Pool Flocculant	Gathers fine debris in pool water together into vacuumable/filterable sizes	Powders

Pool Salt	Can be used by chlorine generators to create chlorine using electrolysis	Solid salt (NaCl)

One of the most common pool chemicals is chlorine, which is extremely important for keeping pool water safe. Chlorine is sold in various types that are used in different situations. One type is liquid chlorine, sodium hypochlorite aqueous solution with 10-12% chlorine, which is sold by the case to pool workers (In the Swim, 2022). Solid chlorine tablets or powders are also used and are often made of dichlor (Dichloro-S-triazinetrione) or trichlor (Trichloro-S-triazonetrione) (In the Swim, 2022), but can also be unstabilized solid chlorine (meaning it lacks cyanuric acid), which is usually made of calcium hypochlorite at high concentration. Liquid and solid chlorine have unique hazards and shared hazards. Liquid chlorine is poured straight into pools and can be a skin, eye, or ingestion hazard due to splashes (California Department of Public Health, 2020). Leaks in liquid chlorine containers can also cause chlorine spills on the workers or leave liquid chlorine exposed in crates, both causing alkaline burns. Solid chlorine can leave chlorine dusts on skin when handled, creating possible dermal or ingestion hazards (California Department of Public Health, 2020). Solid chlorine containers can have a buildup of chlorine vapors inside larger containers, especially if water gets in through a hole to create acidic conditions. Both chlorine types need to be stored properly to limit leakage, chlorine vapor buildup, and container deterioration. Some of the potential health effects of chlorine include eye and nose irritation, chemical burns, throat irritation, coughing, lung damage, and more (California Department of Public Health, 2020).

Muriatic acid (or hydrochloric acid) is used in liquid form by pool cleaners to lower a pool's pH to make chlorine more effective, to prevent scale, and to limit cloudiness. It can also be used to "acid wash" pools to remove stains on concrete. Finally, muriatic acid is commonly used to clean pool filters. Muriatic acid presents similar hazards to liquid chlorine, including skin or eye hazards with splashes and inhalation hazards with hydrogen chloride gas exposures. Muriatic acid can also form dangerous gas clouds when accidentally mixed with chlorine and ammonia producing chemicals, meaning proper handling and storage is very important. Some of the potential health effects of muriatic acid include eye damage, blindness, chemical burns, coughing, chest pain, and more. (California Department of Public Health, 2020).

While chlorine and muriatic acid are some of the most commonly used pool chemicals, many other chemicals are used as well. Soda ash (sodium carbonate) is used to raise the pH of pools. It is usually used in a solid form and can leave dust that can irritate skin or eyes. The health effects of soda ash can include nausea, vomiting, throat/mouth chemical burns, and more. (California Department of Public Health, 2020).

Liquid bromine or even iodine can be used instead of chlorine for sanitation of pools. They present similar hazards of dermal exposure with splashes or spills and inhalation exposure with vapor build up (California Department of Public Health, 2020). Other alternatives to chlorine include chlorine-free stabilizer (preservative free polyhexamethylene biguanide) and mineral sanitizers (including silver nitrate, borates, and magnesium chloride). The health effects include nausea, vomiting, throat/mouth chemical burns, and more

Solid algaecide powders are used to kill persistent algae in pools and have various types including copper sulfates or herbicides like endothall. Various pool clarifiers and flocculants are

used to keep pool water clear. Bags of pool salt (sodium chloride) are added to pool water when a chlorinator is used to make chlorine via electrolysis.

Finally, diatomaceous earth (D.E.) is a fine powder used in some pool filters. It is added to filter grids or straight into pools to be pumped into the filter. D.E. typically removes small particulates from the water that are too small to be caught in a plastic pump basket. Health effects include throat damage, lunch damage, silicosis, and more (California Department of Public Health, 2020).

Repairing or installing pool equipment involves many different processes depending on the pool equipment in question and possible repairs needed to said equipment. Common pool equipment is detailed in Table 3. Essentially, electric pool pumps move water from the pool into the pool system which can include filters, debris baskets, heaters, pool chemical generators, and connective piping. Spas use mostly the same equipment as pools, with some smaller versions.

Table 3. Common Pool System Equipment Names, Uses, and Types (modified from Hayward Pool Products, 2023)

Pool/Spa System Equipment Name	Use in pool system	Types
Pool pump	Pumping water through pool systems and pipes, maintaining pool water circulation, provides water pressure for pool/spa jets	Above ground or below ground pool pumps
Pool Pump Basket	Filters larger debris that are carried into the pool pump	Plastic or metal baskets
Pool Filter	Filters small debris, sediment, and dirt	Cartridge, diatomaceous earth, and sand filters
PVC Piping	Keeps pool equipment connected to other pool equipment and the pool itself	Polyvinyl chloride tubing
Pool Heater	Heats pool or spa water for comfort	Natural gas, propane, solar, and heat pump heaters
Pool Timer/Controller	Automatically runs pool pump at certain time intervals throughout the day/week	Analog and digital timers/controllers

Chlorine Generator	Generates chlorine through electrolysis of salt in pool water	Salt cell
Pool Chemical Feeders	Automatically feeds chemicals like chlorine or minerals into pools/spas for sanitization	Automated chemical feeding systems, plastic chemical floaters, and mineral purifiers
Automatic Pool Cleaners	Uses suction from pool pump system to automatically vacuum pool floors/walls	Robotic, suction side, and pressure side automatic pool cleaners
Pool Skimmer	Skims surface of pools for debris or sucks large debris into plastic/metal skimmer basket	Surface or in ground skimmer

Pool system work involves using many types of tools and methods to install or fix various parts of the pool system. One major unit process in pool system installation or repair is lifting. Lifting of heavy equipment like heaters and pumps is done at the pool supply shop during purchasing and at the installation site. This includes lifting or moving existing equipment for repair and lifting new equipment from a truck bed for new installations. Lifting is also done regularly to move tool bags and pool chemical crates.

Another unit process in pool equipment work is cutting and sawing. PVC pipes and other parts of pool equipment are cut by hand or power tools. Drilling or screwing are also done to

pool equipment using both hand and power tools. Bending and crawling are done during these other processes to access equipment sections for repair/installation. Working with PVC pipe is common with much of pool equipment and has its own unit processes. This includes fitting PVC pipe, tightening with wrenches, and applying PVC primer or glue (California Department of Consumer Affairs, 2023).

Electrical work unit processes include testing electrical currents, connecting and cutting electrical wiring, and soldering (California Department of Consumer Affairs, 2023). Installation and repair may also require swimming when doing underwater installation of equipment like pool lights.

Digging is another process done usually with underground pipes or with connections from equipment to pool/spa. Though pool construction workers do most construction work, pool repairmen sometimes performed related unit processes, like repairing/installing pool tile, grout, plaster, and other materiel. Repair/installation work may also be done with automated pool cleaners, which includes attaching pool vacuum hoses, and removing stuck debris from vacuums. Finally, routine pool/spa maintenance involves processes like pouring water into pumps, cleaning pool filter grids, and cleaning equipment with water or acid.

Some final unit processes for pool cleaners and repairers include administrative and customer service work. Administrative work is key to many small businesses. This includes billing customers for work, recording work done during the day, recording/balancing business costs, ordering pool chemicals/parts, paying workers, and completing tax forms. These tasks can be done both digitally with computers, smart phones, and emails as well as done analog with paper and letter mailing. Customer service is key to much of pool work, as pool businesses often

have many customers on their pool routes. Customer service unit processes include answering phone calls, answering emails, responding to texts, talking to customers in person, and billing customers for labor/material.

