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Ergonomic Criteria and Usability Testing of Cut-Resistant Protective Gloves: An Experimental Study

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Abstract

Background: *Although hand and arm injuries can be prevented with protective gloves, their use may reduce hand dexterity and muscle strength. This study examined the ergonomic criteria and usability of four cut-resistant protective gloves (CRPGs) types to identify the optimal glove choice.* **Methods:** *In this experimental study, 22 male participants were tested under five conditions: barehanded, wearing nitrile-coated gloves, gel-coated gloves, material-coated gloves, and foam nitrile-coated gloves. Dexterity was assessed using the Bennett and O'Connor tests; grip and pinch force were measured with a dynamometer, and a goniometer assessed the range of motion. The gloves' usability was evaluated through the System Usability Scale (SUS) questionnaire. At the same time, localized discomfort in different areas of the hand was assessed using the Local Perceived Discomfort (LPD) questionnaire. Finally, glove comparisons were made using appropriate statistical tests analyzed with SPSS version 24 software.* **Results:** *All examined CRPGs significantly lowered finger dexterity scores ($p < 0.001$). However, the effects of different gloves on hand dexterity varied. Wearing all four gloves reduced grip force, but statistically significant differences in grip force were noted only between the barehanded condition and Glove B ($p = 0.004$). Using all four gloves increased pinch force, though this increase was statistically significant only between the barehanded condition and Glove D ($p = 0.005$). Wearing all gloves caused a statistically significant reduction in wrist, palm, and finger range of motion compared to the barehanded condition ($p < 0.005$). Lastly, there was a significant statistical difference between the gloves regarding usability ($p = 0.001$) and LPD ($p = 0.001$).* **Conclusions:** *CRPGs can greatly influence hand skills. Glove D, featuring a foam nitrile coating, exhibited the highest finger dexterity compared to the other gloves studied. Considering aspects like sweat resistance and anatomical design, this foam nitrile-coated glove is appropriate for cutting-resistant tasks within various industries.*

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1. Introduction

Occupational activities involving sharp objects such as knives, glass, sheet metal, and similar materials pose cuts and hand injury risks, particularly in food processing plants, plastics, textiles, metalworking, glassmaking, and other industries where these tools are utilized [1, 2]. Sharp objects, including knives and metal parts, account for approximately 30% of lost work time and 80% of hand injuries [3]. Studies indicate that hand injuries are among the most common workplace injuries and the second most frequent work-related musculoskeletal disorder [4, 5]. According to statistics provided by the U.S. Bureau of Labor Statistics, nearly 20% of all work-related injuries affect workers' hands. Annually, there are 110,000 cases of time lost due to hand injuries, and 1 million workers seek treatment in emergency rooms due to hand injuries [6].

Human hands have unique physical and sensory capabilities that enable a wide range of delicate and rapid movements, high gripping forces, and repetitive motions with great precision [7]. Therefore, protecting hands in the workplace from mechanical, thermal, radiation, chemical, bloodborne pathogen transmission, electrical, and vibration hazards is crucial for reducing various hand injuries. Consequently, focusing on this body part and preventing injuries is imperative [8].

Personal Protective Equipment (PPE) and protective clothing serve as barriers between hazardous environments and workers' bodies, acting as critical protective measures [9]. In recent years, considerable research has focused on the role of ergonomics in designing and manufacturing protective equipment. Some studies have examined the specific considerations necessary for designing and producing protective footwear for firefighters [10, 11]. Other studies have aimed to develop tools for evaluating medical gloves [12, 13]. Among these, gloves are one of the PPE items frequently used across many professions to safeguard hands against potential hazards [9].

While wearing gloves offers protection and safety, it may also reduce gripping force, decrease skill, and diminish tactile sensitivity, leading to lower performance in manual tasks [14-16]. Manual skill refers to the motor skills involved in the arm, hand, and the range of motion available for the fingers during manual tasks [17]. Factors affecting manual skill include movement restrictions, reduced ability to bend fingers, weak contact between the hand and the target object due to glove thickness or poor fit, and inappropriate gloves [17, 18]. Previous studies have reported that wearing gloves decreases manual dexterity [19]. Other studies have shown a significant correlation between glove type and manual skill [20].

