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Original Article

Human factors in the hospital: Education, skills, and job details

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ABSTRACT

Objective: To present the job requirements and background Human Factors professionals may need to be prepared and succeed in health care facilities.
Background: Both hospitals and Human Factors professionals must be prepared for the predicted growth of Human Factors job openings in health care. Professionals transitioning from another industry or graduating from a Human Factors and Ergonomics (HFE) program may benefit from understanding what hospitals need, education requirements, and the compensatory landscape. To date, there is a lack of baseline information about Human Factors professional job details in health care.
Method: We surveyed hospital-embedded Human Factors professionals. We grouped respondents based on the amount of time dedicated to operations vs. research work.
Results: Of 32 respondents, 75% were women. Hospital-embedded professionals reported an average salary of $153,917 and a median salary of $149,481. Although more institutions required a master's degree, 25% of practitioners had a doctorate degree. Technical and interpersonal skills were similar between researchers and practitioners including data collection and teamwork.
Conclusion: Universities can use this information to tailor educational programs for HFE students interested in a health care track. Hospitals seeking HFE professionals can create targeted job descriptions. HFE professionals can assess their ability to transition into the health care setting.
Application: This information can be used by HFE professionals to assess their readiness to enter the hospital setting and negotiate compensation based on the current market. Hospitals can also use this to determine what skills HFE professionals bring.

1. Introduction

Since its inception as a field, Human Factors and Ergonomics (HFE) professionals have long been established as high value in a variety of industries, particularly those considered high-risk such as nuclear, mining, and aviation. Despite adoption of Human Factors principles and considerable HFE job growth across industries, the application of HFE in hospitals is relatively new and uncharted. It has been two decades since the Institute of Medicine published To Err is Human in 1999 (Kohn et al., 1999) and the health care industry is still determining where and how HFE professionals and their skills should be incorporated and applied.

Historically, the Bureau of Labor and Statistics categorizes Human Factors Engineering and other related fields within the broader category of Health and Safety Engineering (HSE) SOC Code 17-2111. This category also includes employees in manufacturing, engineering and consulting firms, construction, and government (Health and Safety Engineers 2021). In 2019, the Bureau estimated a total of 26,400 individuals employed in HSE, with approximately 0.5% of this total working in state, local, or private hospitals (Health and Safety Engineers 2021). Using these statistics, we extrapolated that less than 132 Health and Safety Engineers were embedded in hospitals in 2019. However, more information is needed to calculate the actual number of professionals and the roles they perform. Optimistically, the Bureau predicts a 4% growth in the HFE category by 2029 (Health and Safety Engineers 2021).

The O*NET program is a resource center sponsored by the U.S. Department of Labor/Employment and Training Administration (O*NET Occupation Data Updates at O*NET Resource Center 2022). The

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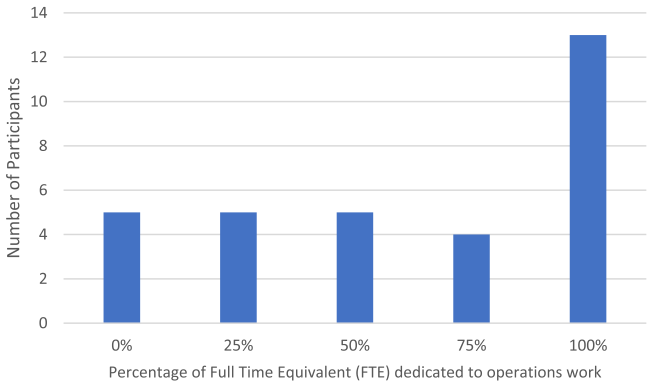

Fig. 1. Percentage of Full Time Equivalent Dedicated to Operations Work.

program provides free standardized data for hundreds of occupations. The O*NET program categorizes Human Factors professionals under "Human Factors Engineers and Ergonomists" (O*NET program job title number: 17.2112.01). This database includes the following job titles: "Certified Professional Ergonomist, Cognitive Engineer, Consulting Ergonomist, Ergonomic Consultant, Ergonomics Consultant, Ergonomics Technical Advisor, Ergonomist, Human Factors Advisor, Human Factors Engineer, and Occupational Ergonomist." (O*NET Occupation Data Updates at O*NET Resource Center 2022) O*Net describes Human Factors Engineering and Ergonomic jobs as a "bright outlook occupation," meaning the occupation is expected to grow 8%-10% between 2021 and 2031 with 22,400 projected job openings (National Center for O*NET Development 2022). However, O*NET does not stratify the industry, thus, these numbers are not specific to those embedded in health care or hospitals.

As the HFE industry continues to expand within health care, HFE professionals will benefit from an expanded understanding of the current job market. The O*NET and Bureau statistics are helpful to estimate field size, but data regarding the characteristics of HFE professionals in hospitals could not be found. The objectives of this study were to survey HFE professionals working in health care facilities to better understand their roles, compensation, and skills, and to determine the differences (if any) between embedded practitioner and traditional academic researcher roles. Our aim is threefold: to understand the current state of the skillsets of HFE professionals working in hospitals, provide knowledge to universities training the next generation of HFE students, and assist hospitals in establishing appropriate job opportunities for HFE professionals that benefits both parties.

