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Faculty of Medicine, BangkokThonburi University
16/10 Leabklongtaweewatana Rd., Taweewatana 10170 Thailand.
Tel : 02-8006800 ext. 2032 | Email: jmedglob@bkkthob.ac.th

EDITORIAL MESSAGES

Assoc. Prof. Thongnard Kumchai
Editor-in-Chief,
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The Faculty of Dentistry
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Good cordiality

With the great support from the president of BangkokThonburi University (BTU), it is our pleasure to announce the production of The Journal of Medical Globalization (J Med Glob), a novel journal that welcomes manuscripts from the medical, dental, and health sciences fields, aiming to help authors from BTU, as well authors from around the world, publish their high-standard, scientific work.

In the future, we believe that articles published in this journal will be well-known, and their information will reach a global stage. We also expect that our journal will be indexed/tracked/covered by PubMed, PubMed Central, Emerging Sources Citation Index (ESCI), Scopus, ISI, Thai Citation Index (TCI), DOI/Crossref, and Google Scholar.

The editors of this journal assure the readers that they will do their best in selecting papers of high scientific value, which will undergo a thorough review process before acceptance, in order to fulfill the expectations of our readers.

We are pleased to inform you that The Journal of Medical Globalization (J Med Glob) is launching its third issue. We would like to invite all authors to submit their work for publication in the journal. We publish original research articles, review articles, technical notes, and theses. This is an online journal that provides international exposure to the work of every author.

Concerning the dental field, the emerging research on dental implants is attracting more and more researchers and clinicians in the meantime, since dental implants are the best option to replace missing teeth, restore function and aesthetics, and improve the quality of life of patients. Therefore, the journal encourages authors to send manuscripts related to this field and promises that articles related to dental implants will be published on a regular basis in J Med Glob.

We look forward to receiving your work, and thank you so much for your support.

Assoc. Prof. Thongnard Kumchai

Original Article

A Comparison of Elbow Flexion and Elbow Extension on Hand Swelling after Surgery in Closed Fracture of Distal End Radius: Pilot Randomized Control Trial

Chidchanok Sakdapanichkul[1], Nattakorn Mahasupachai[1], Parunyu Vilai[1], Cholawish Chanlalit[1*]

1 *Department of Orthopaedics,Faculty of Medicine, Srinakharinwirot University, Rangsit-Nakhon Nayok Rd, Ongkarak Ongkarak, Nakhon Nayok, Thailand 26120*

Abstract

Elbow posture in reducing hand edema was rarely reported in literature. Elbow extension may promote lymphatic and venous drainage better than elbow flexion, which might lead to a better edema reduction after a surgery in an upper extremity. Twenty-four patients who required a surgery for distal end radius fracture were recruited for a pilot study and randomized into elbow flexion and extension groups. Elbow posture was set after the surgery until 48 hours postoperatively. Hand volume was measured at 24 and 48 hours postoperatively. Range of motion, quick Disabilities of Arm, Shoulder, and Hand score, and handgrip strength were recorded at 2, 6, and 12 weeks follow-up. In results, the mean edema reduction was 3.30% (SD=15.36) and 14.14% (SD=8.55) in the elbow flexion and extension groups, respectively. Elbow extension posture significantly reduces the size of the edema by 4.28 times as much as over the 24 hours period as what could be achieved by the elbow flexion posture (p=0.044). In conclusion, this randomized pilot study is feasible for a full-scale project for studying the elbow posture in edema reduction. Elbow posture might play an important role for reducing hand edema in postoperative protocol after a surgery in upper extremity.

Keywords: Distal radius surgery, Elbow flexion and extension; Elbow posture, Reduce hand edema

*** Correspondence to**:
Cholawish Chanlalit
Department of Orthopaedics, Faculty of Medicine, Srinakharinwirot University, Rangsit-Nakhon Nayok Rd, Ongkarak Ongkarak, Nakhon Nayok, Thailand 26120 Phone: 037-3950856 dial to 60610
Email: chanlalit@hotmail.com

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INTRODUCTION

Distal end radius fracture is one of the common fractures seen in the emergency room, accounting for approximately 3 percent of all upper extremity injuries [1]. The main goal of the treatment is to restore the function of the wrist as much as possible [2]. After a surgery, joint stiffness can develop through four stages of bleeding, edema, granulation tissue and finally fibrosis [3]. Stiffness proceeding edema is one of the problems affecting daily activities.

The first and second stages play important roles as they can be minimized. In the first stage, occurring in minutes to hours after the surgery or trauma, bleeding will cause distension of joint capsule and swelling of periarticular tissues. This stage can be minimized by different surgical techniques to reduce bleeding. Later, occurring hours to days in stage 2, platelets and dead cells, including injured cells, will release inflammatory mediators. These mediators will cause the nearby blood vessels to dilate and the plasma to leak, resulting in the

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swelling of periarticular tissue. Similarly, like in the stage one, the compliance of joint movement will be decreased as the joint will be difficult and painful to move. This stage can be minimized by different protocols to reduce edema [4, 5], which will be discussed in this study.

From the principle of elevating an upper limb above heart level in promoting a reduction of edema, venous return will be enhanced by gravity; however, postoperatively in distal end radial fracture with immobilization, upper limb posture will usually be in an elbow flexion. This can lead to compromised circulation around the elbow. Moreover, a study of supracondylar fracture by Mapes RC et al. [6] found that vascular safety can be enhanced by elbow extension and forearm supination. Therefore, elbow extension might have a better venous and lymphatic drainage consequently reducing finger and hand edema better than with the elbow flexion after the surgery of an upper limb.

To our knowledge, there has been no study comparing whether elbow flexion or extension has better efficiency in reducing postoperative edema in the fingers and hand.

Objectives

The primary objective of this study is to compare the efficiency between elbow flexion and extension on reducing fingers and hand edema postoperatively at 48 hours compared with 24 hours. The secondary objective is to compare functional outcomes which are wrist range of motion, handgrip strength, and quick Disabilities of Arm, Shoulder, and Hand (DASH) score [7] between elbow flexion and extension at 2 weeks, 6 weeks, and 12 weeks follow-ups.

MATERIALS AND METHODS

This study was registered in the Thai Clinical Trials Registry (TCTR20210429005). Strategic Wisdom and Research Institute, ethic committees of Srinakharinwirot University, gave approval for ethics review (SWUEC/F-341/2562). A prospective randomized pilot study was conducted at H.R.H. Maha Chakri Sirindhorn Medical Center (MSMC), Srinakharinwirot University, during May 2020 to April 2021. Patients with closed distal end radius fracture who needed a surgery and were older than 18 years old were recruited. Patients who were subject to the satisfaction of the inclusion criteria and exclusion criteria gave written informed consent before starting the experiment. Exclusion criteria were patients who refused operative treatment, did not give consent, underwent revision surgery, had bilateral fractures on upper extremities, pathological fracture, distal end radius fracture for more than 2 weeks, associated ulnar fracture except ulnar styloid, history of major surgery of the contralateral hand, history of breast surgery, concurrent disease of hand (e.g. Dupuytrens or rheumatoid arthritis), contraindication in elevating the hand or flexing or extending elbow, and wound on their hands that prevents them from exposing to water.

Demographic data were obtained for all participants, which were age, gender, duration from accident to surgery, dominant hand, fracture side of hand, AO classification, surgical technique, surgeon, operation time, associated injury, volume of fingers and hand of normal side and surgical side at 24-hour postoperatively.

Before the surgery, the patients were randomized with minimization method into two groups, elbow flexion and elbow extension. The surgeons and patients would not know the group allocation until after the surgery. The factors that were used in minimization are American Orthopedic/Orthopedic Trauma Association (AO/OTA) classification and different surgeons. There were 3 types from AO/OTA classification: extra-articular (A), partial articular (B), and complete articular (C). The surgeons were orthopedic surgeons from Upper Extremity Reconstruction and Sports Orthopedics

Figure 1. (A) Elbow flexion (B) Elbow extension

Figure 2. Volumetry of hand

Medicine Excellent Center and well-trained traumatic orthopedic interns at MSMC.