Among the gloves commonly used in various industries based on the type and nature of work, CRPGs stand out. CRPGs are a category of protective equipment designed to shield individuals from potential injuries. All workers handling sharp objects and tools require these types of gloves. However, some employees believe that using protective gloves can hinder their control over hand tools and affect their task performance, possibly increasing the risk of personal injury [21, 22]. As a result, some individuals prefer to avoid wearing gloves when faced with the risk of hand injury, leading to reduced control over tools and diminished task mastery [23]. Recent studies have also indicated that gloves with poor ergonomic features may raise workplace accident rates due to decreased precision, comfort, tactility, gripping force, and skill [9, 14]. Nevertheless, using thin gloves of the correct size, which have good muscle force to grip conversion capabilities, and ensuring proper sizing can significantly enhance worker protection while simultaneously increasing productivity and reducing upper limb muscle fatigue, thereby preventing potential injuries [24, 25]. Therefore, utilizing CRPGs with appropriate ergonomic features is an effective and cost-efficient safety measure [26].

Given the extensive use of hands and the importance of hand protection for daily tasks, addressing the potential hazards posed by non-ergonomic CRPGs is essential, making the proper selection of this protective equipment crucial to prevent possible injuries [27]. To date, numerous studies have investigated optimal glove selection for professions such as firefighting, healthcare, and other occupations. However, research specifically focusing on CRPGs from the standpoint of ergonomic and usability criteria remains relatively limited. Thus, the current study was designed and conducted to explore the ergonomic and usability requirements of CRPGs.

2. Methods

2.1. Participants

This experimental study involved 22 male volunteers. All participants were male, as men typically perform heavy-duty activities that require the use of CRPGs in Iran. The sample size was calculated using an effect size of 0.63 based on the study by Irzmanska et al. (2016) [19] with G*Power software. The inclusion criteria were as follows: an age range of 20 to 40 years, good health, right-handedness, no musculoskeletal disorders in the hand area, no prior experience with CRPGs to eliminate the experience effect, and individuals with average hand size according to the EN420 standard to eliminate the impact of anthropometric dimensions. Participants' health and absence of musculoskeletal disorders in the hand area were self-reported. Additionally, individuals with a hand circumference of 203-209 mm and a hand length of 182-192 mm, corresponding to the size eight standard according to EN420, were selected as having average hand size [28]. Participants were tested under two conditions, with and without gloves, based on objective and subjective criteria, and the results were compared. This study received approval from the Ethics Committee of Isfahan University of Medical Sciences (Ethics code: IR.MUI.RESEARCH.REC.1401.268). All volunteers read and signed an informed consent form to participate in the study and could withdraw anytime.

2.2. Cut-Resistant Protective Gloves

In this study, four samples of commonly used CRPGs in Iran, including gloves with materials like palm-cut-resistant, nitrile-coated, foam-nitrile-coated, and gel gloves in medium size typically used in various industries, were selected based on input from sellers and experts in this field. The picture and characteristics of these gloves are presented in Table 1.

Table 1. Characteristics of CRPGs used in the study.

Glove	Picture	Main materials	Special characteristic	Application
Glove A		high density polyester covered by nitrile	Resistant to oil, grease, solvent and combustible materials, it has grooved texture for better grip	assembly work, oil and petrochemical industries, home appliance production, printing and packaging, transportation
Glove B		Polyester and polyvinyl chloride	—	Construction, service works, gardening, agriculture and transportation
Glove C		Polyester, latex in the fingers and palm regions	high grip even for smooth and polished work tools	Can be used for working with construction materials, concrete, bricks, metalworking, machinery, storage, automotive industry, transportation
Glove D		Polyester, nitrile foam in the fingers and palm regions	With breathable fibers	Automotive industry, maintenance, oil and gas industries, facilities, production industries, assembly work, storage, transportation