2. Methods

2.1. Study Design

We created an anonymous online survey to assess role characteristics and the interpersonal and technical skills HFE professionals use in health care. The survey included questions regarding demographics (individual and departments), salary, type of projects, project partners, opportunities for education, leadership, skills, and applied research methods. Response categories were a mix of free-text, multiple choice, and 5-point Likert scale. Informed consent was provided on page one of the survey and respondents consented by continuing to the survey items. To participate in the survey, respondents had to be 18 years or older and an HFE (or closely related) professional working in a hospital.

Study analysis included descriptive statistics, T-tests, and linear regression. We asked respondents how much of their full-time employment (FTE) was spent conducting hospital operations work (e.g., embedded in the day-to-day functions of a specific hospital) vs. research (e.g., multi-year studies that were generalizable to multiple organizations), acknowledging that HFE professionals may have a combination of job responsibilities. Response options included 0%, 25%, 50%, 75%, and 100% of an FTE. We categorized respondents spending 75% or 100% of an FTE on operations as "practitioners," and respondents spending 0%, 25%, or 50% of an FTE on operations as "researchers" (moving forward, practitioners and researchers will describe the two groups).

For salary analysis, averages and standard deviations were calculated. We converted all salary information to current rates to account for inflation. We also converted all provided salary information to one location (Washington, D.C.) by using an online tool that calculates salary based upon location (found at salary.com; owned by Accel-KKR, located in Waltham, Massachusetts) to account for cost-of-living differences among locations. We chose Washington, D.C. because it is a large city where none of the respondents listed their current employment. The use of a single city also allows for the conversion of proposed salaries to other locations.

For skill analysis, we stratified skills into two categories: technical and interpersonal. Technical skills include specialized knowledge and expertise required to act as an HFE practitioner. Interpersonal skills, such as coordination and communication, are imperative when working in a team environment. Technical skills were selected from Human Factors Methods: A Practical Guide for Engineering and Design (Stanton et al., 2013).

Respondents rated a series of statements regarding recognition and integration of Human Factors in their workplace on a 5-point Likert scale. We collapsed the responses for the top and bottom boxes to agree, neutral, and disagree.

The survey is presented in the supplementary materials. This research is deemed exempt by the Institutional Review Board at Cincinnati Children's Hospital Medical Center (2020-1015).

2.2. Participant Recruitment

The authors disseminated the survey to Human Factors and Ergonomics Society and Industrial/Organizational Healthcare Network listservs using Google Forms. In addition, the survey was posted on social media platforms including Reddit (r/humanfactors; Advance Publications, Staten Island, New York), Facebook (Mark Zuckerberg, Menlo Park, California), and LinkedIn (Microsoft Corporations, Redmond, Washington). Finally, we used judgment and snowball sampling by reaching out to interpersonal networks and asking HFE peers to broaden the reach of the survey.

3. Results

3.1. Demographics

We collected a total of 37 surveys and excluded one incomplete survey. We excluded another 4 surveys as their current job title (e.g., Legal Psychologist, Clinical Psychologist) and education did not match the study criteria, leaving 32 surveys for analysis. Respondents were stratified between those with different levels of dedicated time to operations work. These groups are identified as researchers (0-50% FTE; n =15) and practitioners (75-100% FTE; n = 17) groups (Fig. 1).

Table 1 describes respondent demographics, education, experience, and number of HFE staff in their organization. Most respondents identified as women (75%) and the remainder identified as men (25%). The overall mean age was 36.25 years (range, 25 to 61 years), and age was similar between women (mean [M]= 35.6 years, standard deviation [SD], 8.5 years; median [Mdn] = 32 years) and men (mean = 38.3 years, SD =7 .7 years; median = 37 years). modal age category for both research (n = 7, 22%) and practitioners (n = 10, 31%) were 30-39 years (Table 1). Respondents reported an average of 8.8 years (SD = 7.6, Max = 35) experience in the health care field, with similar average years of experience in both the researcher (8.7 years) and practitioner (8.9 years) groups. Responses to the question, "what department are you affiliated

Table 1
Demographics Differentiated by All, Researchers, and Practitioners (N=32).