After the surgery, a pillowcase or pillows were used immediately after the patients arrived back at the in-patient ward. At 24-hour postoperatively, the volume of the fingers and hand of both the surgical and normal sides were measured. At 48-hour postoperatively, the volume of the fingers and hand of surgical side was measured.

The volume of fingers and hand was measured by using the water displacement method according to the Archimedes principle. A container will be filled up with room-temperature sterile water to the point of overflowing. Fingers and hand were lowered into the container until the distal volar crease of wrist touches the water. The fingers and hand then displaced the water, which then flowed into a smaller container. The volume of the displaced water equaled the volume of the fingers and hand. The displaced water was measured using a 100-ml graduated cylinder with a 1-ml scale. This method of volumetry had intraclass correlation coefficients (ICCs) for inter- and intra-rate reliability with 0.999 (0.998-1.000) and 0.837 (0.682-0.924), respectively (Figure 2).

To minimize the contamination, the container was sterilized and sterile water was used. The surgical hand was painted with povidone iodine solution and then alcohol before the measurement. The surgical wound was covered with sterile waterproof patch (Tegaderm®) before putting the hand into the water. After the hand was taken off the water, the sterile waterproof patch was opened and the wound was examined immediately. The wound was closed with a new sterile waterproof patch (Tegaderm®) after a wound dressing (Figure 2).

In postoperative medication, a 2-gm bolus dose and then 1 gm of cefazolin intravenously every 6 hours was used as a prophylactic antibiotic. If a patient was allergic to cefazolin, the alternative was 600 mg of clindamycin intravenously every 8 hours. Pain control was 3 to 4 mg of morphine intravenously every 4 hours during the first 24 hours and then every 6 hours during the next 24 hours.

In the first secondary objective, wrist range of motion, grip strength, and quick DASH score were examined after the surgery at 2 weeks, 6 weeks, and 12 weeks. Ranges of motion, including wrist flexion, extension, pronation, and supination, were measured in degrees. The handgrip strength was measured using an electronic hand grip dynamometer and the outcome were shown as kilogram (kg). The quick DASH score was used to evaluate the ability in performing daily activities. In the second of the secondary objectives, each coming adverse event or complication were recorded and managed with standard treatment.

The person who measured the volume was a well-trained nurse from another department who did not look after the patients. The same person measured the volume of each patient. The wrist range of motion, grip strength, and quick DASH score were measured by one well-trained nurse from the outpatient department. The two people who assessed the outcome did not know the group allocation.

Sample Size and Statistical Method

The sample size was calculated by a formula for comparing a proportion between two population groups (Cohen, 1988) [8]. There was no study that had the same intervention with this study and so the calculation was based on a comparable study of Baker et al (2010). They measured the volume of the hand twice, once preoperatively and again 24-hours postoperatively. The percentage of edema of fingers and hand at 24-hour postoperatively compared to preoperatively in hand elevation group and non-elevation group are 2.3% and 4.2%, respectively.

After the sample calculation according to the formula, a sample size of 1362 participants in each group is required to show a clinical significance with the power

of 80% at a confidence interval of 95%. With the expectation of drop out or discontinuation of 10%, a sample size of 1514 participants is required in each group and resulted in 3028 participants in total for this study. However, the duration of this study is limited and rarely possible to collect 3028 participants, prospectively. Moreover, there has been no study comparing whether elbow extension can reduce hand edema better than elbow flexion. This study was conducted as a pilot randomized study with a sample size of 12 participants in each group and so a total of 24 participants in this study.

Demographic data of the sampling population will be analyzed as percentage and count for categorical data while as mean, median, minimum, and maximum for continuous data. The primary objective will be shown as percentage edema reduction mean and analyzed as mean percent difference between the two groups with 95% confidential interval by using independent t-test. The first secondary objective, evaluating on the wrist range of motion, grip strength, and quick DASH score, will be reported as mean differences with 95% CI. T-test and multiple linear regression will be used for the mean difference at 2 weeks, 6 weeks, and 12 weeks. The overall mean difference will be reported by using generalized estimating equation (GEE) with 95% CI. The second secondary objective, which is each coming up adverse event or complication, will be shown as count. A p-value of less than 0.05 was statistically significant. All statistical analysis was performed using STATA version 14.0.

RESULTS

There were 28 patients who met all the inclusion criteria. Four of them were excluded due to refusing to give consent, having wound on hand that could not expose to water, ulnar shaft fracture, and bilateral fracture of upper extremities. Therefore, the remaining 24 patients were allocated into two groups with 12 patients in each group. The data for primary objectives could be obtained from all 24 patients. However, one patient from elbow flexion group and one patient from elbow extension group lost follow up at postoperative 6 weeks and 12 weeks. Two patients from elbow flexion group lost follow up at postoperative 12 weeks.

Demographic data of all patients in both groups were similar (Table 1). The surgical hands after surgeries were significantly swelling compared with normal hand in elbow flexion group (p-value = 0.0004) and elbow extension group (p-value < 0.0001) (Table 2).

Table 1. Demographic data of sampling population.

Characteristics	Elbow Flexion	Elbow Extension	*p*-value
Age (years old)			
Mean ± SD	48.5±16.6	45.2±18.1	0.643
Median (Min, Max)	50 (22,73)	51.5 (22,71)	
Gender			
Male	4	7	0.219
Female	8	5	
Duration from accident to surgery (hours)			
Mean ± SD	10.08±4.73	7.67±4.62	0.170
Median (Min, Max)	12 (0,14)	7.5 (0,14)	
Dominant hand			
Right	12	12	NA
Left	0	0	
Fracture			
Right	4	5	0.673
Left	8	7	
Type: AO Classification			
A	4	2	0.637
B	3	4	
C	5	6	
Surgical technique			
ORIF with PAS (volar approach)	11	11	1.00
Corrective Osteotomy (volar approach)	1	1	
Surgeons			
A	6	6	1.00
B	1	2	
C	2	1	
D	2	1	
E	1	1	
F	0	1	
Operation time (hours)			
Mean ± SD	79.83±15.51	84.92±33.36	0.637
Median (Min, Max)	78.0(60,110)	72.5(47,137)	
Associated injury			
Yes	4	6	0.680
No	8	6	