2.3. Study Procedure

Initially, all participants received detailed explanations regarding the experimental procedures and objectives. Subsequently, the examiner provided practical demonstrations on how to perform the tests. Participants were informed of their right to withdraw from the study at any experiment stage. Each participant required approximately 2.5 hours to complete all test procedures. The dexterity tests were arranged on one table, while the dynamometer and goniometer were set up on another. Each participant initially performed the tests with bare hands and subsequently with each of the four aforementioned gloves. A rest period of 3 to 4 minutes was allocated between tests. Subjective assessments were conducted immediately following the completion of each test. All experiments were conducted between 8:00 AM and 3:30 PM in a laboratory with normal ambient temperature and relative humidity conditions. Participants were seated on adjustable chairs during the tasks, with the flexibility to adjust the chair height for optimal manipulation of objects on the table. The tests performed in this study were:

- Whole hand dexterity test;
- Finger dexterity test;
- Grip force test;
- Pinch force test;
- Range of motion measurement;
- LPD measurement;
- Usability evaluation.

2.3.1. Dexterity Tests

2.3.1.1 Whole Hand Dexterity Test

Whole-hand dexterity refers to manipulating relatively large objects [29]. The Bennett test assesses whole-hand dexterity while utilizing standard mechanical and assembly tools, including gloves. This test involves assembling three different sizes of bolt, nut, and washer combinations onto a vertical wooden board [30]. Each participant was seated in an adjustable chair facing the workbench where the wooden board was positioned. Participants adjusted their seat height to achieve a comfortable working posture. The test included the following steps:

- Loosening bolts using a wrench;
- Unscrewing and completely removing bolts and washers by hand;
- Placing bolts and washers back into the holes;
- Firmly fastening bolts using a wrench.

The process of loosening and unscrewing bolts and washers began at the top row of holes on the left, while the fastening process started at the bottom row of holes on the right. The time taken to complete these four steps demonstrated dexterity [31].

2.3.1.2. Finger Dexterity Test

Tests for finger dexterity are often employed to evaluate performance changes connected to wearing gloves. The O'Connor Finger Dexterity test has proven effective in predicting the rapid manipulation of small objects, particularly in assembly line tasks. This test consists of a plate with multiple holes, where participants must use their fingers to insert three pins into each hole. Dexterity in the O'Connor test is assessed based on the time taken to place three pins into a single hole [32].

2.3.2. Hand Power Tests

2.3.2.1. Grip Force Test

Hand grip entails holding objects with the thumb, fingers, and palm [33]. This study assessed hand grip strength using the standardized test position endorsed by the American Society of Hand Therapists, employing the Saehan hydraulic hand dynamometer. As per the protocol, participants were seated in a height-adjustable chair with their feet flat on the ground. Their shoulders rested in a neutral position without elbow support, and their elbows were maintained at a 90-degree angle. Participants executed the maximum voluntary contraction three times, and the highest recorded score was noted as their hand grip force [34].

2.3.2.2. Pinch Force Test

Pinch grip involves using one or more fingers to manipulate objects and thumb movements without engaging the palm. The strength of the pinch grip was assessed according to the American Society of Hand Therapists protocol [33] and with the Saehan Hydraulic Pinch Gauge. Similar to the grip force test, participants sat in a height-adjustable chair with their feet flat on the ground, shoulders relaxed, and elbows bent at a 90-degree angle. They exerted maximum voluntary contraction three times, and the highest score recorded was considered their pinch grip force [35].

2.3.3. Hand Range of Motion Measurement

A goniometer was used to assess the range of motion of various hand joints [36]. Precisely, the range of motion of the metacarpophalangeal joints in the fingers, the thumb, and wrist flexion was measured under different conditions: bare hand and while wearing gloves A through D. The results from these measurements were then compared to analyze how wearing different gloves impacts hand joint flexibility and mobility.