	All Respondents	Researchers	Practitioners
Gender[a]	**# (%)**	**# (%)**	**# (%)**
Women	24 (75)	11 (34)	13 (41)
Men	8 (25)	4 (13)	4 (13)
Age			
20-29	6 (19)	3 (9)	3 (9)
30-39	17 (53)	7 (22)	10 (31)
40-49	8 (25)	5 (16)	3 (9)
50-59	0 (0)	0 (0)	0 (0)
60-69	1 (3)	0 (0)	1 (3)
Minimum Level Education Required			
PhD	8 (25)	6 (19)	2 (6)
MS/MA	13 (41)	3 (9)	10 (31)
BS/BA	11 (34)	6 (19)	5 (16)
MD	0 (0)	0 (0)	0 (0)
Highest Education Level Attained			
PhD	15 (47)	7 (22)	8 (25)
MS/MA	16 (50)	7 (22)	9 (28)
BS/BA	1 (3)	1 (3)	0 (0)
MD	0 (0)	0 (0)	0 (0)
Mean years of experience (SD)			
In health care	8.80 (7.59)	8.67 (6.96)	8.91 (8.33)
Current hospital	3.85 (2.35)	4.03 (2.38)	3.69 (2.39)
Current position	2.76 (1.70)	2.83 (1.59)	2.70 (1.83)
Number of HFE Staff in Organization			
1 - 3	25 (78)	11 (34)	14 (44)
4 - 6	4 (13)	4 (13)	0 (0)
7 - 9	0 (0)	0 (0)	0 (0)
10 or more	3 (9)	0 (0)	3 (9)

[a] Response categories included women, men, transgender men, transgender women, non-binary/third gender, prefer not to answer, and other. Categories with a zero are not listed to conserve space.

with inside your organization" included patient safety and regulatory areas, clinical areas (surgery, anesthesiology), research and innovation areas, and other (systems engineering and design).

3.2. Salary

One participant did not provide salary information and was excluded, yielding 31 respondents for this analysis. There were no significant differences between practitioners and researchers ($t(24) = 0.707$, $p = 0.49$; Fig. 2). The overall average salary was $153,917 and median salary was $149,481. Practitioners (M = $162, 605, SD = $38, 305; Mdn = $166, 361, SD = 39, 561) reported higher salaries than researchers (M = $144,649, 262, Mdn = $130, 262, SD = $63, 823).

There is no significant salary difference between men and women (M = $169,288, SD = $52,247; Mdn = $155,883 and M = $148,570, SD = $51,129; Mdn = $145,680, respectively; $t(11) = .91$, $p = 0.38$; Fig. 3) though men reported a mean salary that is $21,000 higher and a median salary that is about $10,000 higher.

Respondents with PhDs (M = $172,947, SD = $48,677; Mdn = $166,361) reported significantly higher average salaries (nearly

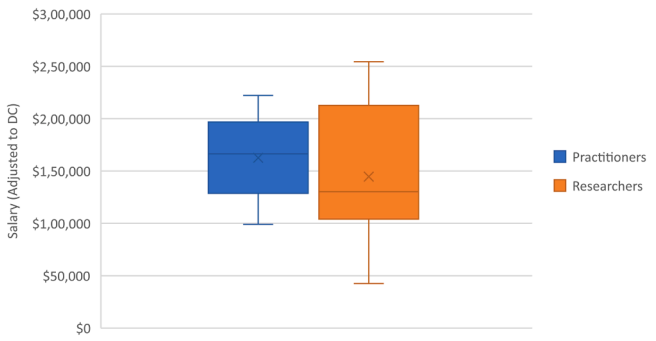

Fig. 2. Salary by practitioners and researchers.

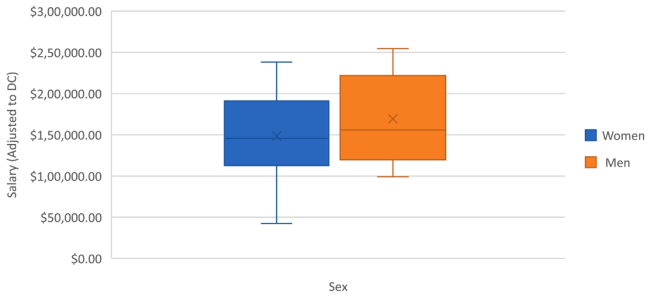

Fig. 3. Salary by gender.

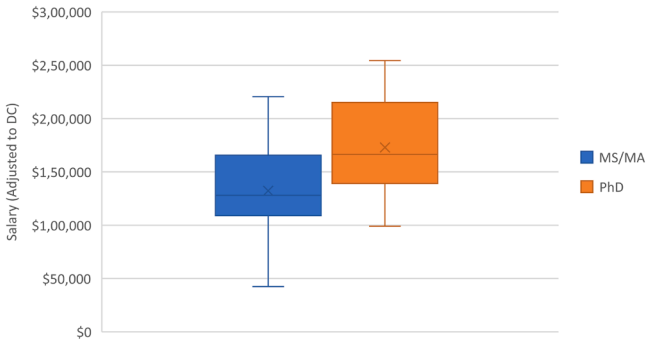

Fig. 4. Salary by degree.

$41,000) than those with master's degrees (M = $132,302, SD = $47,149; Mdn = $128,141), ($t(27) = -2.31$, $p = 0.03$) (Fig. 4). For results including degree attained, we excluded the category with only one response (BS/BA).