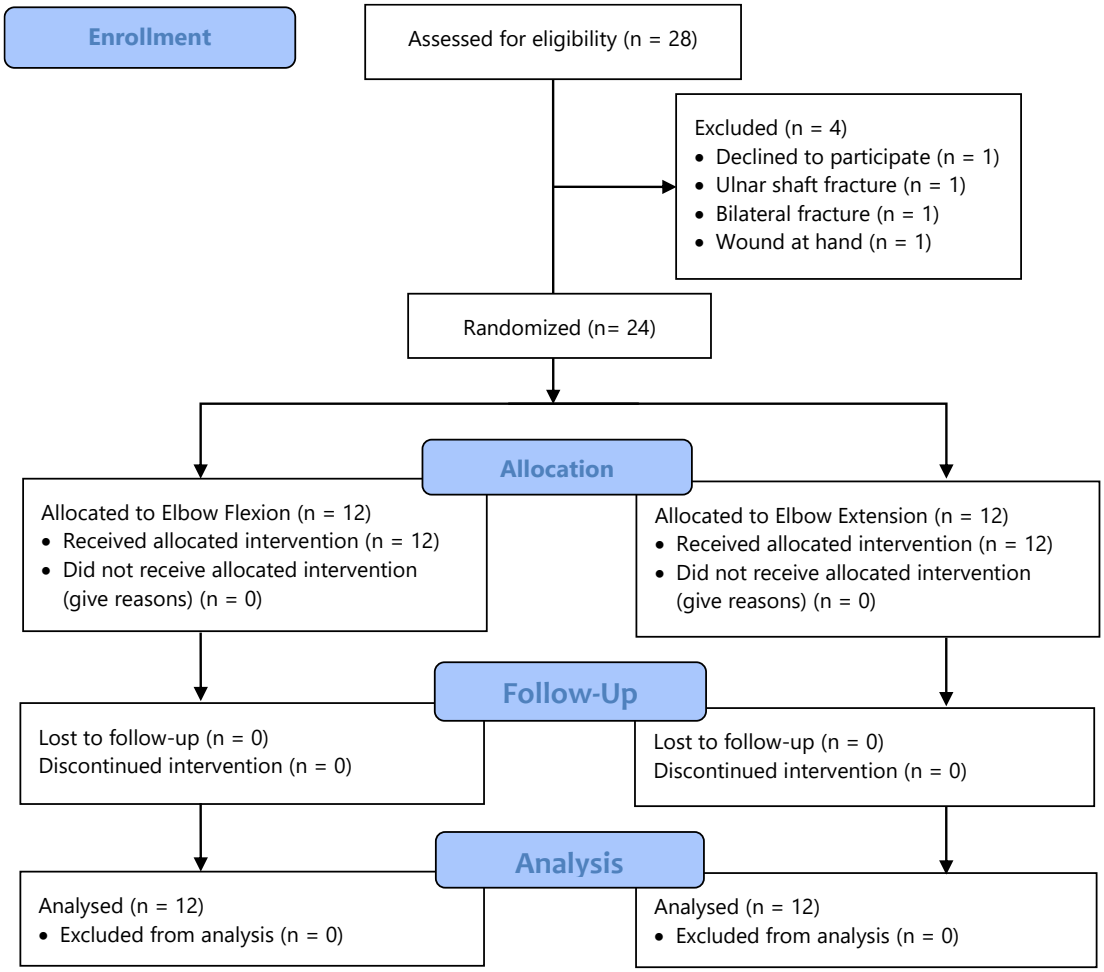

Figure 3. CONSORT Diagram

Table 2. Comparison of mean volume of fingers and hand between normal and surgical hand at 24 hours, postoperatively.

Groups	Volume of fingers and hand (ml)		*p*-value
	Normal Hand (24 hours postoperatively)	Surgical Hand (24 hours postoperatively)	
Elbow Flexion			
Mean±SD	241.25±49.35	301.92±80.84	0.0004
Median (Min, Max)	238.50 (147, 338)	306.50 (151, 486)	
Elbow Extension			
Mean±SD	281.58±44.32	374.42±77.54	<0.0001
Median (Min, Max)	272.50 (229, 402)	351 (292, 557)	

The mean edema reduction, measured postoperatively at 24 and again at 48 hours, was 3.30% (SD=15.36) in the elbow flexion group, and 14.14% (SD=8.55) in the elbow extension group. The results show that using the elbow extension posture significantly reduces the size of the edema by 4.28 times as much as over the 24 hours period as what could be achieved by the elbow flexion posture (p = 0.044) (Table 3).

Table 3. Comparison of mean (SD) values for percentage edema reduction between elbow flexion and extension of surgical side at 24- and 48-hour, postoperatively.

Surgical Side	Percentage Edema Reduction Mean (SD)	Mean Percent Difference (95% CI)	*p*-value
Elbow Flexion	3.3 (15.36)	10.83 (0.31-21.36)	0.0442

Of all the follow-ups, most clinical outcomes were not significant between the two groups (Table 4). Only wrist flexion and extension were better in elbow extension group at 2 weeks follow-up with the mean difference of 16.71° (4.17°–29.25°) (p-value=0.012) and 17.42° (4.50°–30.34°) (p-value=0.011), respectively.

No complication from the protocol occurred.

Table 4. Comparison of wrist range of motion, grip strength, and quick DASH score at 2, 6, and 12 weeks, postoperatively

Outcomes	Elbow Flexion		Elbow Extension		Mean Difference*	95% CI	P-value
	Mean	SD	Mean	SD			
Wrist range of motion (degree): flexion							
2 weeks	16.82	14.01	34.54	11.93	16.71	(4.17-29.25)	0.012
6 weeks	30.45	16.04	40.00	16.43	2.05	(-17.84-13.74)	0.787
12 weeks	46.67	9.68	53.18	18.20	0.90	(-18.02-16.22)	0.912
Overall	N/A	N/A	N/A	N/A	0.34	(-10.25-9.58)	0.947
Wrist range of motion (degree): Extension							
2 weeks	10.91	12.41	23.64	18.32	17.42	(4.50-30.34)	0.011
6 weeks	30.91	15.62	32.72	19.28	10.63	(-24.32-3.06)	0.120
12 weeks	45.00	4.33	49.73	17.25	1.11	(-15.62-13.40)	0.872
Overall	N/A	N/A	N/A	N/A	5.31	(-13.29-2.67)	0.193
Wrist range of motion (degree): Pronation							
2 weeks	56.36	25.11	47.27	23.49	-11.71	(-35.20-11.78)	0.309
6 weeks	61.82	20.65	61.36	18.85	7.78	(-6.76-22.32)	0.275
12 weeks	71.11	22.61	79.09	13.00	11.28	(-2.44-25.02)	0.100
Overall	N/A	N/A	N/A	N/A	10.30	(-0.12-20.74)	0.053
Wrist range of motion (degree): Supination							
2 weeks	48.18	34.22	50.00	26.08	1.59	(-28.36-31.54)	0.912
6 weeks	60.61	31.04	64.09	24.78	5.78	(-13.06-24.63)	0.526
12 weeks	84.44	10.14	82.73	7.86	-1.73	(-10.21-6.74)	0.669
Overall	N/A	N/A	N/A	N/A	3.52	(-7.55-14.59)	0.533
Grip strength (kg)							
2 weeks	1.72	2.99	4.79	5.05	2.98	(-1.11-7.07)	0.143
6 weeks	6.73	5.51	12.23	4.77	1.82	(-1.64-5.28)	0.283
12 weeks	12.44	5.86	19.30	4.83	4.00	(-0.66-8.66)	0.087
Overall	N/A	N/A	N/A	N/A	3.16	(0.10-6.22)	0.043
Quick DASH score (points)							
2 weeks	50.88	20.16	45.74	19.38	-2.10	(-19.97-15.78)	0.808
6 weeks	37.61	15.27	29.72	20.21	-4.01	(-14.98-6.95)	0.451
12 weeks	17.47	14.70	10.66	9.64	-7.01	(-18.98-4.96)	0.231
Overall	N/A	N/A	N/A	N/A	-6.59	(-15.54-2.36)	0.149

***** *Mean difference adjusted for baseline measurements, age, and sex for each visit using analysis of multiple linear regressions. Overall mean difference was analyzed using generalized estimating equations implemented under generalized linear model.*

DISCUSSION

After recruitments of sample population, many of the exclusion criteria were used to eliminate possible confounders that might affect the outcome. They were history of mastectomy, associated injury on ipsilateral upper extremity, pathological fracture, concurrent hand disease such as Dupuytrens and rheumatoid arthritis, and a fracture that occurred for more than 14 days. Furthermore, the demographic data of the sample population showed no difference in age, AO classification, surgical techniques, surgeons, operative time, associated injuries, gender, dominant hands, and the side of fracture. Additionally, there was significant

hand edema of the hand on the surgical side compared to the hand on the normal side.

For the primary outcomes, the result showed that the elbow extension group had a significant higher percentage reduction mean than the elbow flexion group. For secondary outcomes, mostly, there was no difference in clinical outcomes between the two groups.

There are two comparable studies studying about reducing hand edema postoperatively. Baker RP et al9. conducted a randomized study of comparing hand swelling in patients with hand elevation and non-elevation after a surgery of fasciectomy or trapeziectomy for patients with Dupuytren's disease. The volume measurement of hand was performed twice, at 30 minutes before the surgery and at 24-hour postoperatively. The result showed that the swelling was less in the limb elevation group but the result was not statistically significant. Fagan DJ et al10. performed a controlled clinical trial comparing hand swelling in patients with the use of a Bradford sling (elbow flexed 90 degrees) and simple arm sling (elbow flexed 45 degrees) after a surgery of carpal tunnel decompression. In both groups, the hand was placed above heart level. The volume measurement of the hand was performed twice; preoperatively, and at 5 days postoperatively. The result showed that the mean increase in volume of operated hand was less in the Bradford sling than in the simple arm sling, but there was no statistically significant difference in their results. These studies worked on minor surgeries that might not even give a significant hand edema. Secondly, the later study compared different angle of elbow flexion, but not between flexion and extension. Only 45 degrees might not make a big difference in lymphatic and venous drainage.

