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Influence of Expertise and Demographics on Perceived Ergonomic Risks in Physical Tasks

Hari Iyer[1] and Heejin Jeong[1]

Abstract

This study examines how professional experience, and the use of personal protective equipment (PPE) influence perceived ergonomic convenience, risk, proficiency, and safety across three physical task domains: assembly, culinary, and ladder-related activities. Participants ($N = 142$), comprising both professionals and laypersons, completed an assembly task using four tools, a culinary task involving 12 activities, and ladder tasks with and without gloves and sole grips. Data were analyzed using *t*-tests, Pearson correlations, and Bayesian comparisons. Professionals rated assembly tools as significantly less risky than laypersons, though both groups reported similar levels of convenience. In culinary tasks, professionals reported higher proficiency and greater comfort in activities such as stirring and oven use. PPE improved perceived ladder safety, especially when gloves and sole grips were used together. Gender differences were minimal, though some trends emerged in risk perception and task preference. Professional experience influenced perceptions of risk and proficiency, whereas convenience ratings remained consistent across groups. The findings support the need for ergonomic tool design, targeted safety training, and effective PPE implementation across task settings.

Keywords

cognition, human factors and behavior, occupation/industry, perception, performance

Introduction

Workplace safety and ergonomic design are essential for reducing injury risks and improving task efficiency in various work environments (Adiga, 2023). Tasks like assembly (Macwan et al., 2024; Makrini et al., 2019), culinary work (Ovias & Rao, 2020), and ladder use (Califano et al., 2024; Iyer et al., 2025) involve repetitive action and sustained postures that can lead to musculoskeletal disorders. Perceptions of ergonomic risk and convenience shape tool use and task performance (Omoniyi et al., 2020; Tao et al., 2024) yet remain understudied across task categories. While ergonomic design focuses on physical strain, various subjective factors like convenience, expertise, safety, and risk, also influence user behavior, protocol obedience, and comfort. These factors are critical but underexplored across diverse tasks and occupational groups.

This study aims to fill this gap by investigating ergonomic perceptions in three distinct physical task domains: assembly tasks, culinary tasks, and ladder use. Specifically, the research is guided by the following hypotheses:

H1: Professionals will find assembly tasks more ergonomically convenient and less risky than laypersons.

H2: Professionals will report greater ergonomic comfort and task proficiency in culinary tasks compared to laypersons.

H3: The combined use of gloves and sole grips as personal protective equipment (PPE) will be associated with an increased perception of safety in ladder tasks.

Each domain represents discrete biomechanical and cognitive demands. Assembly tasks involve repeated manual actions with hand tools requiring grip strength, with stable wrist and fine motor control. Culinary tasks include dynamic activities like chopping, lifting, and stirring, relying on fluid movement and sequencing. Ladder use involves vertical motion and balance in constrained environments, where perceived risk increases due to instability and fall potential (Iyer et al., 2025). While objective ergonomic assessments have refined tools and protocols, less is known about how

[1]Arizona State University, Mesa, USA

Corresponding Author:
Hari Iyer, The Polytechnic School, Ira A. Fulton Schools of Engineering, Arizona State University, 7418 E. Innovation Way South, Mesa, AZ 85212-6032, USA.
Email: hniyer@asu.edu

individuals subjectively understand these tasks, particularly between professionals and laypersons. With experience, tasks may feel easier and be performed more efficiently, but gradual exposure can desensitize professionals to ergonomic risks still evident to less experienced users. This study examines ergonomic convenience, risk, proficiency, and safety across task types and participant groups to better understand how perceptions shape ergonomic outcomes. Findings support the design of adaptive tools, with task-targeted training and interventions. This study makes four contributions: professional experience influences perceived risk and proficiency; ergonomic convenience is more stable across experience levels; gloves and sole grips enhance perceived ladder safety; and the cross-domain framework enables generalization across physical task environments.