Further delineation between gender and highest education is shown in Fig. 5.

Multiple regression showed a strong association between years of experience and salary ($F(1,29)=14.61$, $p<0.001$, $R^2 = 0.335$; Fig. 6). The interaction between gender and salary was not statistically significant, however the relationship between years of experience was stronger for men than for women ($R^2=0.4$ vs $R^2=0.07$ respectively).

Employers most commonly required a master's degree (43%), followed by a bachelor's degree (33%), doctoral degree (20%), and medical degree (3%), yet no respondents reported having a medical degree. Nearly 47% of respondents obtained a higher degree than required for their position (Fig. 7) and no respondents reported having less education than listed in the job requirement.

More researchers than practitioners worked more than 40 hours a week (Fig. 8).

3.3. Knowledge and Skills

Respondents reviewed the list of skills and selected those that were necessary in their occupation.

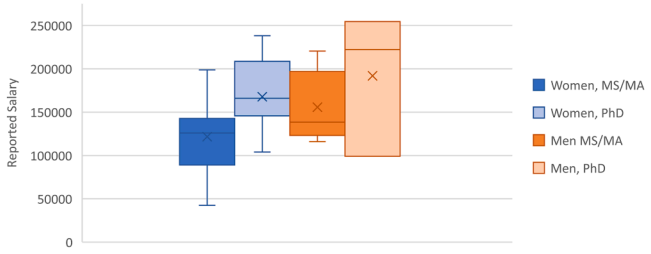

Fig. 5. Salary by gender and highest education level.

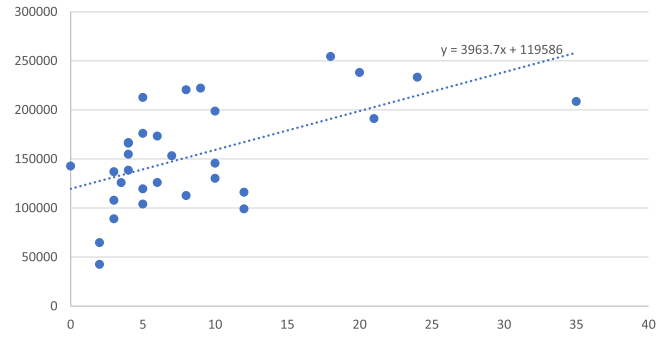

Fig. 6. Salary by years of experience.

3.3.1. *Technical Skills*

Nearly all respondents listed data collection methods as the most important skill. Practitioners rated "user design" and "human error identification" as the next two most important skills (82% and 82%, respectively). Researchers rated "study design and methods" and "qualitative coding and statistics" as the next two most important skills (80% and 73%, respectively) (Fig. 9).

3.3.2. *Interpersonal skills*

Nearly all respondents selected "teamwork" as a necessary interpersonal skill. In addition to "teamwork," every practitioner selected "communication" as a necessary interpersonal skill while only 7% of researchers did. Researchers selected "perseverance and motivation" and "coordination" as the most necessary interpersonal skills (Fig. 10).

3.4. *Integration of Human Factors in the Institution*

A series of Likert scale statements examined HFE integration and recognition of role. Figs 11 and 12 illustrate the researchers' and practitioners' responses, respectively. Ninety-three percent of respondents in each group (practitioners and researchers) agreed that people who did not previously know about HFE were "excited about it once I explained [it]" and 80% in each group disagreed (reverse coded scale) that "they are confused about how it benefits health care." All respondents also reported high agreement (practitioners 93%, researchers 100%) with the statement, "Once people have worked with me, they advocate for my involvement with future projects." (Fig. 12) .

4. Discussion

4.1. *Demographics*

Nearly 75% of Human Factors professionals who responded to this survey were women. This demographic is different from Human Factors professionals in other industries, in which 55% are men and 45% women (Human Factors Scientist Demographics and Statistics [2022]: 2022). Nonetheless, the higher proportion of women reflects the current

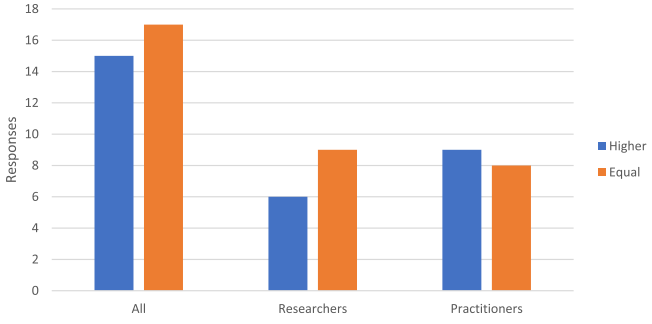

Fig. 7. Minimum education compared to current education level.