In this randomized pilot study, however, it was performed on a major surgery, which was on the distal end radius fracture. The angle of elbow compared was 90 degrees, which was larger than the previous study. Both groups had the surgical hand elevated. This was the first pilot randomized controlled trial study of hand edema reduction that focus seriously on the posture of elbow after a major surgery.

Even though the result came out with statistically significant difference, but it was a pilot study. This cannot yet conclude that the elbow extension group can reduce hand edema better than the elbow flexion group until a full-scale project with a higher sample size was proved.

With this feasible result, in the future, elbow posture might play an important role in postoperative protocol for reducing edema after a surgery in upper extremities.

CONCLUSION

This randomized pilot study is feasible for a full-scale project for comparing the efficiency of edema reduction between elbow flexion and extension methods. Elbow posture might play an important role for reducing hand edema in postoperative protocol after a surgery in upper extremity.

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Conflicts of Interest: The authors declare no conflict of interest.

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Informed Consent Statement: Each participant in the study provided informed consent, including permission for the findings to be published.

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Original Article

Impact of Sexual History and Life Skills on Unprotected Anal Sex: A Cross-sectional Study Among Men Who Have Sex with Men in Mandalay, Myanmar

Myo Zin Oo[1*], MBBS, MPH, PhD, Soe Sandi Tint[2], MBBS, MSc, Alessio Panza[3], MD, MCH, Somporn Naklang[1], BPH, BEd, MPH, Felicitas Calugan Boleyley[1], BSN, MNA

1 *Faculty of Public Health, St Theresa International College, Nakhon Nayok, Thailand*
2 *Department of Family Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand*
3 *College of Public Health Sciences, Chulalongkorn University, Bangkok, Thailand*

Objectives: To study the impact of sexual history and life skills on unprotected anal sex among men who have sex with men (MSM) in Mandalay, Myanmar.

Materials and Methods: Using a cross-sectional study design, 309 MSM between the ages of 15 and 50 participated in the study. The seven townships of Mandalay city in Myanmar were purposely chosen, and the snowball sampling technique was applied to recruit MSM. The study took place between August 2011 and May 2012.

Results: Two thirds of MSM (76.1%) reported having their first anal sex with a man without using a condom. The ability to consistently refuse unwanted sex was reported by a large percent of MSM (84.5%). About 17.5% of MSM admitted to engaging in anal sex without using a condom when their partner proposed it. "Using a condom during anal sex in the previous four months" was statistically strongly associated with life skills to proposing action if partner refuses to use a condom ($p < 0.001$).

Conclusion: Regarding sexual behavior, life skills, and condom use, MSM in Myanmar has relatively little information. Focus should be placed on developing and conducting life skills training because it is crucial for MSM to engage in safe sex activity. Additionally, it is critical to expand the accessibility of services targeted at MSM, such as sex education, condom distribution and promotion.

Keywords: Life skills, Men who have sex with men, Myanmar, Sexual history, Unprotected anal sex

*** Correspondence to**:
Myo Zin Oo
Faculty of Public Health, St Theresa International College, Nakhon Nayok, Thailand, 26120
Tel: (+66) 65-119-3324
E-mail: dr.myozinoo@gmail.com
ORCID: 0000-0001-9980-6343

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INTRODUCTION

Males who have sexual interactions with same sex are known as men who have sex with men (MSM), irrespective of whether they personally or socially identify as homosexual, bisexual, or both [1]. A disproportionate amount of the burden of the worldwide human immunodeficiency virus (HIV) epidemic falls on MSM, with homosexual men and other MSM globally accounting for 23% of new HIV infection cases [2]. Due to their sexual networks, behavior, or biological characteristics, such as the number of concurrent partners, condom-free intercourse, anal sex, or drug

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usage, MSM may have a higher risk of contracting HIV and other sexually transmitted infections (STI) [3].

HIV remains a serious significant public health issue, with low- and middle-income countries enduring a huge proportion of the epidemic's burden. An estimated 940,000 deaths from HIV-related causes occurred in the world in 2017 [4]. In 1988, a person who injected drugs first tested HIV positive in Myanmar. AIDS was initially identified in a patient in 1991 [5]. According to World Health Organization (WHO) data, as of 2017, Myanmar had an HIV prevalence of 0.57%. Throughout the year, there were a total of 11,000 new infections, and about 220,000 people are HIV-positive. Approximately 7,000 people died from HIV-related causes [4]. Myanmar's HIV prevalence estimates for 2019 reported that key populations had the highest prevalence of HIV, with people who inject drugs (19%), MSM (8%), female sex workers (8%), and prisoners (4%).

It is estimated that there are 250, 000 MSM and transgender women in Myanmar, and up to 50% of them may hide their same-sex attractions and behavior [6]. Age at first sexual encounter, unwanted sex experiences, condom use at last intercourse, and accessibility to HIV-related services have all been connected to sexual and gender identities of MSM in Myanmar [7]. When an infected and susceptible person come into contact, using a condom reduces the risk of HIV and STIs [8]. One of the most significant risk reduction strategies for HIV prevention among MSM is consistent condom use during anal sexual intercourse. The availability of condoms and HIV testing are particularly important, as key populations in Myanmar are more susceptible to discrimination and stigma as well as obstacles to receiving HIV services [9].

According to the WHO, life skills are "abilities for adaptive and positive behavior that enable individuals to deal effectively with the demands and challenges of everyday life" [10]. Health issues that young people could encounter, such as the use of drugs, tobacco, alcohol, and unprotected sex, can be identified or prevented with the use of life skills. The improvement of knowledge, communication, critical thinking, self-esteem, negotiation skills and decision-making competences necessary for young people to lead healthy lifestyles and lessen risk-taking behavior has been proven beneficial through life skills programs, particularly for especially for reducing sexual risk behavior [11, 12]. There is still a lack of information on the sexual history and life skills of MSM in Myanmar. This present study aimed to study the impact of sexual history and life skills on unprotected anal sex among MSM in Mandalay, Myanmar.

MATERIALS AND METHODS

Study design, Study population and Study period

This present study applied a cross-sectional study design. A total of seven townships in Mandalay city in Myanmar were purposely chosen. The selection of MSM was then made using the snowball sampling technique, which is a useful technique for conducting research on populations that may be challenging to reach or identify [13]. A total of 309 MSM between the ages of 15 and 50 participated. Due to barriers in Myanmar's cultural and social norms, MSM under the age of 15 were permitted to respond to the questionnaire without parental consent. The study was carried out between August 2011 and May 2012.

Research Instrument

The questionnaire employed in this study was semi-structured and had four sections: (i) socio-demographic characteristics; (ii) sexual history; (iii) life skills; and (iv) unprotected anal sex in the previous four months. The variables in each question are categorical. The variables: "type of MSM", "use of condom during first anal sex with a man", "using a condom during anal sex in the previous four months" were the extended data from the study: "factors related to unprotected sex in men having sex with men (MSM) in Mandalay, Myanmar". To ensure word correspondence between English and Myanmar, the questions were first produced in English and then translated into Myanmar by an expert with knowledge of both languages who was affiliated with the MSM organization. In the event that there were any inconsistencies for the translations of the questionnaire, a second expert performed a back translation from Myanmar to English before the two experts came to an agreement on a common translation.

Data collection procedure

Face-to-face interviews were conducted with the respondents by the researcher and two additional research assistants. The research assistants were health volunteers from MSM focused service providers who had prior experience utilizing questionnaires to perform face-to-face interviews. Prior to collecting data, the researcher trained the two research assistants on how to ask questions to obtain relevant responses (including, if required, by using MSM slang), encouraging interview MSM to participate, and establishing rapport before the interview. Prior to the data collecting process, participants were informed of the study's objectives and advantages as well as the fact that they could opt out of the interview at any moment and remain anonymous and

confidential. They have also been told that participating in the study or declining to participate carries no risks or negative consequences.