2.3.4. Subjective Evaluation

2.3.4.1. Usability Evaluation

Usability, defined as the suitability of an artifact for a specific purpose, was assessed using the SUS questionnaire. The SUS is a ten-item scale that offers a comprehensive view of subjective usability evaluations. Respondents were asked to answer each question right after reading it without overthinking their answers. Each item's score ranged from 0 to 4. One point was deducted from all odd-numbered questions and five points from all even-numbered questions to compute the final score. We then combined the results of the even and odd questions and multiplied by 2.5. The final score ranged from 0 (very poor usability) to 100 (very high usability) [37]. The validity of the SUS questionnaire in evaluating usability has been supported by studies conducted by John Brooke (1996) [37] and Bangor et al. (2008) [38].

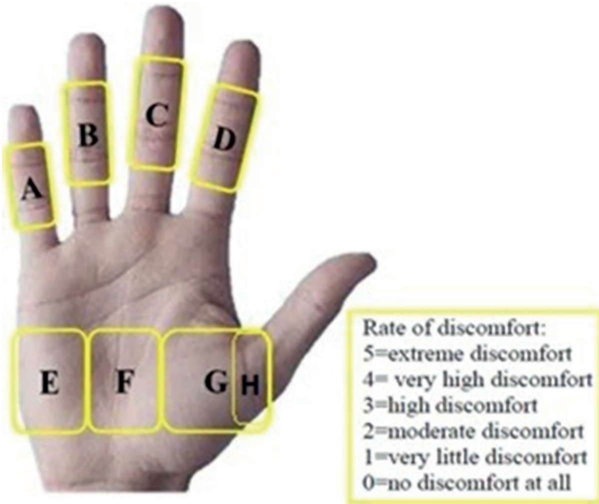

Figure 1. Local perceived Discomfort (LPD) scale.

2.3.4.2 Local Perceived Discomfort Measurement

The LPD questionnaire, a quantitative scale, was employed to evaluate local discomfort. After completing the tests, respondents were asked to report any discomfort experienced in specific areas shown in Figure 1, using a 5-point scale ranging from 0 (no problem) to 5 (extremely uncomfortable) [39]. Previous studies have established the validity and reliability of the LPD scale, with a Cronbach's alpha coefficient of 0.92 indicating high reliability [40].

2.4. Statistical Analyses

Statistical analysis was conducted using SPSS version 24 statistical software. The following steps were taken:

- Normality Assessment: The Shapiro-Wilk test was used to assess the data normality.

Comparison of Quantitative Variables:

- The ANOVA test with rank transform procedure was employed to compare the means of quantitative variables among the four gloves studied (A, B, C, D).

- Pairwise comparisons among the variables were performed using the Post hoc Bonferroni test.

Comparison of Specific Measures:

The Wilcoxon signed-rank test (2-related sample test) was used to compare the following measures between the use of gloves (A, B, C, D) and bare hands:

- Whole hand dexterity;
- Finger dexterity;
- Grip force;
- Pinch force;
- Range of motion.

Statistical Significance:

- A confidence level of 95% (α=0.05) was considered for all statistical tests to determine the significance of the findings.

These statistical methods were used to analyze the data and evaluate differences in performance and usability among the various glove types and between gloved and bare-hand conditions.

3. Results

All participants were male. The average age of participants was 23.05 ± 3.44 years (range = 20-36), and the average body mass index (BMI) was 22.88 ± 3.79 (range = 15.57-28.63). The descriptive and comparative results of hand power tests, hand dexterity tests, and wrist, forearm, and finger range of motion during the use of various gloves and with bare hands are presented in Table 2.

Measurements of overall hand dexterity indicated that the highest dexterity was observed with glove D, while glove A showed the lowest. Gloves C and D led to a shorter completion time for the Bennett test than bare hands, and their use enhanced overall hand dexterity. In contrast, gloves A and B decreased overall hand dexterity concerning the bare-hand condition. However, this difference was statistically significant only with glove D compared to the bare-hand condition. No statistically significant difference was noted in mean overall hand dexterity when using gloves A, B, and C compared to the bare-hand condition (p-value > 0.05).