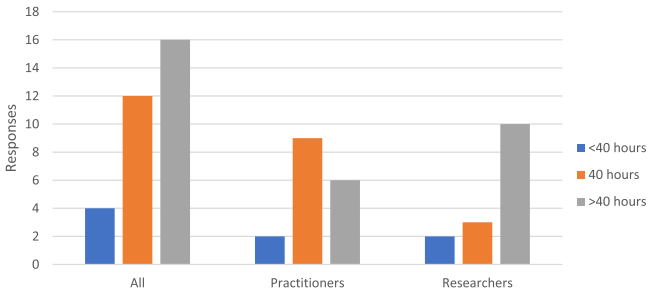

Fig. 8. Hours worked per week.

demographics in the global health care industry in which women are more prevalent (Gooch, 2021). It is possible that people select jobs based on the perceived and anticipated work-life balance, professional and personal satisfaction, the type of work involved, and expectations for gender discrimination and stereotypes (Barbulescu and Bidwell, 2013) and conversely, hospitals may have hiring preferences and biases as well (Turner et al., 2021).

In addition, the age range and experience of the HFE professionals in hospitals was relatively narrow. Most survey respondents were under 50 years of age and had less than 20 years of experience working in health care. Further, HFE professionals reported an approximate average of 3 years in their current position and 4 years in their current hospital, implying respondents either seem to be moving between jobs/hospitals or these positions did not exist in the hospital previously.

4.2. *Salary*

Compared with the median wages in this survey, it appears that health care-focused Human Factors pays above the national average of $95,300 for all Human Factors Engineers and Ergonomists (National Center for O*NET Development 2022). Level of education and years of experience in the field directly impacted salary. Men reported an average of $21,000 more annually than women, though the salary difference was not statistically significant. Based on the national gender gap (Goldin, 2014; Barroso and Brown, 2021), the findings draw attention to the need for future examination regarding potential inequalities. In addition, other factors that contribute to salary need to be included (e.g., negotiation (Barron, 2003), publications (Tuckman and Leahey, 1975)). Further, we did not ask about promotion and the free text data lacked sufficient detail to determine if women have been promoted at the same rate as men. Given that embedded Human Factors practitioners follow the health care trend of being woman-populated, it is necessary to examine leadership to determine if the same gender flip occurs in which men hold more leadership positions (Wong et al., 2018; Pérez-Sánchez et al., 2021,16; Carnes et al., 2015).

Institutions have varying minimum levels of education for Human Factors positions. Our study indicated that 33% of hospitals required a bachelor's degree. Yet O*Net reports that Human Factors Engineers and Ergonomists are expected to have a graduate level education, and describe that 48% will require master's degrees, 20% doctoral degrees, and 14% a post-baccalaureate certificate. Respondents in our study exceeded these education requirements as 50% had master's degrees and 47% had doctoral degrees. This could be a potential explanation for the mismatch between their actual salary and desired salary. Comparing the O*Net expectations and the results of this study, the findings draw attention to the possibility that health care organizations and the HFE industry disagree about the education levels needed to work successfully as an HFE professional.

In addition, some positions that would be appropriate for human factors professionals are restricted to those with clinical experience (e.g., patient safety related positions). Hiring managers may not understand the value of non-clinical expertise in these roles.