Related Work

Ergonomic Principles in Hand Tool Design

Ergonomic principles influence tool and workspace design to enhance safety and comfort (Adiga, 2023; Waters et al., 2011). Hand-tool design impacts fatigue and strain, with features like shape of the handle, mass, and grip material influencing comfort of use (Harih & Dolšak, 2013). Effective design reduces muscular effort, joint divergence, and grip instability, with variables such as weight, balance, and texture playing key roles. Poorly designed tools can potentially elevate wrist extension, perceived effort, and injury risk. However, users may not perceive ergonomic impact equally. These perceptions may impact workplace safety by influencing adherence to proper techniques essential for occupational health.

Assembly Tasks and Expertise

Manual assembly tasks often require repetitive motion with tool use and fine motor control. Experienced workers may develop efficient strategies and tolerate minor ergonomic challenges, but how they perceive tool convenience and risk remains underexplored. Studies show professionals report lower perceived risk and greater efficiency with familiar tools, while novices face usability challenges (Fales et al., 2021; Plamondon et al., 2010). Professionals may rate tools as less risky despite similar biomechanical loads, whereas laypersons perceive more difficulty and danger. These perceptual differences could guide training and tool selection protocols. Ergonomic interventions reduce strain and improve performance, though expertise may moderate these effects (Abareshi et al., 2015).

Ergonomics in Culinary Tasks

Culinary work includes tasks like chopping, stirring, lifting, and reaching, each with distinctive biomechanical demands. While professionals develop task-specific efficiencies, ergonomic investigation in this domain is limited. Recognizing differences in experience and expertise can guide ergonomic guidelines and training to reduce fatigue and injury (Karthik & Rao, 2020). This study examines whether professionals perceive lower ergonomic risks and show greater efficiency, while less experienced individuals report more discomfort with repetitive or sharp-tool tasks (Iyer & Jeong, 2024; Ovias & Rao, 2020). It also considers whether gender-related factors affect comfort due to standard kitchen tool design.

Ladder Safety and Universal Design

Ladder-related injuries are common, particularly in construction and maintenance industries (Roberts et al., 2020). Universal design stresses stable footing, visual cues, and PPE compatibility, yet ladder use requires complex judgment that involves coordination and balance. While gloves and non-slip footwear may lower risk, they can impact tactile feedback and precision. This study examines whether sole grips and gloves improve safety perception more than expertise or gender (Califano et al., 2024).

Methods

This research followed the American Psychological Association Code of Ethics and was approved by the Institutional Review Board at Arizona State University (STUDY00016442). Written informed consent was obtained, and all standard deviation values reflect population SD. Three experiments examined how expertise, gender, and PPE influence perceived ergonomic risk, convenience, proficiency, and safety.

In the assembly task, participants completed four standardized fastening tasks using a screwdriver, manual method, spanner, and Allen key at a seated workstation, rating ergonomic convenience and risk on a scale from 0 to 10. Figure 1 shows the tools used for the tasks. Participants were categorized as professionals or laypersons by experience.

The culinary task involved twelve culinary activities, as shown in Figure 2, with participants rating comfort and proficiency (0–3) after each. Grouping was based on experience.

In the ladder task, participants performed ascent and descent under PPE conditions (gloves, sole grips, both, or none), then rated perceived safety, step assessment ability, risk, and difficulty (0–10). Figure 3 shows demonstrations of the tasks.

Analyses included independent *t*-tests, Pearson correlations (Benesty et al., 2009), and Bayesian generalized linear models with posterior distributions and 95% credible intervals.