Data processing and analysis

The researcher completed data editing, data entry, data analysis, and data interpretation. On the same day that the data was collected, the information was edited as required. The frequency and percentages were used to interpret all category data. Data analysis was carried out using SPSS version 22. Binary logistic regression was performed and statistically significant associations were defined as those with a p-value less than 0.05.

RESULTS

Socio-demographic characteristics of MSM

In the present study, 309 MSM participated, with 62.1% of them being "Apwint: feminine MSM", 20.4% being "Tha Nge: bisexual", and 17.5% being "Apone: masculine MSM". Nearly half of the MSM (44.0%) were in the 25-35 age group. More than half of MSM (64.7%) lived with their parents, followed by their partners (11.0%), relatives (10.4%), themselves (8.4%), and friends (5.5%).

Sexual History of MSM

Regarding their sexual history in table 1, the first anal sex that more than half of MSM (53.3%) had was with a man between the ages of 15 and 19; this was followed by ages between 7 and 11 (20.1%), 12 and 14 (14.9%), and 20 to 31 (11.7%). About two thirds of MSM (76.1%) had first anal sex with a man without using a condom.

Table 1. Sexual history of MSM.

Sexual history (n=309)	Frequency (n)	Percentage (%)
Age of first anal sex with a man (years)		
7 - 11	62	20.1
12 - 14	46	14.9
15 - 19	165	53.3
20 - 31	36	11.7
Mean = 15.49 ± 4.13		
Use of condom during first anal sex with a man		
Yes	74	23.9
No	235	76.1

Life skills of MSM

Table 2 presents life skills for safe sex practice. A high percent of MSM (84.5%) reported having the ability to consistently refuse unwanted sex. When their partner proposed not using a condom during anal sex, about 68.9% of MSM negotiated to use condom, and 17.5% of MSM actually engaged in anal sex without a condom. When under stress, about 53.3% of MSM sought to a trusted friend for help, and 33.7% of MSM looked to friends for drinking.

Table 2. Life skills of MSM.

Life Skills (n=309)	Frequency (n)	Percentage (%)
Life skill to refuse undesired		
Always	261	84.5
Sometimes	43	13.9
Never	5	1.6
Propose action taken if partner refuses to use condom		
Avoid sex	42	13.6
Negotiate to use condom	213	68.9
Have sex without condom	54	17.5
If you are under stress		
Seek friends for drinking	104	33.7
Seek trusted person for help	165	53.3
Drink alcohol alone	12	3.9
Others[#]	28	9.1

[#] Others – Meditation, travelling, listening songs and watching movie

Unprotected anal sex among MSM

Nearly half of MSM (43.4%) had anal sex in the previous four months without using a condom.

Table 3. Unprotected anal sex in the previous four months.

Unprotected anal sexual intercourse (n=309)	Frequency (n)	Percentage (%)
Using a condom during anal sex in the previous four months		
Yes	175	56.6
No	134	43.4

Table 4. Binary analysis of sexual history and life skills with "using a condom during anal sex in the previous four months" (n=309)

Variables	Using a condom during anal sex in the previous four months			
	B	SE	Crude OR (95% CI)	p-value
Age of first anal sex with a man				
7 - 11 years			1 (ref:)	**<0.001***
12 - 19 years	1.276	0.307	3.58 (1.96 - 6.53)	**<0.001**
20 - 31 years	1.194	0.437	3.3 (1.4 - 7.77)	0.006
Use of condom during first anal sex with a man				
No			1 (ref:)	0.272
Yes	0.300	0.273	1.35 (0.79 - 2.31)	
Life skills to refuse undesired sex				
No			1 (ref:)	0.187
Yes	0.416	0.315	1.52 (0.82 - 2.81)	
Life skills to proposing action if partner refuses to use condom				
Avoid sex			1 (ref:)	**<0.001***
Negotiate to use	-0.334	0.362	0.72 (0.35 - 1.46)	0.357
Have sex without condom	-1.758	0.451	0.17 (0.07 - 0.42)	<0.001
Life skills to relieve stress				
Seek friends for drinking			1 (ref:)	**0.016***
Seek trusted person for Help	-0.506	0.255	0.6 (0.37 - 0.99)	0.047
Drink alcohol alone	0.223	0.645	1.25 (0.35 - 4.42)	0.729
Others[#]	0.829	0.503	2.29 (0.86 - 6.14)	0.099

[#] *Others - Meditation, travelling, listening songs and watching movie*

Impact of sexual history and life skills on unprotected anal sex

By applying binary analysis, table 4 interprets the impact of sexual history and life skills on "using a condom during anal sex in the previous four months". There was a strong statistically significant association between age at first anal sex with a man and using a condom during anal sex in the previous four months ($p < 0.001$), condom use was higher in the age groups of 12 and 19 years, and 20 and 31 years than in the age group of 7 and 11 years. "using a condom during anal sex in the previous four months" was also statistically strongly associated with life skills to proposing action if partner refuses to use a condom ($p < 0.001$). In addition, "using a condom during anal sex in the previous four months" was strongly statistically associated with life skills to relieve stress ($p = 0.016$), and MSM were more likely to use condoms when they had taken medication, traveled, listened to music, or watched movies to reduce stress.

DISCUSSION

In this present study, the mean age at first anal sex with a man was 15.49, which was contrasted to the results of studies conducted among MSM in China and Tanzania because these studies' average age of the first anal sex were higher (22.3 years and 18.3 years respectively) [14, 15]. Other studies among MSM regarding the age of first anal sex encounters provided support for the findings of this study, which revealed that MSM have early sexual debut ages (15 years) [16, 17, 18]. Several psychological and medical conditions have been linked to early first sexual experiences, including a higher likelihood of contracting a sexually transmitted diseases (STD) [16, 19, 20].

This present study found out that a high percent of MSM (76.1%) did not use condom when they had first anal sex. MSM who engage in their first anal sex without using a condom have a greater chance of contracting HIV [21]. Unprotected early anal sex was strongly linked to irregular condom usage among MSM [22]. The first anal sex without using condom may have occurred due to the accessibility of condoms and a lack of information

among MSM regarding the benefits of having safe anal sex and HIV prevalence among MSM. The National AIDS program (NAP) and other MSM focused service organizations may fall short in their efforts to provide sexual education and condoms. MSM in Myanmar are not supported in terms of sociocultural context. The discrimination and stigma against sexual minorities still exist in Myanmar. Although it appears that this law is rarely put into practice in Myanmar, it still serves to legitimize the harassment or intimidation of sexual minorities, posing major obstacles to sex education and HIV testing by fostering stigma and discrimination [23].

In this present study, the majority of MSM (84.5%) had the life skills to refuse unwanted sex. There was a strong significant association between life skills to propose action if partner refuses to use condom and condom use ($p < 0.001$). When their partner refused to use a condom, MSM who avoided having anal sex used more condoms than MSM who negotiated to use a condom or who had sex without condom. Studies among MSM in South Africa on unprotected anal sex and self-efficacy and condom use decision-making provide additional support for the findings of the present study that MSM who have lower self-efficacy scales on condom use are more likely to have unsafe anal sex, which includes negotiating skills to use condom when having anal sex [24, 25].

The study among young men in Chile for unwanted sexual experiences, which supports this present study's finding regarding life skills to refuse undesired sex but it is still a public health concern with little attention [26]. Teenagers who lack life skills are reported to engage in risky behavior that have long-lasting negative effects on their health and capacity to participate in society. A study which was conducted among adolescents in Ethiopia on sexual behavior and life skills revealed that there is an association between risky sexual behavior and unfavorable life skills [27]. In Myanmar, MSM lack the freedom to choose their gender identity and sexual orientation. They also lack the life skills necessary to defend themselves from unwanted and unsafe sex, especially among "Apone: masculine MSM", and need interventions that emphasize life skills training.