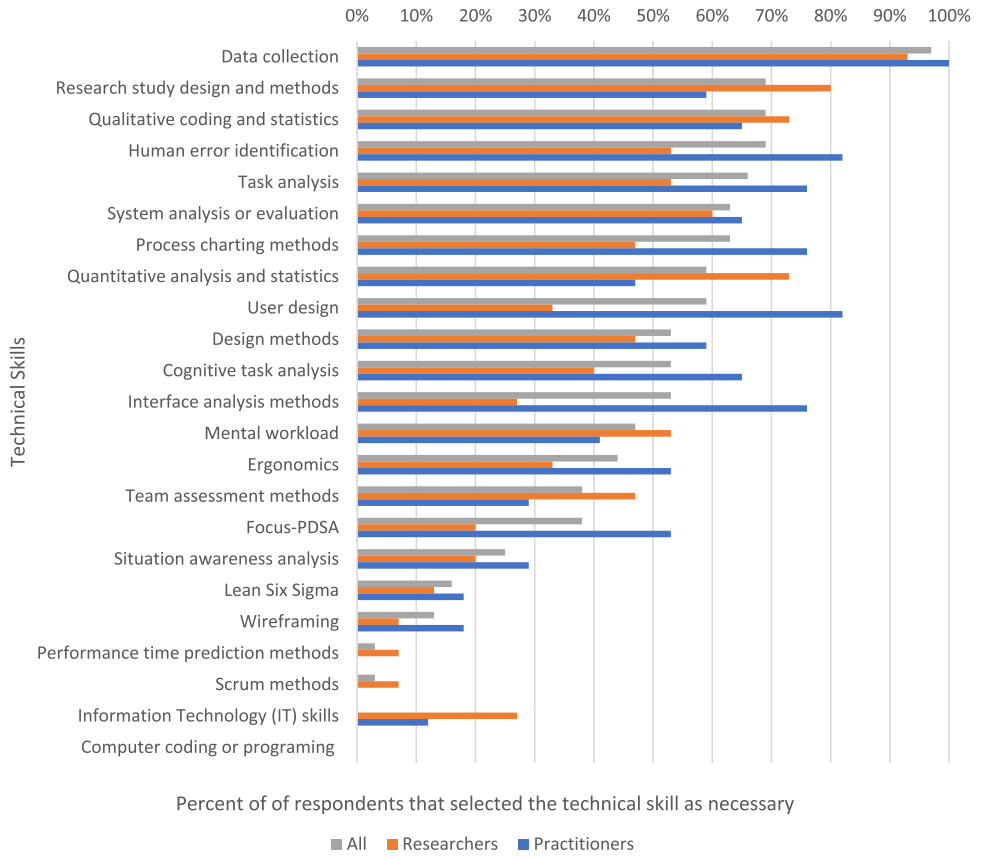

Fig. 9. Technical Skills Note: The percentages for the categories are based on the following: All responses (N=32), Practitioners (N=17), and Researchers (N=15).

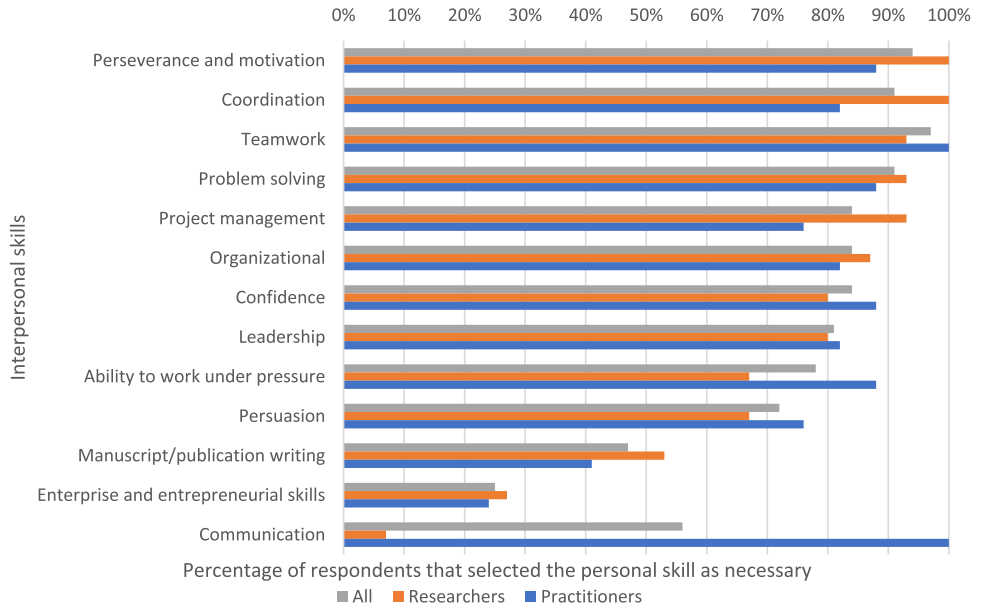

Fig. 10. Interpersonal skills.

4.3. Knowledge and Skills

Practitioner and researcher respondents reported the need for slightly different technical skills, but not so different that it would be difficult to transition from one role to the other. One skill that neither group selected was entrepreneurship. However, this could be due to university and institutional guidelines for employees relative to product development and intellectual property. Anecdotally, the biggest barrier to transitioning from being a researcher to a practitioner is the faster pace to meet deadlines and quantity of projects managed at any given point within the hospital. Conversely, the biggest barrier to transitioning from being a practitioner to a researcher is the necessity to secure grant funding and manage large, longer duration projects. Interpersonal skills chosen were also similar between the two groups. Of note, researchers