Results

Assembly Task

The correlation between perceived convenience and risk across assembly tools is illustrated in Figure 4. Significant correlations in assembly tasks showed strong alignment in

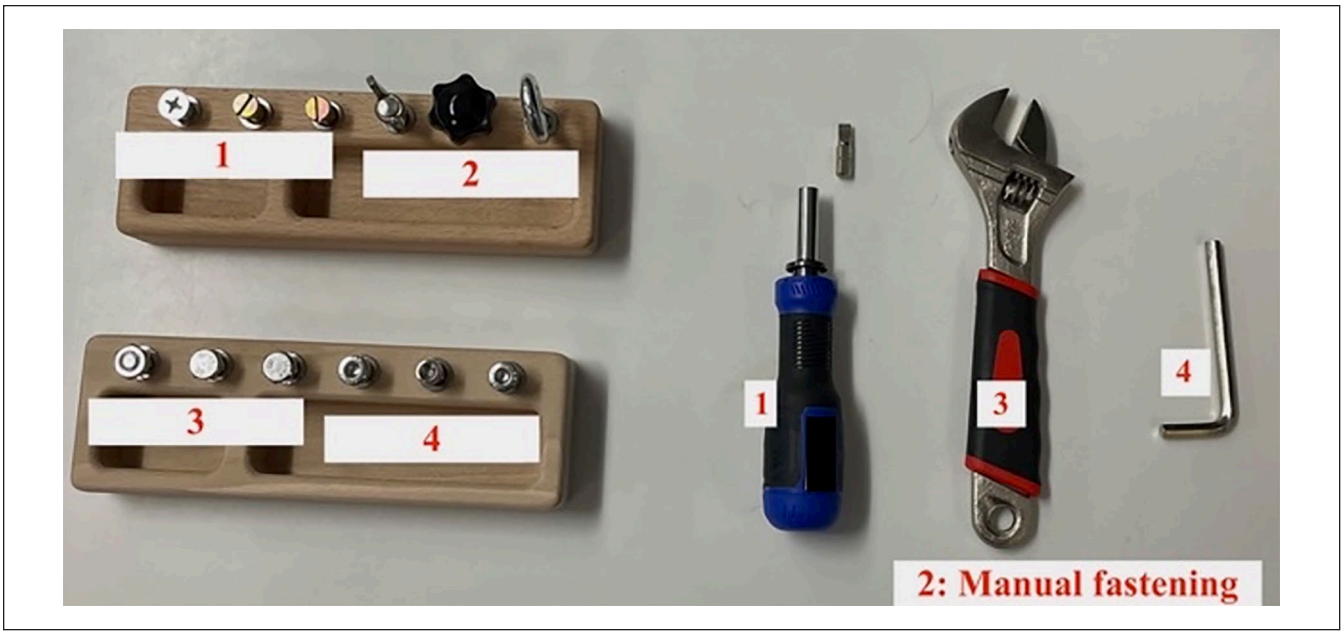

Figure 1. Tools and components for manual fastening (Task 2). Participants used four tool–fastener pairs. (1) screwdriver, (2) manual fastening, (3) spanner, and (4) Allen key, organized in trays to assess ergonomic perceptions across fastening scenarios.