2.0 Methods

A literature review was performed to identify occupational health and safety information about the pool service industry. Search terms like "swimming pool" and "pool service" were used as keywords to help search across multiple scholarly search engines, including: Google Scholar, PubMed, and CAS SciFinder. Initially, studies that were included in the literature review were studies that had direct occupational health data on swimming pool service workers. However, inclusion expanded to include studies involving occupational health risks around swimming pools (like disinfection by-products or indoor pool workers). Initially, studies were excluded if they did not specifically involve the occupational health of pool workers. However, little such data were found, and the literature review later excluded studies that were not relevant to swimming pools/spas. Studies were also excluded if they were not relevant for setting up the pilot study.

A survey was designed to assess occupational hazards in the pool service industry (Appendix 1). The goal was to help fill a research gap by directly asking pool service workers themselves questions like basic demographic data, what work do they do, what hazards they face, what PPE they use, and what opinions they have on safety in the pool service industry. The survey was distributed in a paper form and online.

Both the paper and online survey contained identical questions, with small differences in the survey instructions and introduction. The start of the survey involved a brief introduction which gave instructions for survey completion and a link or mention of the study information sheet. For paper surveys, the study information sheet was provided alongside the survey (Appendix 2). For online surveys, the survey included a link to an online version of the study

information sheet. The surveys then asked for basic demographic questions including age, gender and ethnicity. Next came questions about the respondent's work in the industry including time worked in the industry, whether the respondent previously worked in the industry, and whether the respondent was a pool service business owner. The rationale for these questions was to get a good base of knowledge of the pool service worker demographics. After those questions, the survey asked about what unit processes the respondent did. The demographic and worker description questions were multiple choice. Next, the survey asked about what hazards workers faced, what PPE workers used, and what chemicals workers used. These questions were meant to find out the most relevant and common hazards perceived by pool workers at the job. The questions were also multiple choice, but questions about hazards and PPE also asked how often workers encountered hazards or used PPE. Finally, respondents were asked their opinions on various factors around pool service safety including opinions on their feelings of safety, industry safety practices, and hazard importance. The short answer questions were meant to give workers a direct voice through this paper and to catch context missed in the published data. These questions let respondents reply via short answer or larger paragraphs. Finally, the survey aimed to be as anonymous as possible for respondents and did not collect personal identifiable information on either online or paper surveys.

The PI partnered with businesses to provide the surveys to pool service workers. Pool service workers are often decentralized small businesses so reaching them may be difficult. Because pool service workers frequently buy pool chemicals from pool supply warehouses, two commercial pool warehouses were selected for paper survey distribution. The PI worked with Pool Water Products in Canoga Park (in the Los Angeles area) and Pool Water Products in Clairemont Mesa (in the San Diego area). The businesses kindly let surveys (Appendix 1), study

advertisements (Appendix 3), and study information sheets (Appendix 2) sit at their front desks for workers to fill out if they wanted to.

The study materials were then printed and distributed to the pool supply warehouses. The study materials were supplied in person by the PI in Canoga Park while study materials were mailed to the warehouse in Clairemont Mesa. One aim of the study was to not overly burden warehouse employees so employees at the pool warehouses only needed to store paper surveys that pool service workers filled out. The warehouses were to be contacted by phone call in 2-3 months after survey distribution when surveys were to be picked up. Otherwise, pool service workers could fill out the surveys at their leisure. Links to the online survey were also listed on the study materials if workers preferred a digital survey.

After a period of 2-3 months, the surveys were collected back from the pool supply businesses. After calling the businesses 1 day earlier to notify them of the pickup, surveys were collected in person by the PI and transported by car back to Los Angeles from both San Diego and Canoga Park. The anonymous surveys were then digitally organized into Excel for data analysis purposes. The anonymous online surveys were also entered into the Excel sheet so all the data could be analyzed together.

This study was reviewed by the UCLA Institutional Review Board and was determined to be exempt with the IRB number IRB#23-000281.

Fisher's exact test was used to analyze several potential associations between three occupational hazards and whether the worker was an employee or a business owner. Fisher's exact test was chosen because of the categorical variables chosen and the very low sample size. The hazards chosen to test the independence of the variables were heat stress, back pain, and

heavy lifting hazards as they provided a good range of hazards faced commonly when working in the field during pool cleaning work.

3.0 Literature Review Results

The existing literature on the occupational hazards for pool service workers is currently very limited. To begin with, government data do not fully show the workplace situations pool workers face. The BLS does not have a category for pool cleaners as an occupation. Instead, pool service workers fall under NAICS Code 561790, Other Services to Buildings and Dwellings (NAICS Association, 2023). This makes it difficult to collect injury and fatality data for the pool service industry. The California Department of Public Health (CDPH) has some recommendations for pool employees, including pool storage practices, personal protective equipment (PPE) use, and workplace asthma (California Department of Public Health, 2020). However, CDPH does not have workplace injury and fatality numbers for pool workers specifically.

Next, the academic research literature does not have much research published regarding pool service workers. Much of the similar or relevant research relates to two specific situations. The first situation is studying the disinfection by-products produced by pool chemicals. One example is Carter and Joll (2017). This paper examined the disinfection by-products, or DBPs, that occur when pool chemicals react with human and organic matter in pools (Carter and Joll, 2017). Such DBPs for chlorinated water include chloroform, methylene chloride, methyl chloride and aldehydes/ketones. Pool service workers try to expose only their arms to water and are not nearly as exposed as swimmers. One important aspect for pool service workers is that if there are more DBPs in pools, the air above the pool tends to have elevated levels of DBPs as well (Carter and Joll, 2017). However, occupational studies on outdoor pool workers were not found in the literature review.

The other major situation of academic interest involves air quality for indoor pools. These papers tend to be more occupationally focused, but mostly study workers like lifeguards who stay indoors at a pool the whole shift. One example is a study on occupational trichloramine in Swedish Indoor Swimming Pools (Westerlund et al., 2015). However, the majority of the pools in the pool service industry are outdoor rather than indoor (IBISWorld, 2023). In addition, pool cleaners typically move from pool to pool, which is a very different situation compared to the longer exposure for workers remaining on-site in studies like the Westerlund et al. study.

Another relevant area of academic research includes studies on bacterial and viral disease in swimming pools. For example, a study by Ryan et al. studied *Cryptosporidium* outbreaks and gastroenteritis from swimming pools (Ryan et al., 2016). Another example is the Bonadonna and La Rosa study on how viral diseases spread through swimming pools (Bonadonna and La Rosa, 2019). While bacterial and viral exposures are relevant to swimming pool workers, both studies mainly focus on swimmers or bathers who spend much more time in the water and are more likely to ingest water than pool workers.

Despite the lack of occupational research on pools, there are some excellent studies on pool service worker specific diseases. Blank and Cohen (2020) reviewed the variety of dermatoses pool cleaners face, and detailed how sanitizing chemicals, bacteria/viruses, and disinfection by-products in pools can result in minor to serious skin problems for pool workers (Blank and Cohen, 2020). Some of the problems include chemical burns from sanitizing agents like muriatic acid, rashes from bromine-treated pools, cutaneous infection from bacteria/viruses, and bladder cancer from disinfection by-products (Blank and Cohen, 2020).