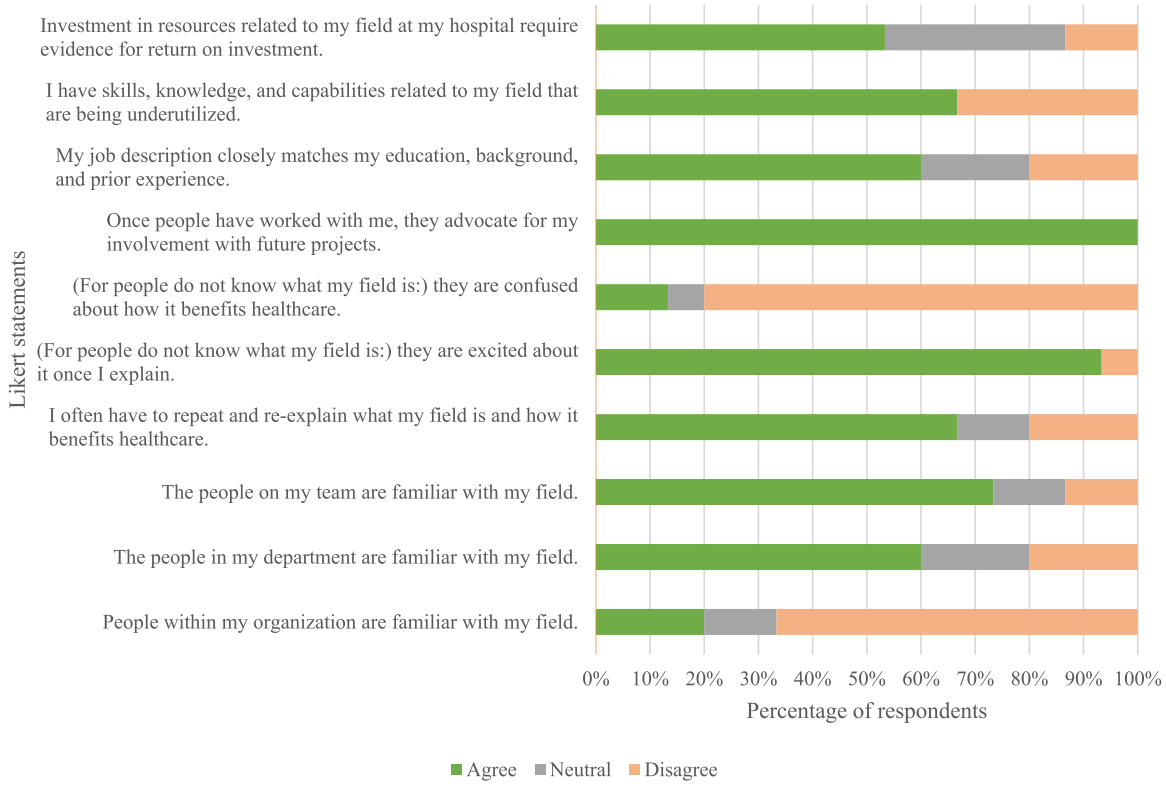

Fig. 11. Researcher's Likert statement responses.

did not select "communication" as one of the most important interpersonal skills, yet many researchers are required to publish manuscripts, a form of written communication rather than verbal.

4.4. Integration of Human Factors in the Institution

Our comparison of the skills respondents indicated as necessary in health care against the skills list from the O*NET Resources Center suggests that health care organizations do not know what skills to include in HFE job descriptions. If organizations are using generalized skill sets, rather than focused on health care, they may not create effective job descriptions. More importantly, staff in the organization lack an understanding of the value that HFE brings to the health care environment. This recognition of value was echoed in nearly 100% of respondents reporting that many staff inside their organization were excited after the HFE role was explained, and after working together, wanted HFE involvement in future projects. When working with staff on new projects, HFE practitioners usually have to provide background of their role and skills they bring to inform other team members who might not be familiar with HFE. To help bridge this gap, leadership can promote HFE as a resource to achieve sustainable system solutions, similar to quality improvement resources.

Leaders and organizations who are interested in incorporating or expanding existing HFE capabilities could turn to industry experts to understand the breadth and depth of value that HFE can offer. Professional organizations like Human Factors and Ergonomics Society and Human Factors Transforming Healthcare can offer ideas and create relationships with institutions to help align goals and provide information about HFE. Further, existing HFE practitioners may already have ideas for how to expand HFE as they are already embedded and familiar with the institution's culture.

4.5. Limitations

One, this study includes a small sample, though the number of people in these positions is small. Moreover, our sample size (N=32) is slightly larger than the sample of 20-21 responses the O*Net Resource Center uses to provide information about occupational information.

Two, we recruited participants through two professional societies and likely did not reach all current HFE practitioners working in health care.

Three, we could not determine job levels based on job titles alone. It is unclear if there is a relationship between compensation and title.

Four, we also did not include information related to other methods of compensation such as health insurance, paid leave, retirement benefits, etc.

Last, we did not include questions about opportunities for career advancement inside their organization. Future studies should elicit this information to add transparency to compensation.

This survey included some questions and information that is not reported here as the information was either not answered or there was not enough detail to draw reasonable conclusions. These questions should be expanded upon to gain accurate insight.

4.6. Future research

Further research is needed to understand why more women responded to the survey to determine if this reflects the potential different in interest in healthcare between the genders or if health care organizations may unintentionally having hiring preferences. In addition, these studies should include race/ethnicity as another possible variable to assess salary differences. Future research should explore the reasons why HFE professionals transition jobs after approximately 4 years.