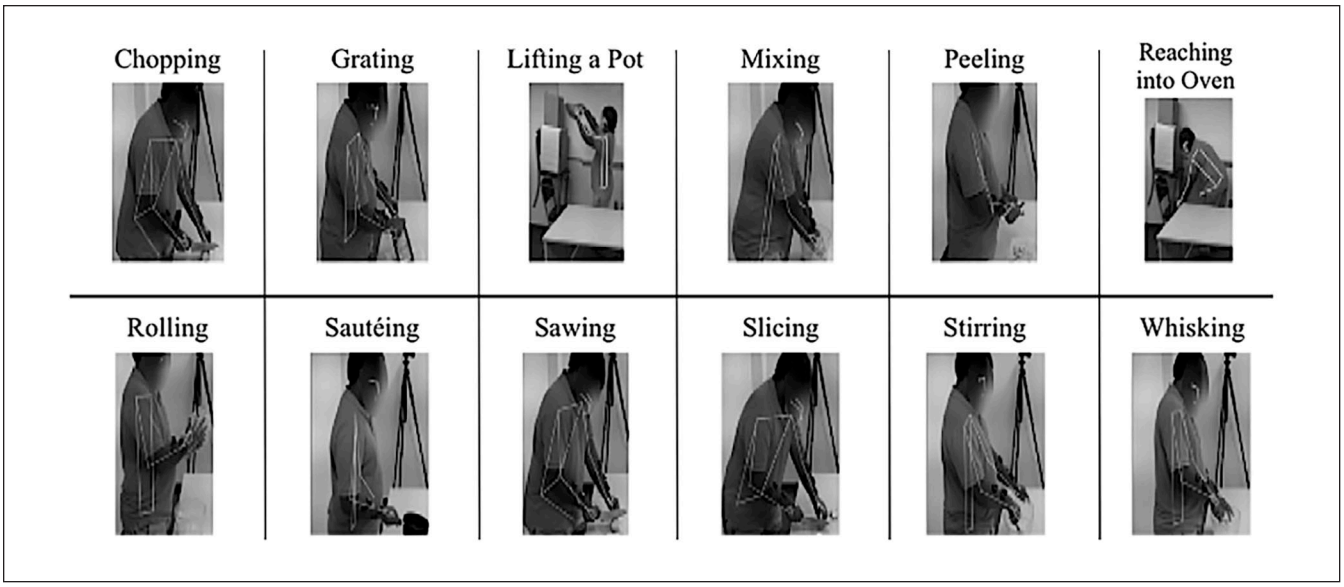

Figure 2. Culinary task actions used in the study.

perceived risk between screwdriver and Allen key ($r=.62$, $p<.001$) and spanner and Allen key ($r=62$, $p<.001$). For convenience, screwdriver correlated positively with Allen key ($r=.48$, $p<.01$) and spanner ($r=.49$, $p<.01$). Negative correlations included manual fastening's ergonomic and risk ratings ($r=-.61$, $p<.001$) and screwdriver versus spanner risk ratings ($r=-.37$, $p<.05$). Professionals rated all tools as significantly less risky, including spanner ($t=2.52$, $p=.016$) and manual fastening ($t=2.42$, $p=.021$), while convenience ratings showed no significant group differences ($.238<p<.771$). Professionals rated tools slightly more convenient (e.g., spanner: 7.60 vs. 6.62), and much less risky (e.g., screwdriver: 0.50 vs. 1.81; spanner: 1.00 vs. 2.77). Bayesian analysis showed strong support for higher professional convenience ratings (manual fastening: mean diff = 0.524, 95% CI [0.172, 0.875], prob > 0 = .998; Allen key: 0.354, CI [0.095, 0.613], prob > 0 = .996). Risk differences had weak evidence (prob > 0 = .601–.649, CIs crossed zero). Among laypersons, males rated tools more convenient (screwdriver: 8.08 vs. 7.08; spanner: 7.08 vs. 6.15), while females rated spanner risk higher (3.38 vs. 2.15). No significant gender differences were found ($p>.139$).