This present study revealed that there was an association between life skill to relieve stress and "using a condom during anal sex in the previous four months" ($p= 0.016$). MSM in Myanmar may be at risk for mental health problems not only as a result of discrimination and stigmatization by the community but also as a condition of the law that stigmatizes MSM by forbidding them from disclosing their perceptions and expression. In comparison to "Apwint: feminine MSM", "Apone: masculine MSM" and "Tha Nge: bisexual," may be much more prone to mental health issues, because a high percent of MSM in this present study were "Apwint: feminine MSM" [28]. Because MSM was hard to get in the community and the snowball sampling technique produced fewer "Apone: masculine MSM" and "Tha Nge: bisexual" participants, the study's high proportion of "Apwint: feminine MSM" was attributable to these reasons. When offering MSM-focused services, it is critical to figure out how to reach all MSM types.

The information of MSM in Myanmar is very limited and this study is one of the few studies which was conducted about the sexual behavior, life skills and condom use among MSM. The results of this study will be helpful for MSM focused service organizations and NAP to evaluate, create, and implement the essential services in terms of sex education, life skills training, free condom distribution and condom usage promotion, and psychosocial support. MSM will also be knowledgeable about MSM focused services and the accessibility of their services to engage in safe sex. Due to the fact that Mandalay was purposefully chosen for the present study and the snowball sampling technique was used, there may be limitation of generalization to MSM nationwide. The present study was cross-sectional and analytical; additional qualitative research on sexual, life skills, and reason of non-condom use is needed to establish results that are more generally applicable.

CONCLUSION

In this present study, there were impact of sexual history and life skills on "using a condom during anal sex in the previous four months". To reach all types of MSM with sex education and health education on prevention of HIV, STDs, and other infectious diseases due to unprotected sex, the NAP and other MSM focused service organizations are recommended to enhance their services. Additionally, life skills training should be provided to MSM in order to change their attitudes and behavior towards safe sex. For a deeper understanding of sexual behavior and life skills of MSM, a longitudinal study or qualitative research is recommended.

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Original Article

Insights into the Kidney Tissue Proteins Signaling Responded to Sodium Intake Using Multiplex Quantitative Proteomics

Atchariya Suwanich[1*]

1 *Department of Physiology, Faculty of Medicine, BangkokThonburi University, Thailand*

Abstract

Dietary sodium intake has been linked to the amount of kidney proteins in the body. High sodium intake can lead to an increase in the amount of proteins found in the kidneys, which can in turn lead to an increased risk of hypertension and other kidney-related health issues. In this study, the difference levels of sodium rat chow were used to alter rats' kidney tissue. Body weight was not affected by sodium intake. Urine volume was increased in high sodium group, and urine osmolality was decreased in low sodium intake compared to control. The homogenized kidney tissues were analyzed by multiplex quantitative proteomics. Quantitative analysis showed that total proteins data revealed 4054 proteins in kidney tissue at $p<0.05$. Among this, low sodium diet showed 259 significantly difference proteins compared to control. High sodium diet showed 357 significantly difference proteins compared to control. Protein-proteins interaction analysis showed the predominant signaling pathway are serine/threonine metabolism and proteins trafficking.

Keywords: Kidney tissue proteome, Sodium intake

*** Correspondence to**:
Atchariya Suwanich
Department of Physiology, Faculty of Medicine,
Bangkokthonburi University, Thailand
Email: atchariya.suw@bkkthon.ac.th

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INTRODUCTION

Salt, or sodium chloride, is an essential nutrient that the body needs in small amounts to help regulate fluid balance, nerve and muscle function, and blood pressure. However, consuming too much salt can have adverse effects on health, particularly on the kidneys. The average American consumes about 3,400 milligrams of salt per day, which is much higher than the recommended daily intake of 2,300 milligrams. [1] Eating a diet high in salt can lead to a number of health problems, including an increased risk for developing high blood pressure, stroke, and heart disease. It can also have a negative effect on kidney health. [2-4] A high-salt diet can cause damage to the kidneys by increasing the amount of salt and water retained in the body. This can lead to an increase in blood volume, which can put a strain on the kidneys and lead to high blood pressure. High blood pressure can damage the delicate filtering system of the kidneys, leading to a decrease in kidney function and an increased risk of developing kidney disease. The kidneys are a vital organ, responsible for filtering and eliminating waste from the body. Low salt diets have become increasingly popular in recent years as a way to reduce the risk of high blood pressure and other health conditions. However, there is some evidence to suggest that a low salt diet may have an adverse effect on the kidneys. [5-7]

The kidneys regulate the amount of salt in the body by eliminating excess salt through the urine. Therefore, when salt intake is reduced, the kidneys work harder to maintain the necessary balance. This can lead to a decrease in the ability of the kidneys to filter waste,

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which can lead to a buildup of toxins and other unwanted substances in the blood. In addition, the kidneys may be unable to effectively absorb certain nutrients, leading to deficiencies. There are other potential risks associated with a low salt diet, as well. A decrease in salt intake can increase the risk of dehydration, as the body needs salt to help retain water. In addition, a low salt diet may lead to an electrolyte imbalance, which can cause serious health problems. Although a low salt diet may have some potential benefits, such as reducing the risk of high blood pressure, it is important to consider the potential risks associated with this type of diet.

The proteome of kidney tissue is a complex network of proteins that is essential for normal kidney function. It is also affected by changes in dietary intake of sodium. When sodium levels in the body become too high, the kidneys must work harder to excrete the extra sodium, which can lead to an increase in blood pressure and an increase in the risk of developing hypertension. Conversely, when sodium levels in the body become too low, the kidneys must work to absorb more sodium, which can lead to an increase in blood pressure and an increased risk of developing hyponatremia. The proteome of kidney tissue is affected by changes in dietary intake of sodium in several ways. Proteomes are composed of proteins, which are a critical component of normal kidney function. Sodium is an essential electrolyte, and it affects the regulation of water balance, acid-base balance, osmotic pressure, and cellular signaling in the body. Therefore, changes in dietary intake of sodium can significantly affect the proteome of kidney tissue. [8, 9]

One-way dietary intake of sodium can affect the proteome of kidney tissue is by altering the protein profile. Sodium is a key factor in maintaining normal kidney function, and changes in sodium intake can lead to changes in the expression of various proteins. [10] In particular, changes in dietary sodium can alter the expression of proteins involved in renal tubular reabsorption and secretion, as well as proteins involved in the regulation of blood pressure. This can lead to changes in the overall protein profile of kidney tissue and, in turn, to changes in its proteome. [11] Another way dietary intake of sodium can affect the proteome of kidney tissue is by altering the metabolic activity of the tissue. [12] Sodium is necessary for the normal functioning of the kidneys, and changes in dietary intake can lead to changes in the metabolic activity of the kidney. This study explores changed of tissue proteome in responded to difference sodium intake even high or low level of dietary sodium.

MATERIALS AND METHODS

Animals and experimental group

Sprague Dawley male rats weighing between 200-250 grams were obtained. All rats were acclimatized and treated in the metabolic cages (Tecniplast™ Metabolic Cage Systems for Rodents, Thermo Scientific™, Canada), day-night cycle 12 hours, temperature 25°C. Rats were divided into 3 groups, the difference composition of the rat chow consisting of dietary sodium restriction rat chow (0.001% Na+) for low sodium (LS) group, regular rat chow (0.4% Na+) for control (Con) group, and high sodium rat chow (4% Na+) for high sodium (HS) group were used. All rats were treated with difference rat chow for 4 days. At the end of experiment the kidney cortexes were harvested and prepared according to the In-solution digestion and mass spectrometry sample preparation protocol.

In-solution digestion

Homogenized Renal cortical tissue was lysed with 5% sodium deoxycholate (SDC)(D6750, Sigma) in 50mM Triethylammonium bicarbonate (TEAB) containing 1x protease inhibitor cocktail (Halt™, Thermo Scientific™) and 1x phosphatase inhibitor cocktail (Pierce™, Thermo Scientific™). All samples were quenched with DTT for 15 minutes at room temperature and incubated with trypsin solution (Sequencing Grade Modified Trypsin, V511A, Promega, Wisconsin, USA) at concentration 0.1ug/µl at 1:50 ratio at 37oC for 12-16 hours. The digested peptides amount of samples were measured with the Pierce Quantitative Fluorometric Peptide Assay.