Some research outside of the pool service industry could also be very relevant. Similar jobs would include workers that often spend much of the day driving from location to location, involve outdoor work in residential areas, and do both cleaning and mechanical work. This could include jobs like landscaping or gardening, for example. However, additional studies must connect the job to pool cleaning before a parallel can be made and many of the problems in pool cleaning are unique. Because of the overall limited occupational health data on pool service workers, the thesis shifted to a pilot study and survey to gain that data.

3.1 Survey Results

Overall, the survey was a collection of data suitable for a small pilot study and not for drawing global conclusions about the pool service sector. The survey had a sample size of 10 which leaves room for improvement in future studies.

A series of demographic questions were asked, including questions on age, ethnicity, gender, and industry-related questions. Full results are provided in Table 4. For demographics, the majority of those surveyed were male, specifically White and Asian males. In fact, all but one subject identified as either White (4 subjects) or Asian (4 subjects). For age, 7 out of the 10 subjects belonged in the 55-64 age bracket with only 1 subject each in the 18-24, 25-34, and 45-54 age brackets. The survey had a mix of current and former workers as well as a mix of business owners and employees. However, all subjects worked either full or part-time, with the majority (7 subjects) working full-time. Finally, all subjects worked at least one year in the pool industry, with a surprisingly high number working 10+ years in the pool industry.

Table 4. Pool Service Survey Demographic Data

Sample Characteristic	Total (N= 10)
Gender	
Male	8 (80%)
Female	2 (20%)
Age	
18-24	1 (10%)
	1 (10%)
35-44	0 (0%)
45-54	1 (10%)
55-64	7 (70%)
65+	0 (0%)
Ethnicity	
Caucasian	4 (40%)
African-American	0 (0%)
Hispanic/Latinx	0 (0%)
Asian	4 (40%)
Native American	0 (0%)
Pacific Islander	0 (0%)
Two or more	2 (20%)
Current / Former Worker	
Current Worker	6 (60%)
Former Worker	4 (40%)
Business Owner / Employee	
Owner	3 (30%)
Employee	7 (70%)
Work Status	
Full-Time	7 (70%)
Part-Time	3 (30%)
Temporary	0 (0%)
Not currently in the pool industry	0 (0%)
Small/Large Business	
Small Business	9 (90%)
Large Business (10+ Employees)	1 (10%)
Time Worked in Pool Industry	
1-6 months	0 (0%)
6-12 months	0 (0%)
1-5 years	3 (30%)
5-10 years	2 (20%)
10+ years	5 (50%)

Next, questions were asked about unit processes worked. The results are in Figure 1. The question asked what unit-processes a worker did during their career in pool service, including various cleaning unit processes, administrative unit processes, and unit work processes. Overall, most workers did a wide variety of different work during their careers. Cleaning-related work and chemical-related work were the most common types, though the other types of work were also done by most workers.

Repair-related work had its own question as well, with results in Figure 2. Again, most workers did a variety of repair work, with a few exceptions. Replacing or repairing pool filter filtration systems like filter cartridges or filter grids was the most common repair work while only 1 worker worked on pool solar repair.

Figure 1. General Unit Process Done by Pool Service

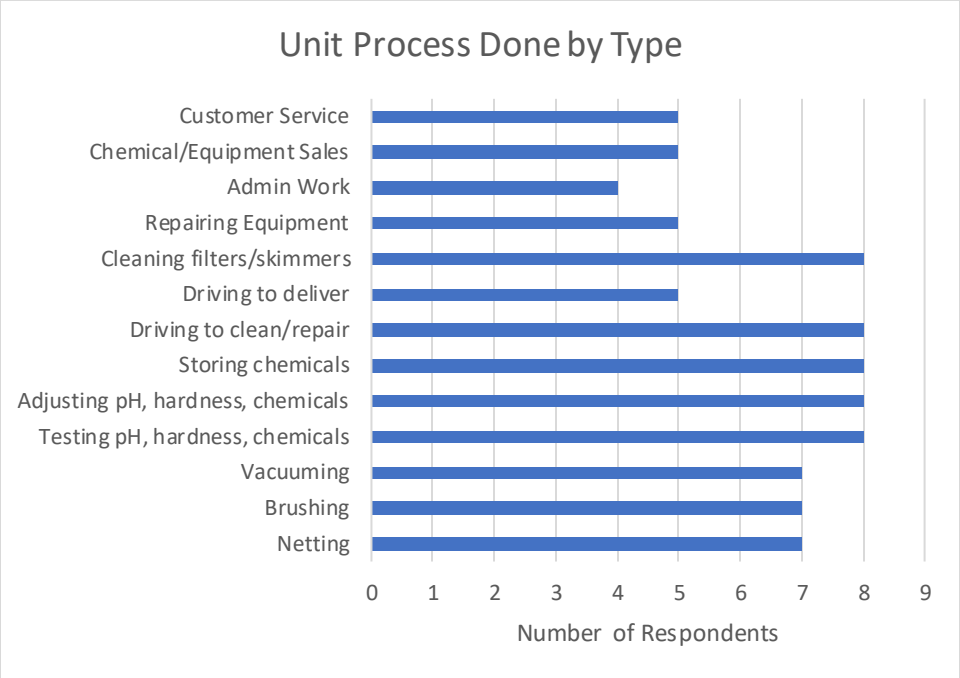
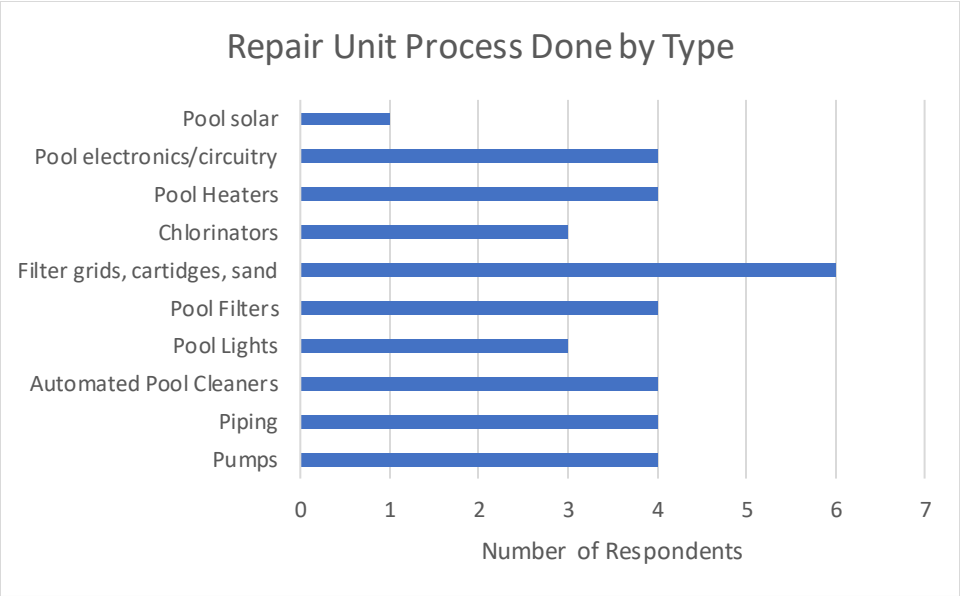