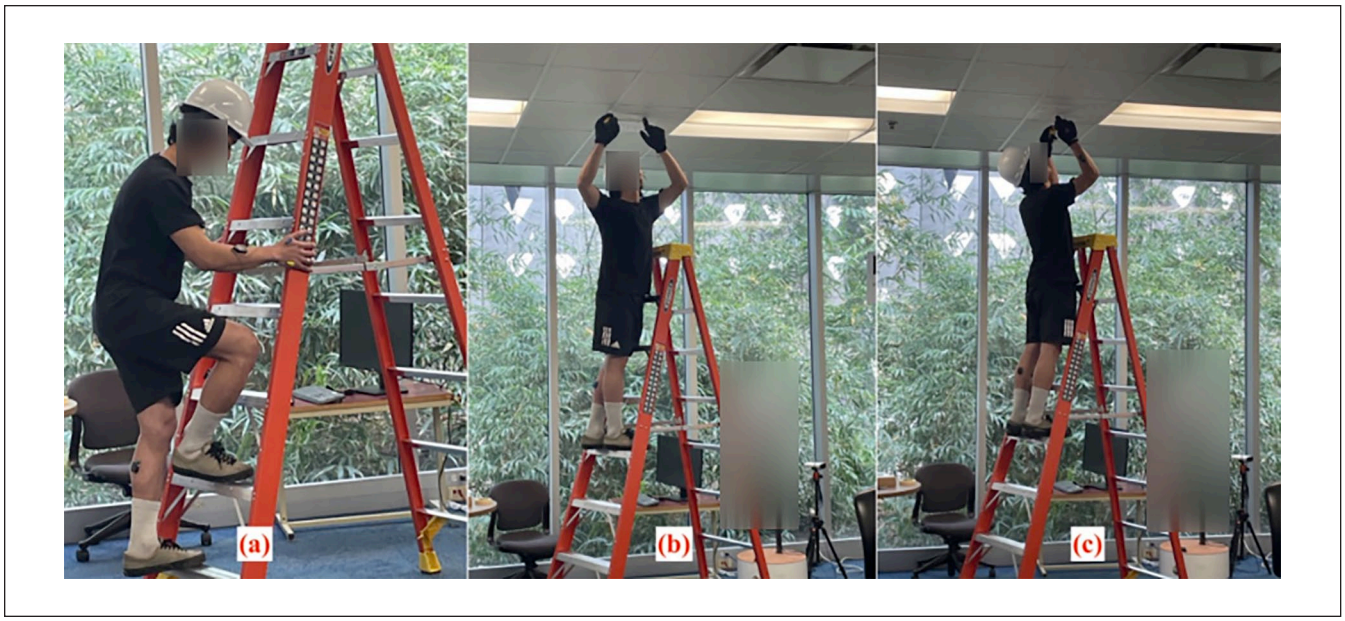

Figure 3. Ladder task phases: (a) climbing the ladder, (b) reaching overhead with gloves, and (c) reaching with both gloves and sole grips.