Tandem mass tag (TMT10plex™)

Tandem Mass Tag reagent kit (TMT10plex™ Isobaric Label Reagent, Thermo Scientific™) was chose to label digested peptides due to number of samples. LC/MS run. TMT10plex™Reagent was prepared according to the manufacturer's instructions. Briefly, dissolve reagent with 99% anhydrous acetonitrile (ACN) for 5 minutes with occasional vortex. Add equal amount of each sample into TMT10plex™ label reagent tube, one sample per one amine-reactive number (Figure 3.12) The samples were mixed by vortexing follow by centrifugation, then incubated the reaction for 1 hour at room temperature. After incubation, quench the reaction by added 8 µl of 5% hydroxylamine to the sample and incubated for 15 minutes.

LC-MS/MS and data analysis

All tagged samples were analyzed by a Q-Exactive Orbitrap mass spectrometer (Thermo Scientific™) via the

electrospray ionization (ESI) technique couple with EASY-nLC1000 system (Thermo Scientific™) for total protein analysis and phosphoprotein analysis, respectively. For total protein analysis, 33 µg of sample were divided into 8 fractions. Each fraction was resuspended in 0.1% FA to the final concentration 27.5 ng/µl. The injected sample contained 302.5 ng of peptide. Samples were pick up and loading into an EASY-nLC1000 system eluted with 4 difference gradients and times, at flow rate 300 nl/min (1) 4-20% acetonitrile in 0.1% FA for 60 minutes followed by (2) 20-40% acetonitrile in 0.1% FA for 15 minutes, (3) 40-95% acetonitrile in 0.1% FA for 10 minutes, and (4) 95-95% acetonitrile in 0.1% FA for 5 minutes, 90 minutes in total. Relative abundance and distribution of signal were determined, then small distribution or flat or sporadic signal was repeated with new gradients and times. Quantitative MS data were analyzed by MaxQuant v1.6.10 version against 8,050 proteins on "Rat proteomes reviewed (Swiss-Prot)", FASTA (canonical & isoform) data base on UP000002494, 26 Jan, 2019. The searching parameters were following setup 1) peptide-spectrum match (PSM) false discovery rate (FDR): 0.01, 2) protein FDR: 0.01.

Statistical analysis

Data were expressed as mean (±SD). The normal or non-normal distribution of all data was investigated using Shapiro-Wilk test. Statistical analysis that were applied for MS data consist of normalized peak intensity log2 ratios of each sample to reference intensity of its injection set was compared, ANOVA at threshold p-value <0.05 followed by Benjamini–Hochberg procedure to control false discovery rate (FDR) at q-value 0.05 were applied.

RESULTS AND DISCUSSION

Effects of salt restricted diet and high salt diet on rat body weight and urine output

Body weight (mean ± SD) at start date (before treatment) (Con: 275.78±19.13, LS: 270.33±22.16, HS: 276.11±32.05), 2 day and 4 day after treatment were measured. The mean body weight of low salt diet and high salt diet treated groups both day2 (Con: 274.67±21.25, LS: 270.00±24.94, HS: 273.56±28.87) and day4 (Con: 293.33±20.95, LS: 305.50±22.27, HS: 274.95±31.06) are comparable to that of control (Fig. 1 A). 24hr urine volume that was collected daily of control group and low salt group was not changed since day1 to day4 of experiment (Con day1: 17.83±9.70, Con day2: 18.00±7.92, Con day3: 14.83±8.54, Con day4: 17.16±5.98), low salt group (LS day1: 22.50±9.99, LS day2: 21.00±10.16, LS day3: 21.50±7.47, LS day4: 23.66±7.08). However, I found a significantly increased 24hr urine volume in High salt group on day2 to day4 at $p<0.05$ ((HS day1: 25.83±10.99, HS day2: 31.00±11.66, HS day3: 28.33±12.11, HS day4: 30.66±10.21) (Fig. 1 B) and 24hr urine volume of the high salt group on day 2 significantly increased compared to the low salt group at $p<0.05$. After treatment, urine osmolality was measured. Low salt group (1523.33±650.31) showed significantly decrease urine osmolality ($p<0.05$) compared to control (2599.66±856.56), while High salt group's urine osmolality (1840.00±652.38) was comparable to control (Fig. 1 C). After 4 days of treatments Low salt group

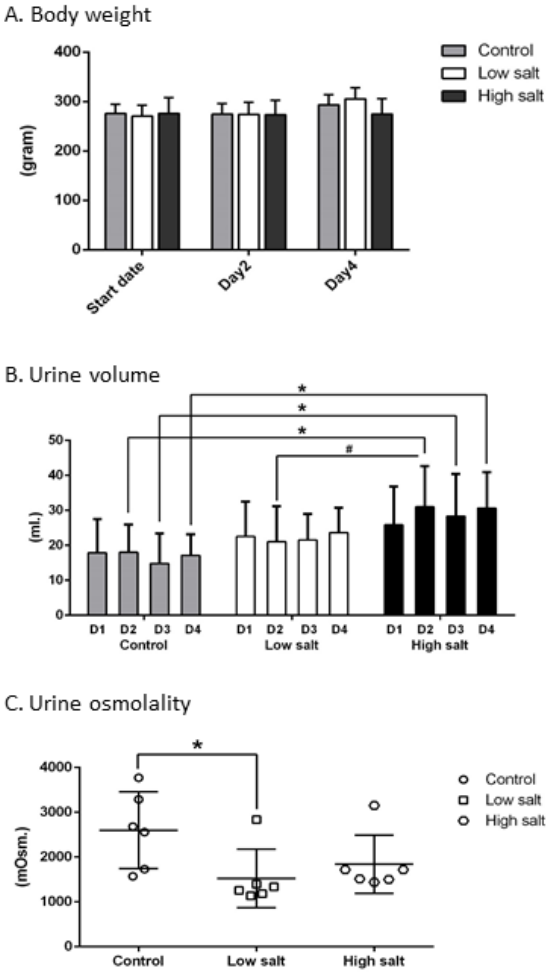

Figure 1. *Panel A.* Mean (±SD) rats body weight before treatment (Start date), day 2, and day 4 (end of experiment). *Panel B.* Mean (±SD) 24hr urine volume on day 1 to day 4. *Panel C.* Mean (±SD) urine osmolality after treatment, *, # $p<0.05$ compared to Control group, and Low salt group respectively.

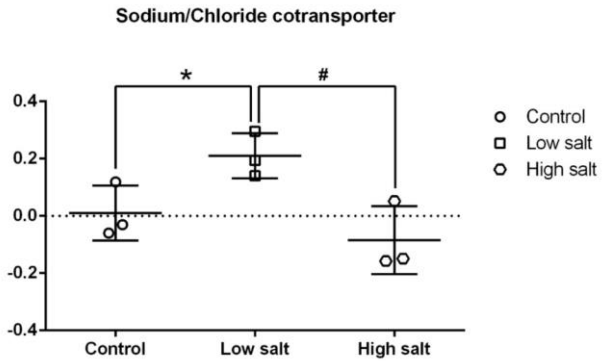

Figure 2. Mean (±SD) after treatment sodium/chloride cotransporter (NCC) abundance from mass spectrometry analysis. *, # $p<0.05$ compared to Control group, and Low salt group respectively.

showed decreased urine osmolality compared to regular diet. The mechanism for this change is control by reabsorption of sodium by the kidneys. This finding corresponding to increased expression of NCC in the kidney of Low salt group compared to Normal diet group. Urine osmolality of High salt group was comparable to control group but the increasing of urine volume since day-2 to day-4 could represent more sodium and water excretion than the control group.