The highest level of finger dexterity was observed in the bare-hand condition. In contrast, the lowest level of finger dexterity was recorded with glove A. Pairwise comparisons of mean finger dexterity for each glove, compared to the bare-hand condition, showed that all gloves led to a statistically significant decrease in finger dexterity concerning the bare-hand condition.

The highest grip force was recorded in the bare-hand condition (mean: 47.105 kg). The use of any of the four types of gloves resulted in a reduction in grip force. Glove A had the highest mean grip force (mean: 45.69 kg), while glove B showed the lowest (mean: 43.8 kg). Statistical analysis revealed that grip force varied significantly only between the bare-hand condition and glove B. No statistically significant difference in grip force was found between the bare-hand condition and gloves A, C, and D.

The measurements of pinch force indicated that the highest pinch force was associated with glove D (mean: 12.03 kg), while the lowest was observed in the bare-hand condition (mean: 11.06 kg). The results demonstrated that using any gloves increased pinch force compared to the bare-hand condition. Statistical analysis revealed a significant difference in pinch force only between the bare-hand condition and glove D. No statistically significant differences were found when comparing the bare-hand condition with gloves A, B, and C. All four types of gloves reduced the range of motion in the wrist, forearm, and finger joints. Glove C was associated with the lowest range of motion in the wrist, while glove D had the highest. The lowest range of motion in the forearm was noted with glove B, and the highest was observed with glove D. For the fingers, glove D was linked to the lowest range of motion, whereas glove A reflected the highest. Statistical analysis indicated significant wrist, forearm, and finger joint range of motion variations between all gloves and the bare-hand condition.

Table 3 presents the comparative results of overall hand dexterity, finger dexterity, grip strength, pinch

Table 2. The results of dexterity tests, hands power tests, and range of motion of wrists, thumbs, and fingers.

	Bare hand		**Glove A**			**Glove B**			**Glove C**			**Glove D**		
	Mean	**SD**	**Mean**	**SD**	**p**	**Mean**	**SD**	**p**	**Mean**	**SD**	**p**	**Mean**	**SD**	**p**
Grip force (kg)	47.1	8.2	45.7	8.1	0.204	43.8	7.8	0.004	45.5	7.6	0.100	45.3	8.6	0.113
Pinch force (Kg)	11.1	3.0	11.7	3.6	0.119	11.5	3.3	0.154	11.7	3.7	0.144	12.0	3.4	0.005
Finger dexterity (s)	134.3	36.3	178.8	71.5	<0.001	172.5	6.3	<0.001	174.7	57.8	0.001	163.7	48.3	<0.001
Hand dexterity (s)	472.9	113.9	492.1	169.8	0.661	475.9	139.7	0.910	449.5	137.2	0.055	426.7	116.5	0.024
Wrist range motion	81.0	6.7	78.1	7.5	0.002	77.8	7.0	0.002	76.7	7.5	0.001	78.6	6.3	0.005
Thumb range motion	70.3	12.4	65.2	14.0	<0.001	64.4	13.8	<0.001	65.3	14.1	<0.001	65.4	14.5	<0.001
Fingers range motion	118.5	7.2	113.5	7.6	<0.001	108.6	7.2	<0.001	112.1	7.3	<0.001	107.7	9.6	<0.001

**Wilcoxon 2-related sample test wit barehand.*

Table 3. Comparative results of dexterity tests, hand power tests, and range of motion of wrists, thumbs, and fingers between the studied gloves.