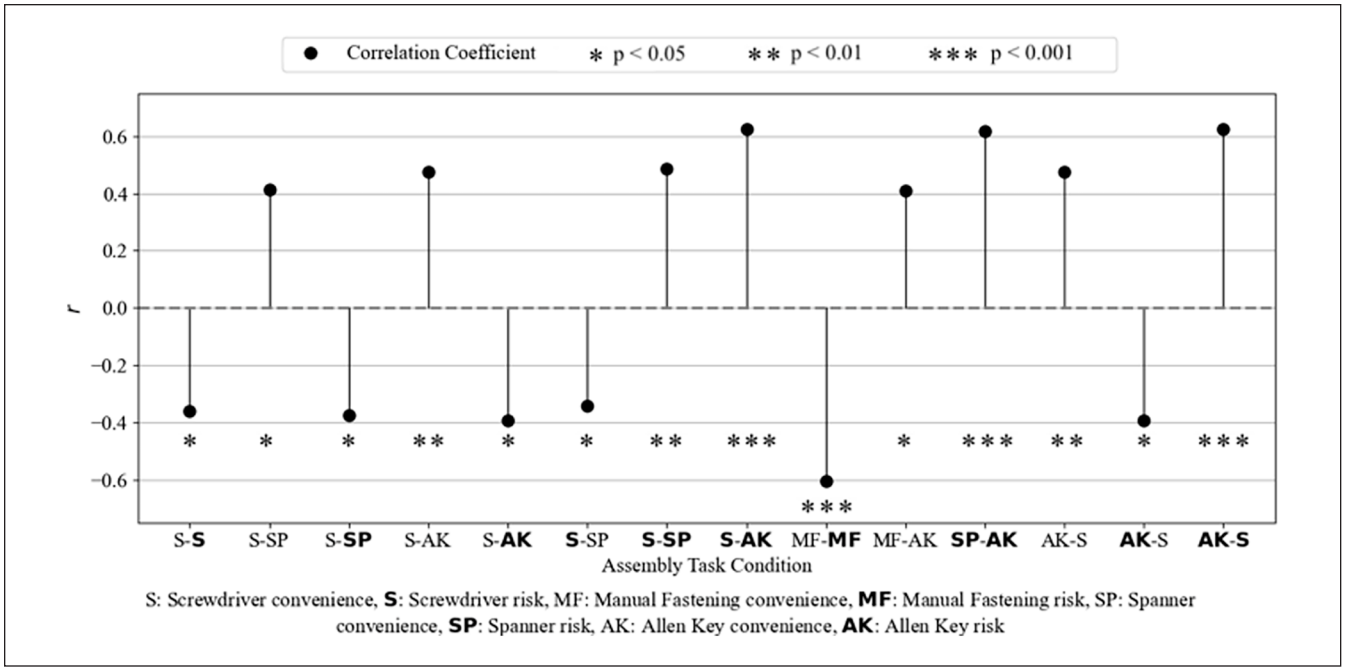

Figure 4. Correlation between perceived convenience and risk across assembly tools.

Culinary Task

Mean ergonomic convenience ratings were similar between laypersons (2.69) and professionals (2.75), with professionals rating most tasks slightly higher. Largest differences were for lifting a pot (2.81 vs. 3.00) and stirring (2.73 vs. 3.00), while rolling was rated lower by professionals (2.38 vs. 2.69). For task proficiency, professionals rated themselves higher overall (2.88 vs. 2.69), especially for reaching into the oven (2.65 vs. 3.00), lifting a pot (2.85 vs. 3.00), and mixing (2.77 vs. 3.00). Group comparisons showed no significant differences in most ergonomic comfort ratings, though stirring ($t=-2.57$, $p=.016$) and mixing ($t=-2.57$, $p=.016$) were significant; lifting a pot ($t=-2.00$, $p=.057$) approached significance. Professionals also rated themselves significantly more proficient in mixing ($t=-2.29$, $p=.031$) and oven use ($t=-2.56$, $p=.017$). Gender comparisons among laypersons showed significant differences in comfort for slicing

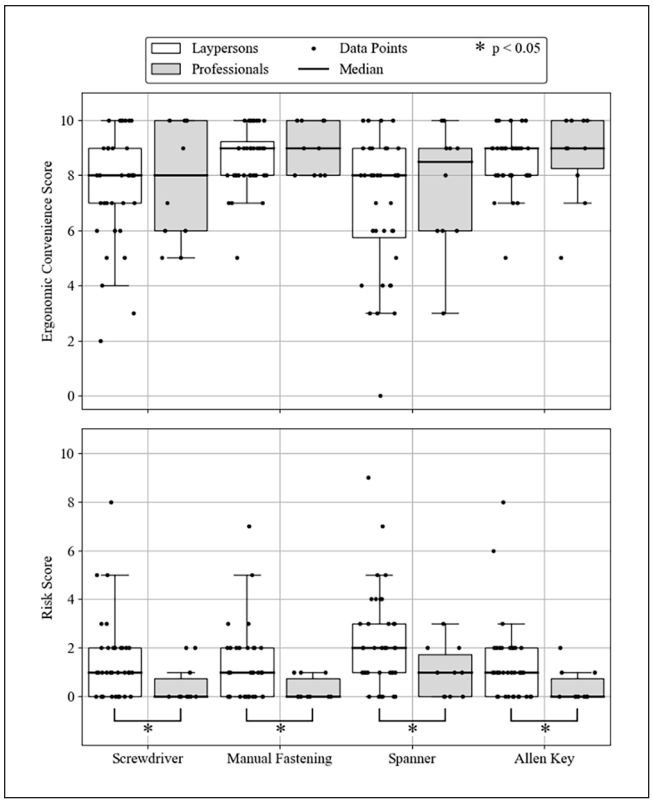

Figure 5. *t*-Test results on convenience and Risk in culinary tasks (laypersons vs. professionals).