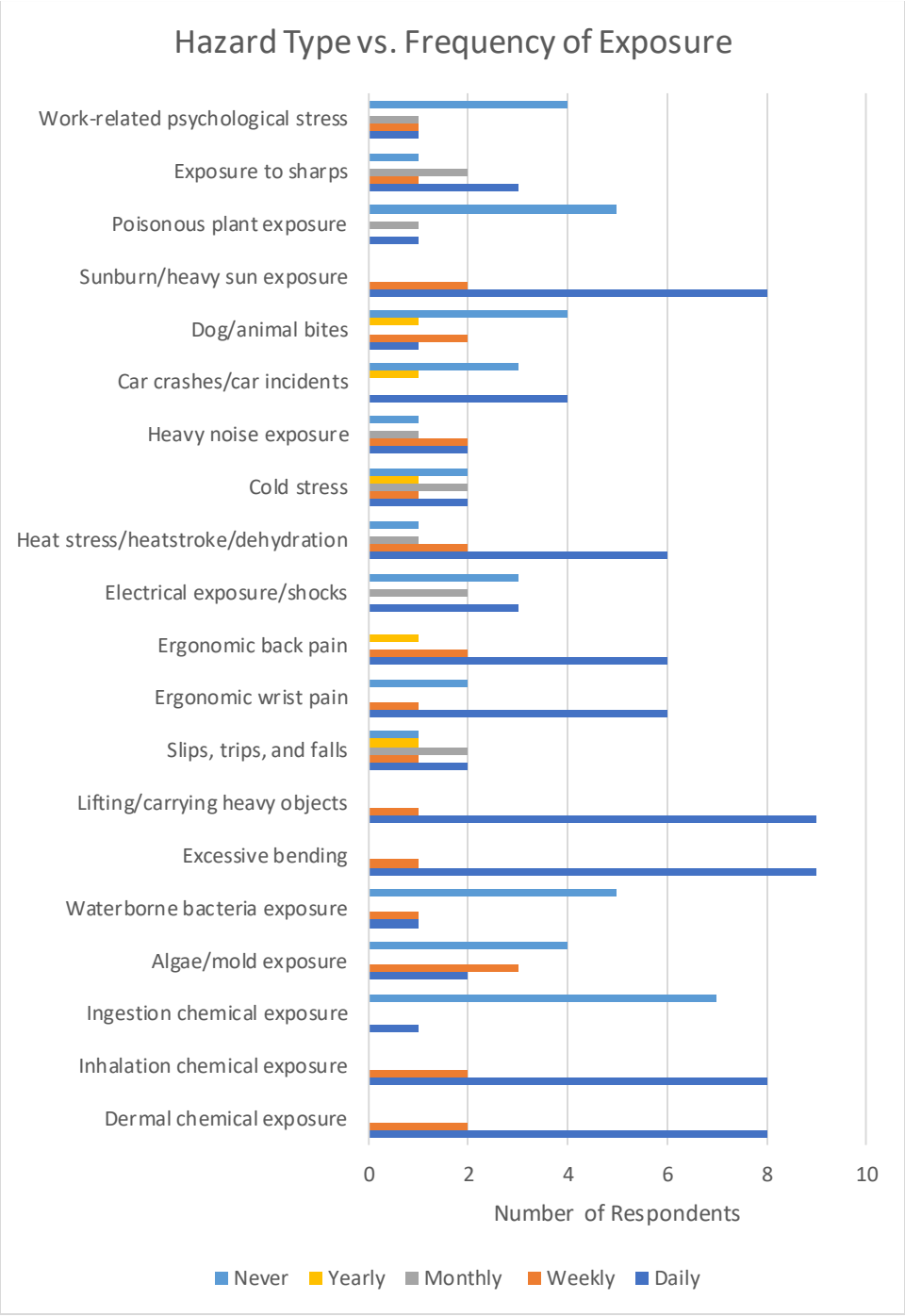
Figure 2. Repair Unit Processes Done by Pool Service Workers



The next question focused on what hazards pool workers faced throughout a year of work. The question asked what hazard types a worker was exposed to and how often they were

exposed to that particular hazard. The results are in Figure 3. The workers in the survey experienced a variety of different hazards of varying frequencies. However, there are some notable results. Many workers experienced many different types of hazards daily. This included ergonomic hazards (like excessive bending and repetitive wrist movement), heat-related hazards (like dehydration and heavy sun exposure), and chemical exposures (like dermal and inhalation exposures). Several exposures, like chemical exposure through ingestion and waterborne bacteria exposure, were never experienced according to many of the subjects. Finally, many of the subjects left many of the exposures blank, which could potentially be out of confusion with the question, or because certain exposures were much rarer.

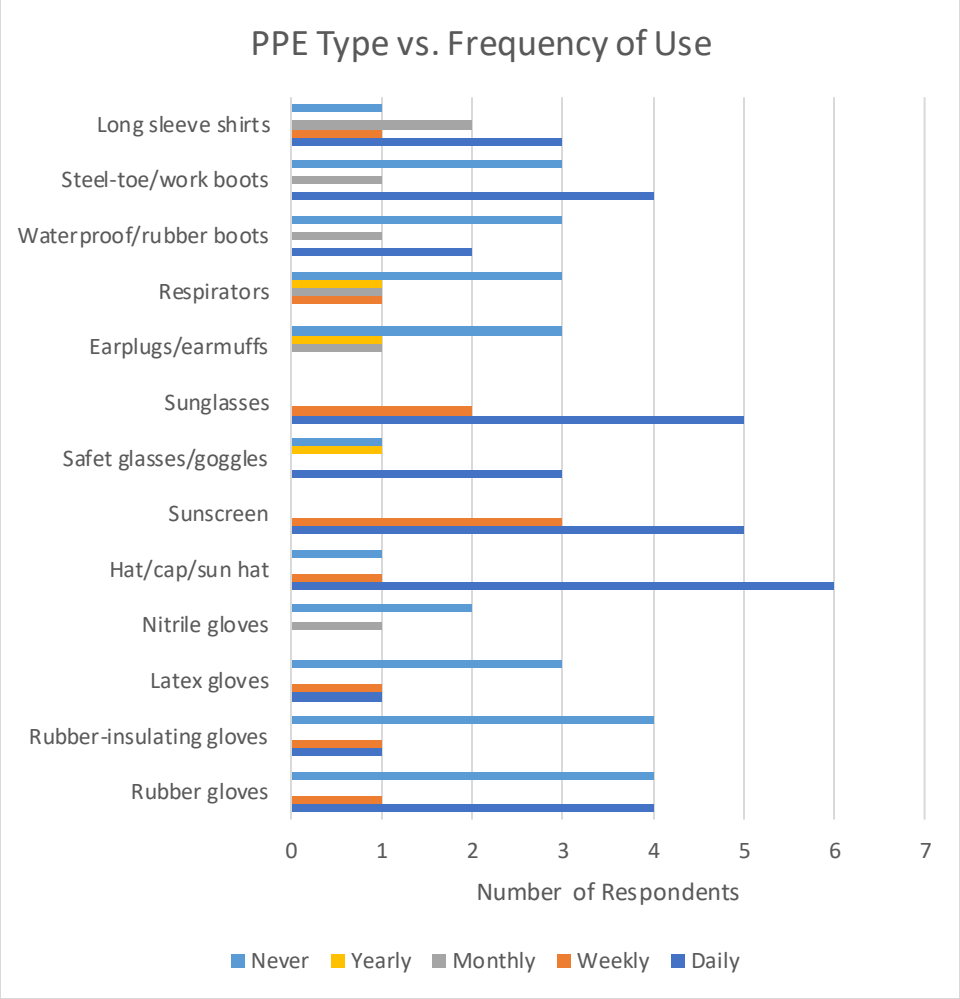
Figure 3. Frequency of Hazard Exposure for Pool Service Workers by Type of Hazard