		SS	DF	MS	F	p value
Grip force	Between groups	121.8	4	30.5	0.470	0.76
	Within groups	6806.1	105	64.8		
Pinch force	Between groups	10.9	4	2.7	0.236	0.92
	Within groups	1215.5	105	11.6		
Finger dexterity	Between groups	2680.6	3	893.5	0.248	0.86
	Within groups	302762.9	84	3604.3		
Whole hand dexterity within groups	Between groups	67663.1	3	22554.4	1.090	0.36
	Within groups	1737666.8	84	20686.5		
Range motion of the wrist	Between groups	40.9	3	13.6	0.271	0.85
	Within groups	4231.0	84	50.4		
Range motion of the thumb	Between groups	13.4	3	4.5	0.022	0.99
	Within groups	16695.0	84	198.8		
Range motion of the fingers	Between groups	520.2	3	173.4	2.724	0.051
	Within groups	5347.8	84	63.7		

Table 4. The results of examining subjective criteria at CRPGs.

	Glove A			Glove B			Glove C			Glove D		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
SUS	69.9	16.2	42.5-92.5	55.0	20.8	20.0-97.5	77.2	15.0	30.0-100	73.8	18.8	27.5-100
LPD	0.5	0.5	0-1.6	1.0	0.8	0-3.0	0.4	0.3	0-1.0	0.4	0.4	0-1.25

strength, and the range of motion for the wrist, forearm, and finger joints among the analyzed gloves. Statistical analysis using One-Way ANOVA indicated no statistically significant differences among the gloves concerning grip strength, pinch strength, finger dexterity, hand dexterity, wrist range of motion, thumb range of motion, and the range of motion for four fingers.

Table 4 shows the descriptive results of subjective measures, including usability assessments and localized discomfort, from the SUS and LPD questionnaires on CRPGs.

The findings reveal that glove C received the highest usability score of 77.16, while glove B had the lowest score of 55. Glove B also reported the highest LPD score, averaging 0.954, whereas glove C recorded the lowest LPD score, averaging 0.352. Statistical analysis using One-Way ANOVA indicated a significant difference between the various gloves regarding usability and LPD.

A post hoc Bonferroni test analyzed the statistical differences between pairs of glove groups in usability and LPD. Significant differences in usability were found between gloves A and B, gloves B and C, and gloves B and D. Additionally, significant differences in LPD were found between gloves A and B, gloves B and C, and gloves B and D. These findings emphasize specific pairwise differences in usability and LPD.

4. Discussion

This study aimed to achieve several objectives. Four well-known CRPGs, commonly employed in major industries, were analyzed and compared using objective and subjective criteria. The different gloves produced varying effects on several manual dexterity tests.

According to the results, all four types of gloves led to a significant decrease in finger dexterity, which is consistent with the findings of Irzeminska et al. (2017) and Ghasemi et al. (2021) [20, 29]. Berger et al. (2009) [32] also reached similar conclusions in their study. The results of finger dexterity assessments indicated that gloves D, B, C, and A had the least negative impact on finger dexterity, respectively. Gloves A and B specifically reduced overall hand dexterity, aligning with Ghasemi et al.'s findings (2021) [29]. However, contrary to expectations, gloves C and D positively affected overall hand dexterity, inconsistent with Ghasemi et al.'s findings (2021) [29]. Glove C is made from polyester with a latex coating, providing enhanced friction and performance for the user. Similarly, glove D possesses an appropriate coefficient of friction. Participant feedback also supported this observation.

Furthermore, based on these gloves' catalogs and technical specifications, glove C is characterized by slip resistance and high flexibility. In contrast, glove D is known for its comfort and ergonomic design to prevent fatigue, comprising breathable and sweat-resistant fibers. These factors enable participants to control tools easily while wearing these gloves without experiencing sweating, slipping, pain, or fatigue. This contrasted with conditions without gloves, where some participants encountered sweating in their palms and fingers, which led to the French wrench slipping and longer test completion times.