($p=.021$), and in proficiency for peeling ($p=.022$), stirring ($p=.026$), and sautéing ($p=.008$). Chopping, lifting a pot, and rolling showed near-significant gender differences.

Figure 5 presents the *t*-test results comparing ergonomic convenience and perceived risk in culinary tasks between laypersons and professionals. While overall comfort ratings were similar, professionals reported significantly higher comfort in tasks such as stirring and mixing.

Ladder Task

Sole grips received the highest ascent safety rating ($M=7.17$, $SD=2.28$); gloves were rated highest for descent ($M=7.46$, $SD=1.56$). Ladder step placement felt safer during ascent ($M=8.04$, $SD=2.03$) than descent ($M=7.58$, $SD=1.41$). Taking hands off the ladder had the lowest safety rating ($M=4.42$, $SD=2.81$). Significant paired differences were found in ascent, gloves differed from step placement ($t=-2.37$, $p=.027$), unhanding ($t=2.93$, $p=.008$), and shape assessment ($t=1.82$, $p=.081$); sole grips differed from unhanding ($t=3.29$, $p=.003$) and shape assessment ($t=2.70$, $p=.013$). In descent, gloves differed significantly from risky tasks ($t=4.60$, $p<.001$) and shape dimensions ($t=3.26$, $p=.003$); sole grips also differed ($t=3.96$, $p=.001$; $t=3.08$, $p=.005$). PPE preferences were gloves + foot protection ($n=11$), foot protection only ($n=8$), gloves only ($n=5$). Most-used gloves: AV408 Medium ($n=7$); sole grips: Medium ($n=16$). Males rated sole grips higher (ascent: 7.67 vs. 6.67; descent: 7.83 vs. 6.83), while females rated gloves higher (ascent: 6.83 vs. 6.42; descent: 7.67 vs. 7.25). Males rated ladder placement higher (ascent: 8.50 vs. 7.58; descent: 7.92 vs. 7.25); females rated greater risk for unhanding (5.25 vs. 3.58) and shape difficulty (5.67 vs. 4.83). No gender differences were statistically significant ($p=.257<p<.695$ for safety; 0.279/0.260 for placement; $p=.151$ for unhanding; $p=.429$ for shape). Table 1 presents paired *t*-test comparisons of perception metrics across tasks, highlighting significant differences between PPE conditions and risk-related actions during ladder ascent and descent.

Discussion

This study examined how professional experience and protective equipment influence ergonomic perceptions across three physical task domains. The results support all three hypotheses, though with varying degrees of statistical strength and significance.

H1 was supported. In the assembly task, professionals consistently rated tools as significantly less risky than laypersons, aligning with prior findings that familiarity lowers perceived hazard. Although convenience ratings did not differ significantly between groups, Bayesian analyses suggested a high probability that professionals found some tools (e.g., manual fastener, Allen key) more convenient. These findings support the view that while ergonomic convenience may show stable physical affordances, perceived risk has higher sensitive to expertise.

H2 was partially supported. In culinary tasks, professionals reported significantly greater task proficiency and higher comfort ratings for certain activities such as mixing and reaching into oven. However, convenience ratings were largely similar across groups, with only stirring and mixing reaching statistical significance. These results suggest that proficiency perceptions are more influenced by professional experience than comfort, which may be shaped by both familiarity and individual physical variation. Gender-based trends in comfort and proficiency were observed across tasks, especially among laypersons, although these did not substantially shift overall group-level outcomes.