A question on PPE use was asked based on frequency of use similar to the question on hazard types experienced. The results are presented in Figure 4. Again, results varied with some standouts. Heat or sun-related PPE like sunglasses, sunscreen, or hats were very commonly used

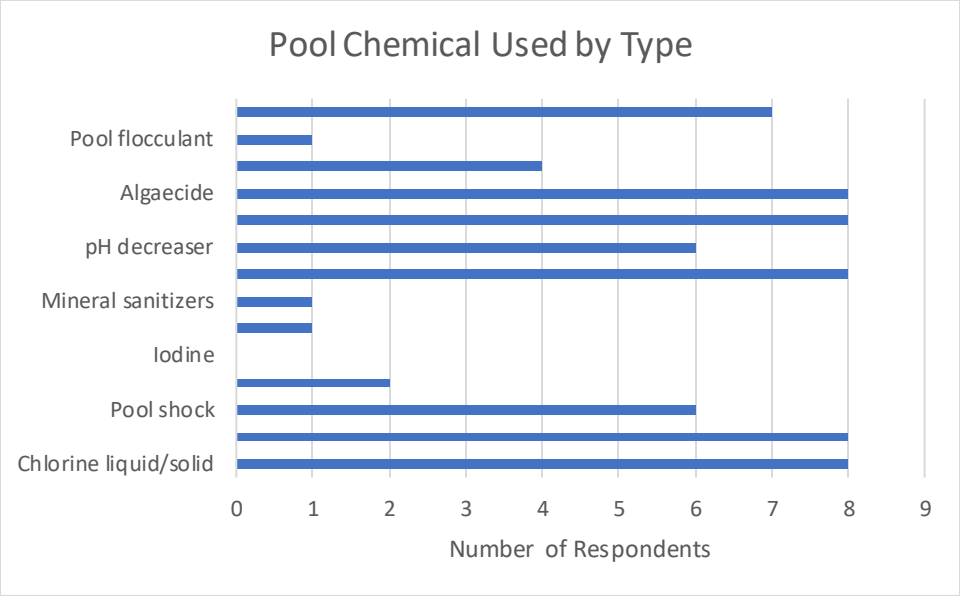
by the workers (often daily). Rubber gloves were the most used glove type, and many used rubber gloves daily. In contrast, rubber-insulating, latex, and nitrile gloves were used far less often if at all. Many of the workers wore either waterproof boots or general work boots, which is good considering the slips possible from working outside around water. Finally, hearing and breathing protection were not commonly used if used at all.

Figure 4. Frequency of PPE used by PPE Type



A question about pool chemicals was next. The responses are in Figure 5.

Figure 5. Count of Pool Chemical Used by Type



Finally, the last questions were short-answer questions where the workers were asked their opinions on various aspects of safety in the pool service industry. Workers and business owners alike both commented that they felt that the pool service business was a relatively safe business, especially with regards to other similar industries. When asked about important or overlooked hazards in the industry, multiple respondents talked about slips, trips, and falls from slippery surfaces. They noted that it could lead to drowning if a worker fell in a pool after injuring themselves after a fall. Car crashes were also indicated as a hazard. When asked about potential regulation, respondents said that the industry was relatively safe and that regulations are unnecessary in this case. One respondent talked about the general safety of the industry but also noted that serious health damage can occur. They mentioned having a friend that went blind in one eye from an errant splash of hydrochloric acid onto their face.

Many pool businesses are small businesses, and one goal of this study was to see if the business owners and normal employees faced similar hazards in their average workdays.

Fisher's exact test was used to test this comparison. For each of the 3 tests, the null hypothesis tested was whether experiencing that certain hazard daily was the same whether you were an employee or a business owner. The significance level for the tests was 0.5. Relative to worker type vs. daily heat stress frequency, the p value was 1.0. For worker type vs. daily heavy lifting frequency, the p value was 0.2. For worker type vs. daily back pain frequency, the p value was 1.0. In all 3 cases, there was no significant p value, There is not sufficient evidence to say that worker type and any of the 3 daily hazard variables are not independent. This makes sense given how common small businesses are in the pool industry and how small business owners often do the same work as their employees.

Table 5. Worker Type vs. Heat Stress, Back Pain, or Heavy Lifting Frequency

Worker Type vs. Heat Stress Frequency

	Owner	Employee	Total
Daily Heat Stress	2	4	6
Non Daily Heat Stress	1	3	4
Total	3	7	10

Two tailed p value: 1.0

Worker Type vs. Back Pain Frequency

	Owner	Employee	Total
Daily Back Pain	3	3	6
Non Daily Back Pain	0	4	4
Total	3	7	10

Two tailed p value: 0.2

Worker Type vs. Heavy Lifting Frequency

	Owner	Employee	Total
Daily Heavy Lifting	3	6	9
Non Daily Heavy Lifting	0	1	1
Total	3	7	10

Two tailed p value: 1.0

4.0 Survey Discussion

The results from this survey are very interesting, especially given the low amount of existing research on the pool service industry and small sample size. For example, the demographics data shows that many of the respondents were White or Asian. This somewhat matches the ethnicities around the survey locations. Future work can expand upon this data to answer questions and paint a better picture of the industry. Those demographics can also be very important when considering other factors for worker injury, like an aging workforce.

The unit process answers reveal a workforce that does a variety of work and repairs, meaning that workers can be exposed to many different hazards through the varied types of work done in an average career in the industry.

It is worth discussing the different types of work. Cleaning tasks in the pool industry involve chemical risks with cleaning agents, ergonomic risks with repetitive motions, slip/trip/fall risks from slippery surfaces around pools, and heat-related risks from spending a large amount of time outdoors in backyards. The variety of repairs done means that workers can face electrical hazards when connecting pool equipment to a home's power grid, mechanical hazards from heavy lifting or strenuous pipe fixing, and even some inhalation risks from silica from filter powder during filter repairs.

The work done flows directly into the hazards, where varied work leads to many different hazards being faced often by workers. The variety of hazards and the fact that many hazards faced are very different may make safety programs and interventions very difficult to design. More research with more subjects would be very useful when trying to find what hazards should be focused on in the future. However, the fact that many workers use different types of PPE

when not required means that there is room to potentially improve PPE use with education or other efforts. For example, workers may be reluctant to wear safety goggles or chemical-rated gloves in regard to chemical PPE but could potentially be convinced to keep sunglasses and rubber gloves on when using chemicals like muriatic acid. Finally, studies or interventions focused on chemical injuries may want to focus on commonly used chemicals like chlorine, muriatic acid, algaecides, and soda ash.