The evaluation of pinch and grip force was conducted according to the standardized testing protocol approved by the American Society of Hand Therapists, utilizing the Saehan Hydraulic Hand Dynamometer. Grip force varied depending on the type of glove worn and the specific test administered. All glove types resulted in a reduction in grip force, consistent with findings from studies by Wimer et al. (2010) [22], Ramadan et al. (2017) [15], Annie Yu et al. (2022) [23], and Ghasemi et al. (2021) [29]. In that order, gloves A, C, D, and B had the least negative impact on grip force. The results indicated that wearing gloves increased pinch force, which aligns with Annie Yu et al.'s findings (2022) [23]. According to participant feedback, this effect could be attributed to increased friction between the glove and the dynamometer, resulting in improved grip performance and control over the dynamometer. Glove D had the most positive effect on pinch force, while glove B exhibited the least positive effect.

The SUS questionnaire was employed to assess usability. This questionnaire is a reliable and cost-effective scale that can be used globally to evaluate the usability of various systems [37]. Based on the results of the subjective tests, gloves C and D achieved the highest usability scores, while gloves B garnered the lowest. Correspondingly, the level of LPD caused by the gloves was lowest with gloves C and D and highest with gloves B. As observed, gloves C and D induced less discomfort and consequently demonstrated better usability for the participants. Furthermore, they did not negatively impact overall hand dexterity.

This study had certain limitations that need to be acknowledged. We examined four types of gloves with varying materials and thicknesses. The material of the gloves determines characteristics such as surface friction, hardness, and flexibility [41, 42]. Due to time constraints, we could not evaluate these parameters, including glove thickness, in this study. Additionally, the usage scenarios for the gloves studied were diverse. It is recommended that future studies employ gloves with consistent usage scenarios to ensure comparability and reliability in findings. In this study, only 22 men participated. The small sample size may reduce the generalizability of the data. Larger sample sizes and a more diverse participant pool would provide more robust data and improve the generalizability of the results. One of the strengths of this study is the concurrent investigation of different manual skills alongside the usability of various gloves. Furthermore, given that learning effects are a common challenge in such studies, we attempted to mitigate this issue by randomizing the sequence of experiments. This approach aimed to minimize potential biases associated with the order of tasks and the learning curve [43].

Designers and manufacturers of CRPGs primarily focus on safety issues to enhance usability and manual skills. Therefore, it is recommended that ergonomic considerations be more integrated into new designs. Manufacturers should avoid producing gloves with unnecessary thickness. Indeed, a balance between safety and individual performance should always be maintained. In this regard, the use of developed nano-materials that provide a high level of protection with minimal thickness is recommended [44]. The current study's findings will assist product designers in cultivating ergonomic protective gloves that meet the needs of workers.

5. Conclusion

CRPGs can have an impact on manual skills. In this study, using CRPGs resulted in decreased hand dexterity, range of motion, and grip force but had no adverse effect on pinch force. The best performance during hand and finger force tests was associated with gloves A and D, respectively. Hand and finger dexterity was best in glove D. Cognitive tests also indicated that gloves C and D exhibited the best usability and least LPD among individuals. Consequently, glove A, made of polyester and nitrile material for power activities, showed better performance and had the least interference in the motion of four fingers. However, due to its low usability and LPD in the hand, its use is not recommended.

In contrast, glove D with nitrile foam coating exhibited the best finger dexterity compared to other gloves studied. This glove had the least negative impact on wrist and hand motion range. Additionally, it increased hand dexterity and pinch force without negatively affecting these skills while wearing and strengthening them. Subjective tests also indicated the high usability of this glove, with the least LPD among individuals. Considering this glove's descriptions and features, such as its sweat-resistant properties and anatomical design, it can be suitable for performing cut-resistant activities in the industry. This is because attention has been paid not only to safety but also to its ergonomic characteristics.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved as a research project by the research ethics committees of Isfahan University of Medical Sciences under the ethics code IR.MUI.RESEARCH.REC.1401.268. All participants filled out and signed the informed consent forms. The researchers only had access to unidentified data.

Informed Consent Statement: Written consent forms were prepared and provided to the participants before the study. All participants completed and signed the informed consent forms.

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