H3 was supported. Ladder task data showed that combined use of gloves and sole grips yielded the highest perceived safety ratings, especially for descent and tasks involving balance or assessment under risk. Statistically significant differences were found between PPE conditions and control or risky actions (e.g., unhanding the ladder). These findings confirm that comprehensive PPE can improve subjective safety, even in conditions with minimal physical risk differentials. While gender-based differences in ladder perceptions were present (e.g., males rated sole grips higher; females rated gloves higher), none reached statistical significance, suggesting that task context and PPE configuration influence perception more than user demographics.

Table 1. Paired *t*-Test Results for Perception Metrics by Task and Comparison Type (Ascent (A); Descent (D)).

Metric 1	Metric 2	*t*	*p*
Within-task comparisons			
Ascent task safety impact			
Gloves	Sole grips	−0.77	.446
Gloves	Ladder step placement	−2.37	.027
Gloves	Unhanding ladder	2.93	.008
Gloves	Assessment task	1.82	.081
Sole grips	Ladder step placement	−2.41	.024
Sole grips	Unhanding ladder	3.29	.003
Sole grips	Assessment task	2.70	.013
Descent task safety impact			
Gloves	Sole grips	0.22	.827
Gloves	Ladder step placement	−0.28	.779
Gloves	Risky (hands off ladder)	4.60	.000
Gloves	Assessment task	3.26	.003
Sole grips	Ladder step placement	−0.84	.408
Sole grips	Risky (hands off ladder)	3.96	.001
Sole grips	Assessment task	3.08	.005
Cross-task comparisons (Ascent vs. Descent)			
Gloves (A)	Gloves (D)	−1.96	.062
Gloves (A)	Sole grips (D)	−1.08	.291
Gloves (A)	Ladder step placement (A)	−2.37	.027
Gloves (A)	Ladder step placement (D)	−1.57	.129
Gloves (A)	Risky (hands off ladder)	2.93	.008
Gloves (A)	Assessment task	1.82	.081
Sole grips (A)	Gloves (D)	−0.53	.599
Sole grips (A)	Sole grips (D)	−0.53	.604
Sole grips (A)	Ladder step placement (A)	−2.41	.024
Sole grips (A)	Ladder step placement (D)	−1.24	.226
Sole grips (ascent safety)	Risky (hands off ladder)	3.29	.003
Sole grips (A)	Assessment task	2.70	.013
Ladder step placement (A)	Ladder step placement (D)	1.19	.246
Ladder step placement (A)	Risky (hands off ladder)	4.13	.000
Ladder step placement (A)	Assessment task	3.92	.001
Ladder step placement (D)	Risky (hands off ladder)	4.62	.000
Ladder step placement (D)	Assessment task	3.98	.001
Risky (hands off ladder)	Assessment task	−1.52	.141

The study highlights the importance of integrating perceptual data into ergonomic evaluation. Expertise significantly influences how users interpret ergonomic demands, particularly for risk and proficiency, while convenience ratings remain relatively stable. PPE use, especially when well-integrated, can improve user confidence, highlighting the importance of subjective feedback in designing effective safety equipment. These results show the need for ergonomic interventions that align both physical and perceptual factors across diverse task environments.

Conclusion

This study emphasizes the role of expertise and demographic factors in shaping ergonomic risk perception and task convenience. Professionals consistently reported better ergonomic outcomes, likely due to familiarity with tools and optimized task execution strategies. Gender differences were most evident in culinary tasks, where female participants reported greater discomfort with certain tools. In ladder-related activities, safety perceptions were influenced more by equipment design than by user demographics. These findings highlight the need to design tools for diverse users, though the perceived risk may not always align with biomechanical demands. Future research should explore more inclusive workplace designs and settings, such as adjustable tool grips and task-specific ergonomic training. Real-world validation studies in occupational settings could refine ergonomic assessments and interventions. By considering expertise and demographic diversity in ergonomic workplace design, workplaces can improve safety, comfort, and productivity for workers.

Declaration of Conflicting Interests

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ORCID iD

Heejin Jeong https://orcid.org/0000-0002-0122-532X

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