Despite the potential usefulness of the data from this survey, readers should take any potential insights from this survey with caution. This study was mainly focused on being a pilot study that can point to productive ways to conduct further research with pool service workers in the future. There was only a very small sample size of 10, which means that many of the potential takeaways may be unreliable. In addition, this study falls under many different types of bias that can heavily skew results. For example, the wording of some of the questions was probably unclear to the workers. Specifically with the questions on hazards, many respondents thought the question asked how often they got into a dangerous situation rather than how often could they potentially be injured due to exposure to a hazard. For example, many respondents noted a daily hazard exposure of heavy sun because they are outside all day. In contrast, many respondents did not feel they were exposed to car accident risk despite the fact many pool service workers drive in pool routes in neighborhoods practically every day they work. They may have not been in a car crash recently and marked the answer as yearly or never. There could also be heavy potential bias from the venue where subject recruitment occurred. Many of the respondents were older in this survey, and many were business owners. However, that does not inherently mean the pool industry has an older workplace. It could be that experienced, older workers and business owners often buy the pool chemicals for their companies at these pool

warehouses and were more likely to fill out the survey as a result. Recruiting pool workers who often work in small businesses in decentralized pool routes means that study subject recruitment can already be very difficult, and selection bias may be a worry for this study and future studies in the industry.

Fisher's exact test was used due to the small sample size of the survey and the comparison of categorical variables. The assumptions of fixed totals, mutually independent observations, and mutually exclusive observations were satisfied for this test. In the pool business, many of the small business owners work alongside their employees and often do the same work of servicing pools that their employees do. If that were true from the data gathered, that could mean that interventions targeting employee safety could help both the employees and business owners. The statistical results on independence all found no evidence for independence between employees and bosses on how often they faced daily hazards in heat stress, back pain, or heavy lifting. However, the results of these tests are not conclusive as there were many limitations with low sample size and survey question wording problems.

Finally, the study results are not meant to draw conclusions for policy, interventions, and safety programs. This study suffers from the heavy drawbacks of small sample size and heavy bias, as discussed above. This is especially important as there is a lack of existing research on the topic, meaning that there are limited data for comparison and corroboration. As discussed with some short answer questions, the pool industry is a small, decentralized, and often overlooked industry. Many of the workers work in small businesses or for themselves and they have mentioned a skepticism against regulation. That is another key reason why further research is important.

5.0 Conclusions

Overall, the pool service industry is an understudied industry in the occupational space. It is a space dominated by small businesses and contractors, meaning that future research may have trouble with recruitment of subjects. The multitude of different work types done on a regular basis means that pool service workers run the gamut of a variety of different hazards in a regular workweek. Like many other small and decentralized service industries, workers in the pool service industry may be not fully protected occupationally despite their work in the backyards of thousands across the United States. However, this lack of data means that there is ample need and ample prospects for future research into the occupational safety in the pool service industry.

In addition, the study PI presented the preliminary results from the study at the American Industrial Hygiene Conference and Expo in May 2023 in Phoenix, Arizona. If readers wish to view the presentation, the poster for the presentation is in Appendix 4.

5.1 Suggestions for Future Study

The focus of this pilot study is to present potential avenues of research and to guide the design of future research on the pool service industry. One major focus of design should be on recruitment. Recruitment proved to be a difficult challenge despite the fact that the PI was formerly a pool service worker and had knowledge about how the pool industry operated. Working with pool warehouses was a productive method. These warehouses provided a point where many of the small businesses, contractors, and workers all converged to pick up chemicals for a week of work. The warehouses were very cooperative and understanding, and research partnership with these businesses is a good way to reach workers. Some common pool supply companies in the

Southern California area include Pool Water Products (PWP) and Superior Pool Products (SCP). Pool service businesses do not typically buy from consumer focused pool companies like Leslie's or Home Depot, for example. However, warehouse recruitment may underrepresent younger, less experienced, non-business owning workers in study recruitment. Following up with business owners and asking if their workers could also be a part of the study may be a good way to get a better overall subject population. Another aspect learned was that clear wording is extremely important. Having pool workers screen questions for clarity before sending the questions out may be a method to make sure questions are clear for workers. Pool service workers also tended to fill out paper forms rather than the online version, so paper or in-person studies can be useful. In addition, workers may have a different idea of what is considered a dangerous exposure compared to researchers. Therefore, an aspect of a future study that may be useful is a quantitative field study where researchers ride along with pool workers in a field study and record what hazards they find. This can be compared to what the workers see to check for a difference. Finally, pool service workers are often extremely strapped for time. Even when waiting at a front desk for pool supplies, pool service workers have little time to fill out longer surveys. Having short surveys or providing ample incentives for participating in the study may be key to getting a significant sample size. Many workers felt they did not have time to complete the long survey in this study, for example.

Appendices

Appendix 1. Swimming Pool Cleaner and Technician Health Hazards Survey

Swimming Pool/Spa Cleaner and Technician Work Hazards Survey

Thank you for filling out our survey! This survey is open to all current or former swimming pool cleaners, technicians, repairmen, or chemical/equipment delivery drivers. For paper surveys, please use a pencil or a pen with black/blue ink.
Please do not include any personal or identifying information on the survey. Please only fill out the survey if you are 18+ years old. An online survey is also available at https://www.surveymonkey.com/r/J6LJD2R .

1. What is your gender?

Mark only one oval.

- ◯ Male
- ◯ Female
- ◯ Prefer not to say
- ◯ Other: _____

2. What is your age?

Mark only one oval.

- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65+
- ◯ Prefer not to say

3. What is your ethnicity?

Mark only one oval.

- ◯ Caucasian
- ◯ African-American
- ◯ Hispanic/Latinx
- ◯ Asian
- ◯ Native American
- ◯ Pacific Islander
- ◯ Two or more
- ◯ Prefer not to say
- ◯ Other: _____

4. Are you a current or former pool industry worker?

Mark only one oval.

- ◯ Currently work in the industry
- ◯ Formerly worked in the industry

5. Are you a:

Mark only one oval.

- ◯ Business Owner
- ◯ Employee

6. In the pool industry, do you currently work:

Mark only one oval.

- ◯ Full-Time
- ◯ Part-Time
- ◯ Temporary
- ◯ Not currently in the pool industry
- ◯ Prefer not to say

7. Do you work at a business that is:

Mark only one oval.

- ◯ Small (less than 10 workers)
- ◯ Large (more than 10 workers)

8. How long have you worked in the pool/spa industry?

Mark only one oval.

- ◯ 1-6 months
- ◯ 6-12 months
- ◯ 1-5 years
- ◯ 5-10 years
- ◯ 10+ years

9. Do you spend the majority of your time (over 50%) on outdoor pools/spas or indoor pools/spas?

Mark only one oval.

- ◯ Outdoor pools/spas
- ◯ Indoor pools/spas

10. What work do you do as a swimming pool cleaner, technician, or driver? (Select all that apply.)

Check all that apply.

- [ ] Netting pool debris
- [ ] Brushing tile or algae
- [ ] Vacuuming pool debris
- [ ] Testing pool pH, hardness, or chemical levels
- [ ] Adjusting pool pH, hardness, or chemical levels
- [ ] Storing pool chemicals
- [ ] Driving to clean or repair pool equipment
- [ ] Driving to deliver pool chemicals/equipment
- [ ] Cleaning pool filters and skimmers
- [ ] Repairing or installing pool equipment (pumps, pipes, pool lights, etc.)
- [ ] Administrative work (Billing, writing emails, etc.)
- [ ] Pool chemical/equipment sales to customers (both professional and non-professional)
- [ ] Customer service (working at a front desk, responding to customer calls, etc.)
- [ ] Other: _____

11. If you do pool equipment repair or installation work, what type of repairs do you do?

Check all that apply.