Future qualitative research is warranted to better understand the role of embedded human factors and how to support their growth in health

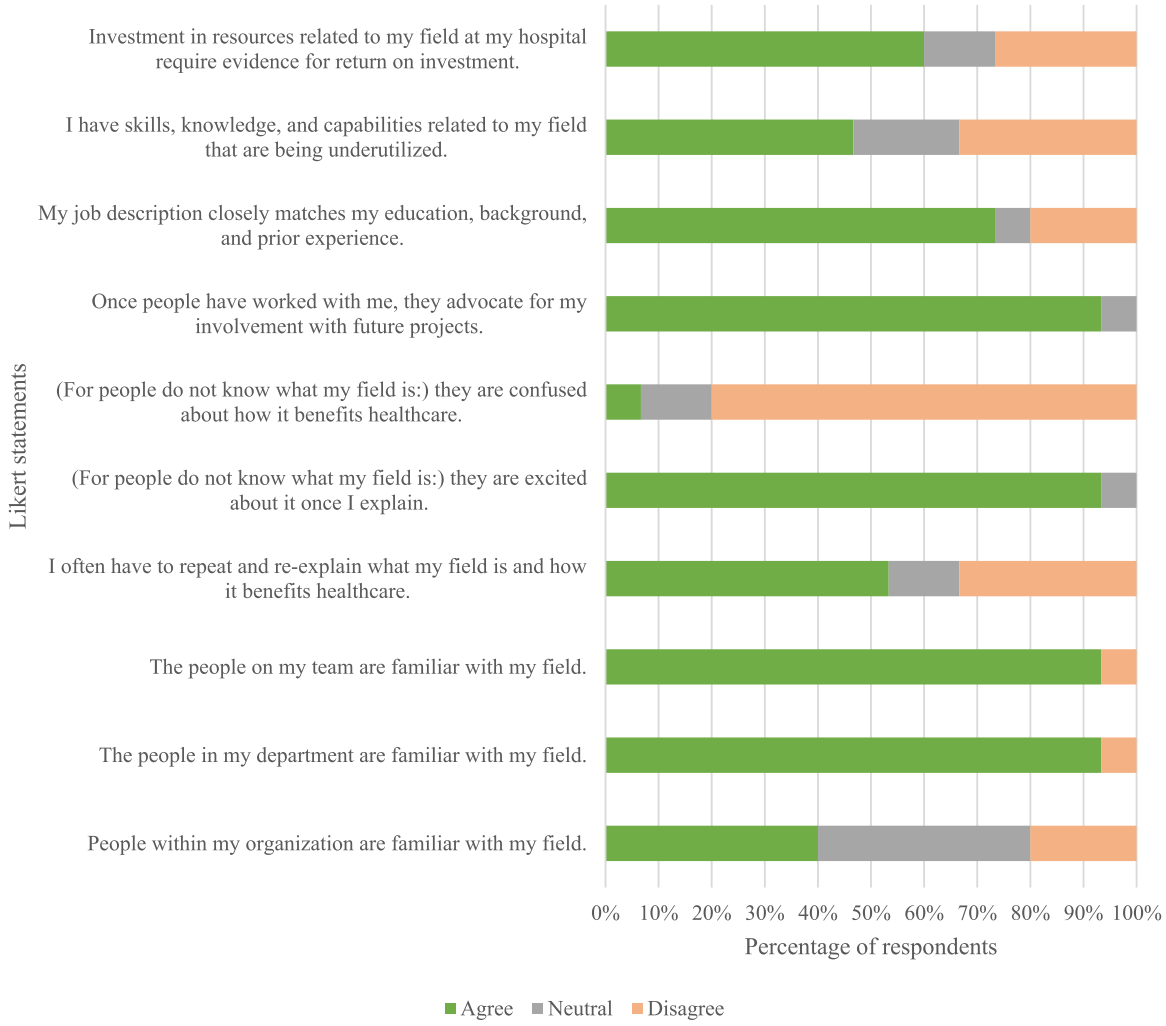

Fig. 12. Practitioner's Likert statement responses.

care. We employed a limited set of questions. Expansion of these questions through qualitative interviews would allow for a more robust data set as it is difficult to glean the breadth, depth, and unique variation of the day-to-day work via a survey.

5. Conclusion

This study provides education, knowledge, skills, and compensation information for a variety of purposes. For health care administrators, it offers insight into the knowledge and skillset that HFE professionals provide. HFE students can ensure they have the knowledge and skills necessary to be successful in health care and the general expectations of the researcher and practitioner roles. Hospitals can recognize the value of HFE, write targeted HFE job descriptions, and offer competitive compensation packages.

Key Points

1. As Human Factors in health care is expected to grow over the next 20 years, it is prudent to understand what hospitals need to prepare Human Factors practitioners who will fill these positions.
2. Hospitals and practitioners should be aware of the impact of gender, experience, and education on salaries. While a master's degree is usually accepted in these positions, a doctorate degree will potentially increase salary, but not necessarily.
3. Technical skills and interpersonal skills were similar for research and operations work, allowing a smoother transition between roles and shared training.
4. Human factors work is relatively unknown in health care but welcomed by staff once understood. Human factors practitioners will need to explain the impact of Human Factors quickly and effectively in the health care environment.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Kristen Webster reports a relationship with Indiana Society for Healthcare Risk Managment that includes: speaking and lecture fees.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.hfh.2023.100045.

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