- [ ] Fixing/installing pool pumps
- [ ] Fixing/installing piping (i.e. PVC pipe or other pipe)
- [ ] Fixing/installing automated pool cleaners (pressure, suction, or robotic cleaners)
- [ ] Fixing/installing pool lights
- [ ] Fixing/installing full pool filters
- [ ] Cleaning/replacing filter grids, filter cartridges, or filter sand
- [ ] Fixing/installing chlorinators
- [ ] Fixing/installing pool heaters
- [ ] Fixing/installing pool electronics and circuitry (i.e. digital pool timers, pool controllers, etc.)
- [ ] Fixing/installing pool solar heating
- [ ] Other: _____

12. Which of these hazards do you face at work and how often do you face them?

Mark only one oval per row.

	Daily	Weekly	Monthly	Yearly	Never
Dermal (skin) exposure to pool chemicals	◯	◯	◯	◯	◯
Inhalation (breathing) exposure of pool chemicals	◯	◯	◯	◯	◯
Ingestion (swallowing) of pool chemicals; eating food while working with pool chemicals	◯	◯	◯	◯	◯
Algae/mold exposure (skin, breathing, or swallowing)	◯	◯	◯	◯	◯
Waterborne bacterial exposure (skin, breathing, or swallowing)	◯	◯	◯	◯	◯
Excessive bending	◯	◯	◯	◯	◯
Lifting/carrying heavy loads	◯	◯	◯	◯	◯
Slips, trips, and falls	◯	◯	◯	◯	◯
Ergonomic wrist pain (from netting, writing bills, typing, etc.)	◯	◯	◯	◯	◯
Ergonomic back pain (from sitting, driving, etc.)	◯	◯	◯	◯	◯
Electrical exposure/shocks	◯	◯	◯	◯	◯
Heat stress/heatstroke/dehydration	◯	◯	◯	◯	◯

Cold stress (from cold water in pools, rain, or snow)	◯	◯	◯	◯	◯
Heavy noise exposure (i.e. heavy equipment noise, opening windows on the freeway, etc.)	◯	◯	◯	◯	◯
Car crashes or car-related incidents	◯	◯	◯	◯	◯
Dog or other animal bites	◯	◯	◯	◯	◯
Sunburn or heavy sun exposure	◯	◯	◯	◯	◯
Poisonous plant exposure (i.e. poison ivy, etc.)	◯	◯	◯	◯	◯
Exposure to sharps (i.e. broken glass, plant/palm spikes, sharp metal, etc.)	◯	◯	◯	◯	◯
Work related psychological stress	◯	◯	◯	◯	◯

13. What PPE (personal protective equipment) do you use?

Mark only one oval per row.

	Daily	Weekly	Monthly	Yearly	Never
Rubber gloves	◯	◯	◯	◯	◯
Rubber-insulating gloves (electrical gloves)	◯	◯	◯	◯	◯
Latex gloves	◯	◯	◯	◯	◯
Nitrile gloves	◯	◯	◯	◯	◯
Hat/cap/sun hat	◯	◯	◯	◯	◯
Sunscreen	◯	◯	◯	◯	◯
Safety goggles/glasses	◯	◯	◯	◯	◯
Sunglasses	◯	◯	◯	◯	◯
Earplugs/Earmuffs	◯	◯	◯	◯	◯
Respirators (Disposable, cartridge, or supplied air)	◯	◯	◯	◯	◯
Waterproof or rubber boots	◯	◯	◯	◯	◯
Steel-toe or work boots	◯	◯	◯	◯	◯
Long sleeve shirts	◯	◯	◯	◯	◯

14. If you handle pool chemicals at work, what pool chemicals do you use?

Check all that apply.

- [ ] Chlorine (sodium hypochlorite) - liquid and solid (tabs/granules)
- [ ] Chlorine pool stabilizer (cyanuric acid)
- [ ] Pool chock/unstablilized chlorine (calcium hypochlorite)
- [ ] Bromine - liquid and solid
- [ ] Iodine
- [ ] Chlorine free sanitizers (Biguanide and others)
- [ ] Mineral Sanitizers (silver, borates, magnesium chloride)
- [ ] pH increaser (baking soda, soda ash)
- [ ] pH decreaser (muriatic acid, sodium bisulfate)
- [ ] pH liquid test kits/test strips
- [ ] Alagecide
- [ ] Pool clarifier
- [ ] Pool flocculant
- [ ] Pool salt
- [ ] Other: _____

Open Ended Questions (Optional)

These questions are meant to gauge the opinions of everyday workers in the field. Feel free to answer all, some, or no questions.

15. Are there any major hazards or PPE that are not listed above? How often are the hazards encountered or PPE used?

_____

_____

_____

_____

_____

16. What hazards, in your experience, are the most common, dangerous, or important in the swimming pool industry?

17. Are there any hazards in the pool industry that you feel are overlooked or ignored?

18. Do you feel safe while working every day in the pool business? Do you feel that work hazards or stress follow you home after work?

19. What are your opinions on the current rules and regulations faced by pool businesses and workers? Would you add, remove, or change any rules/regulations?

20. What do you think people who do not work in the pool industry get wrong about pool industry hazards and safety? Are there any common misconceptions that you would want changed?

Appendix 2. Study Information Sheet

University of California, Los Angeles

RESEARCH INFORMATION SHEET

Review of Occupational Hazards for Swimming Pool Cleaners and Technicians

INTRODUCTION

Thomas Mackey and Dr. Shane Que Hee from the Environmental Health Sciences at the University of California, Los Angeles are conducting a research study. This study is being funded by the UCLA Center for Occupational and Environmental Health. You were selected as a possible participant in this study because of your profession. Your participation in this research study is voluntary.

WHAT SHOULD I KNOW ABOUT A RESEARCH STUDY?

- Whether or not you take part is up to you.
- You can choose not to take part.
- You can agree to take part and later change your mind.
- Your decision will not be held against you.

WHY IS THIS RESEARCH BEING DONE?

We want to better understand what hazards affect pool cleaning and maintenance workers to make the profession safer by a set of recommendations.

HOW LONG WILL THE RESEARCH LAST AND WHAT WILL I NEED TO DO?

Participation will take a total of about 15-25 minutes.

If you volunteer to participate in this study, the researcher will ask you to do the following:

- Answer survey questions on paper or online to the best of your ability.
- Questions will be about demographic information, work hazards, and job responsibilities.
- Questions will be in multiple choice and short answer format, with some questions optional.
- Please do not include any personal or identifying information on the survey.
- Please only fill out a survey if you are 18+ years old.
- The online survey is available at https://www.surveymonkey.com/r/J6LJD2R .

ARE THERE ANY RISKS IF I PARTICIPATE?

There are no anticipated risks or discomforts.

ARE THERE ANY BENEFITS IF I PARTICIPATE?

You will not directly benefit from your participation in the research.

The results of the research may help researchers gain the perspectives of the everyday workers who do work in the field.

HOW WILL INFORMATION ABOUT ME AND MY PARTICIPATION BE KEPT CONFIDENTIAL?

The researchers will do their best to make sure that your private information is kept confidential. Information about you will be handled as confidentially as possible but participating in research may involve a loss of privacy and the potential for a breach in confidentiality. Study data will be physically and

electronically secured. As with any use of electronic means to store data, there is a risk of breach of data security.

Use of personal information that can identify you:
Surveys will be anonymous and has minimal potential identifying demographic information (like race or gender).

How information about you will be stored:
Data will be stored on the servers for the online survey software (Google Surveys). Any paper surveys will be scanned for computer storage and the paper will be shredded/disposed of.

People and agencies that will have access to your information:

The research team and authorized UCLA personnel may have access to study data and records to monitor the study. Research records provided to authorized, non-UCLA personnel will not contain identifiable information about you. Publications and/or presentations that result from this study will not identify you by name.

How long information from the study will be kept:
Data from the surveys may be kept up to 5 years.

USE OF DATA FOR FUTURE RESEARCH

Your data, including de-identified data may be kept for use in future research.

WHO CAN I CONTACT IF I HAVE QUESTIONS ABOUT THIS STUDY?

The research team:
If you have any questions, comments or concerns about the research, you can talk to the one of the researchers. Please contact: Thomas Mackey at trmackey7@g.ucla.edu or at 858-382-3988. If unavailable, please contact Professor Shane Que Hee at squehee@ucla.edu or at 310-206-7388.

UCLA Office of the Human Research Protection Program (OHRPP):

If you have questions about your rights as a research subject, or you have concerns or suggestions and you want to talk to someone other than the researchers, you may contact the UCLA OHRPP by phone: (310) 206-2040; by email: participants@research.ucla.edu or by mail: Box 951406, Los Angeles, CA 90095-1406.

WHAT ARE MY RIGHTS IF I TAKE PART IN THIS STUDY?

- You can choose whether or not you want to be in this study, and you may withdraw your consent and discontinue participation at any time.
- Whatever decision you make, there will be no penalty to you, and no loss of benefits to which you were otherwise entitled.
- You may refuse to answer any questions that you do not want to answer and still remain in the study.

You will be given a copy of this information to keep for your records.

Appendix 3. Study Advertisement

Appendix 4. AIHce Poster Presentation

Industrial Hygiene Aspects of Swimming Pool Service Workers

Thomas Mackey
Shane Que Hee, PhD, MSc, RPIH, FAIHA
University of California, Los Angeles

DESCRIPTION

Swimming Pool and Spa service workers are an understudied subset of workers that do work around swimming pools and spas. There are around 90,000 pool service workers in the U.S., with many of them being small businesses and independent contractors (IBISWorld, 2023). Their work has multiple sides, including cleaning pools, maintaining pool chemical levels, and repairing pool system equipment. As a result of the varied work done, pool service workers are subject to hazards including physical hazards from working outdoors, chemical hazards from pool chemicals like hydrochloric acid, mechanical hazards from pool equipment, and even electrical hazards from repairing pool equipment. This project aims to be a case study for future research on pool worker hazards and includes an overview of pool service unit processes, pool equipment, pool chemicals, a literature review, and an occupational hazard survey.

PROBLEM

Pool service workers are an understudied population occupationally. Pool service is not a massive industry in the overall economy and are mainly comprised of small (<10 employee) businesses or independent contractors. These businesses are often not required to provide the same injury or safety data compared to larger employers, resulting in less data. The BLS does not even have a worker category for pool service workers, instead having them fall under NAICS code 561790 (Other Services to Buildings and Dwellings) (NAICS Association, 2023). This makes it difficult to find research on the topic or collect data on occupational hazards. In addition, much of the existing research related to pool/spa hazards tend to focus on swimmer hazards, indoor pool hazards, or disinfection byproducts rather than the occupational hazards for workers servicing pools. As a result, the project changed from only a literature review to a survey to start collecting occupational hazard data on pool service workers. Overall, the goal was to make a survey that could act as a pilot study for future research on pool service occupational hazards.

METHODS

Literature Review

Inclusion:

- Occupational studies on pool and spa service workers published after 2000.
- This includes studies on hazards including pool chemical hazards, slip and fall hazards, physical hazards, and studies on pool worker health.

Exclusion:

- Studies related to pools but not pertaining to occupational hazards that pool service workers face.
- This includes studies on non-occupational populations like swimmers or studies on other aspects of the pool industry like construction.

Occupational Hazard Survey

A paper and online survey was developed to ask workers about occupational hazards in the pool industry.

Multiple Choice Sections:

- Basic demographic questions
- Questions about pool industry (time in industry, etc.)
- What unit processes worker did
- What hazards workers faced
- What pool chemicals workers used
- What PPE workers used

Short Answer Section:

- Opinions on pool worker safety and the pool service industry

- The study required UCLA IRB (institutional review board) approval and required a UCLA standard study information sheet.
- This study partnered with 2 Southern California pool warehouses where pool workers often stop by for chemicals and equipment. One warehouse was in Los Angeles while another was in San Diego.

PRELIMINARY RESULTS

- The study is still in progress and surveys are still out for workers to fill out until June. However, 8 completed surveys were obtained from workers at the San Diego location.
- These results are not the final study results and should be looked at with scrutiny because of the very low sample size. However, it may be interesting to view as part of the case study.

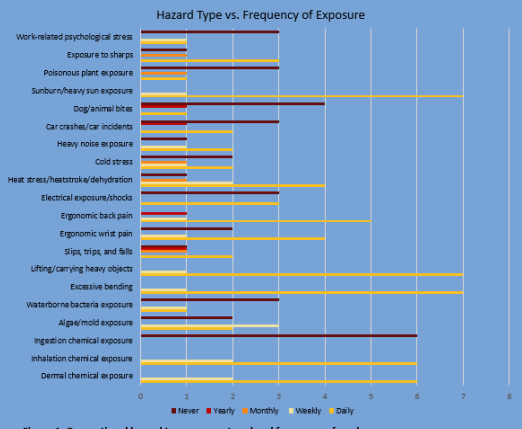


Figure 1. Occupational hazard types encountered and frequency of worker exposure

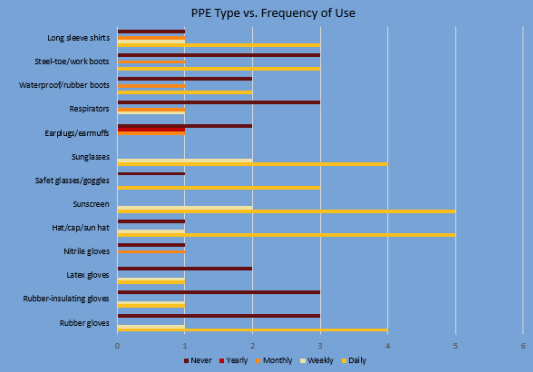


Figure 2. Different protective equipment used and frequency of use by workers

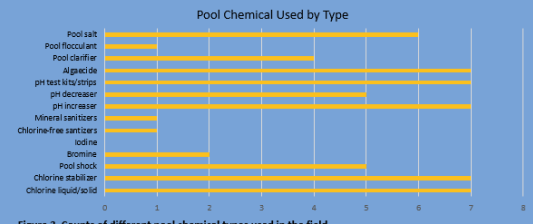


Figure 3. Counts of different pool chemical types used in the field

DISCUSSION AND CONCLUSIONS

- In the short answer, employers and employees alike reported feeling safe at their jobs and asked for no new regulations in pool service.
- They also noted drowning after falling into pools and driving accidents as some commonly overlooked risks.
- Workers were often confused hazard exposure and injuries, so future studies should make a clear distinction.

FUTURE STUDIES

- This case study provides a potential blueprint for future studies on the pool industry. Similar studies partnering with pool warehouse/supply companies may be a promising way to connect with workers.
- One of the flaws of this study was the lack of total participants. A larger study with better funding may be able to partner with more pool supply companies and provide better incentive for time-strapped workers to fill out surveys.
- Another research avenue is to have better quantitative sampling of hazards in the actual field with pool service workers.

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