Effects of salt restricted diet and high salt diet on rat kidney cortical tissue protein abundance

After 4 day of treatment 3 homogenized rat kidney cortical tissue samples (From N=6) from each group were randomly picked up to be a representative to proceed along TMT10plex labeling coupled with mass spectrometry. MS data was quantification and statistical analysis revealed that 0.001% sodium diet could raise sodium-chloride cotransporter (NCC) abundance in kidney cortical tissue (0.209850±0.078) compared to control (0.009678±0.095) and significantly increased when compared to high salt group at $p<0.05$. Moreover, NCC in rat kidney cortical tissue abundance in high salt group tended to decreased but not significant compared to control (Fig. 2). In this study low salt and high potassium diet could elevate serum aldosterone level. Combination of low salt and high potassium diet could induce aldosterone release in an addition pattern. ENaC response in the same manner as changes in serum

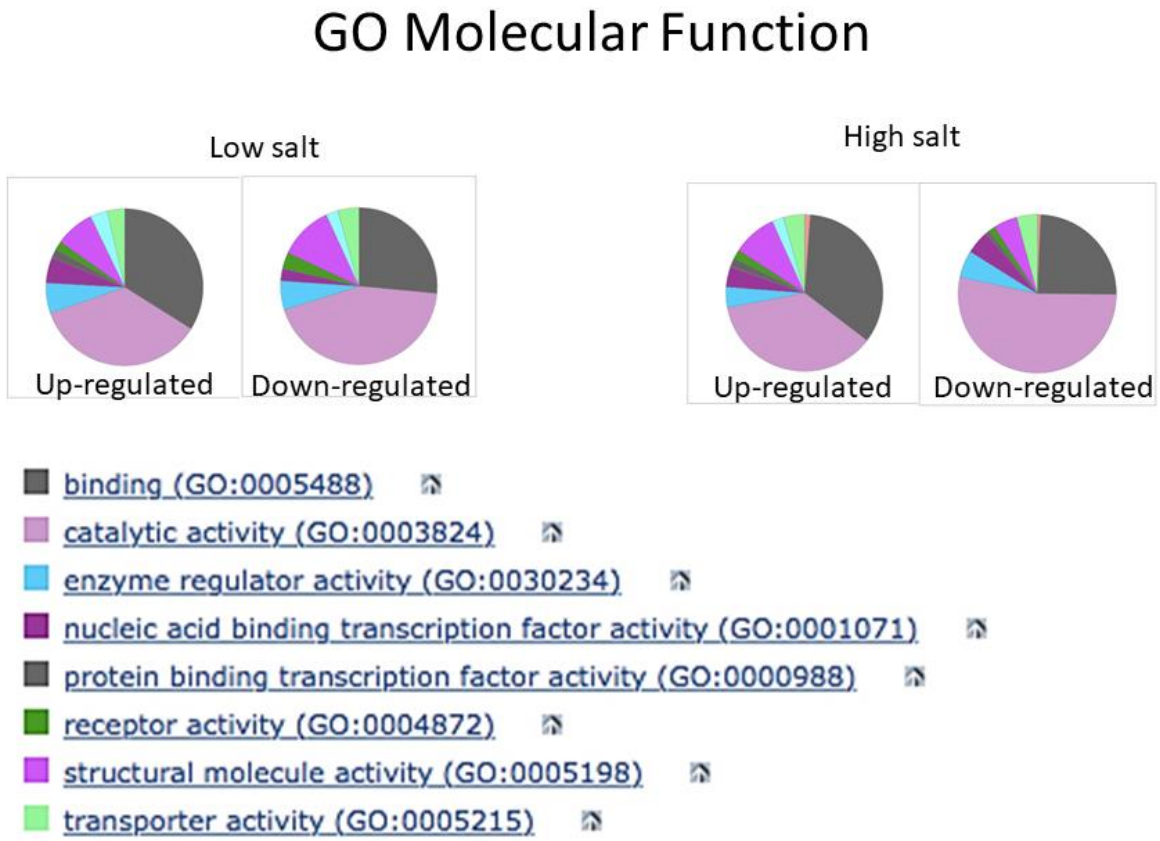

Figure 3. Ratio of the number of proteins categorized by GO molecular function that significant changed compared to control group

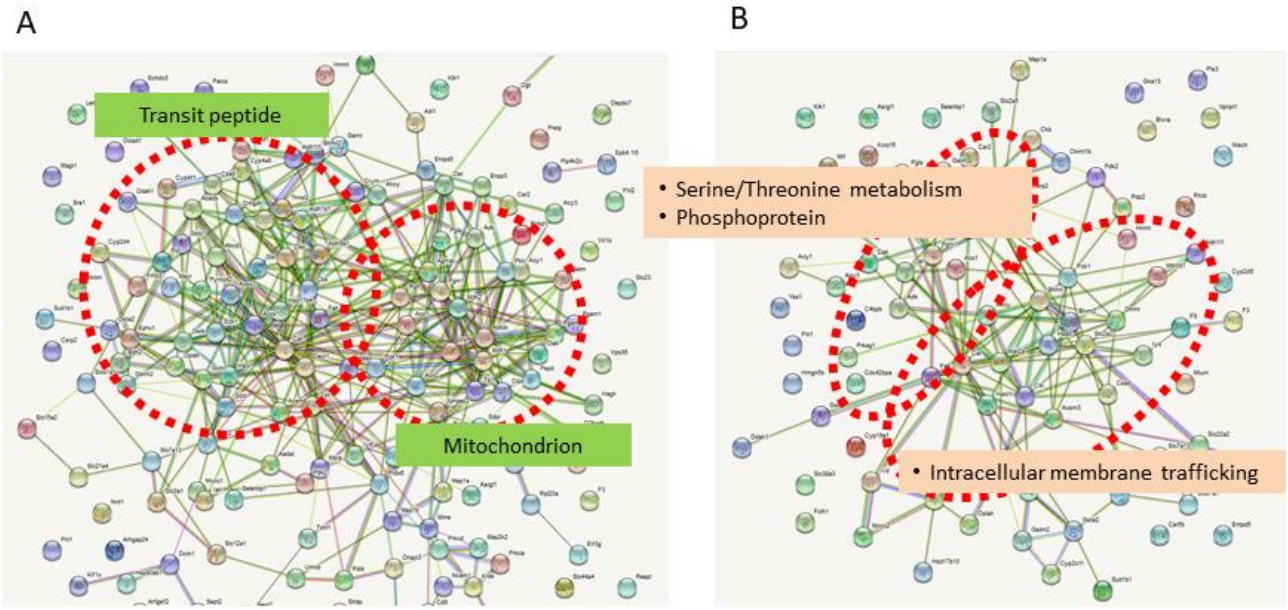

Figure 4. STRING algorithm shows the proteins interaction responses to difference dietary sodium intake. *Panel A.* Up-regulation proteins in Low sodium group compared to control group. *Panel B.* Up-regulation proteins in High sodium group compared to control group.

aldosterone. The results consistent with previous study by Nils van der Lubbe and coworkers, who study in rodent models with low salt and/or high potassium diet. They found ENaC expression corresponded with aldosterone level, but not NCC. [13] They also confirmed that NCC phosphorylation domain was essential for NCC expression level. On the other hand, NCC level were changed according to serum angiotensin II level. Angiotensin II regulated NCC via WNK-SPAK signaling pathway. Increasing angiotensin II will increase phosphorylate of WNK1 the further activate NCC by phosphorylation. In this study, I found that rat treated with combined diet had highest angiotensin II level and higher level of pNCC/NCC expression ratio from the immunoblot analysis than the other groups. [14]

Proteins Molecular function and cellular pathways changed

Quantitative analysis showed that total proteins data revealed 4054 proteins in kidney tissue at $p<0.05$. Among this, low sodium diet showed 259 significantly difference proteins compared to control. High sodium diet showed 357 significantly difference proteins compared to control. While 173 proteins are the significant proteins compared between low and high sodium treated rats at $p<0.05$. I categorized the significantly changed proteins of kidney tissue by low sodium and high sodium after 4 day compared to control group. Gene ontology (GO) molecular function revealed that the significantly changed proteins are the proteins involved in binding proteins, catalytic activity, enzyme regulator activity, nucleic acid binding transcription factor activity, protein binding transcription factor activity, receptor activity, structural molecular activity and transporter activity, respectively. (Fig. 3)

All significant proteins ID were further analyzed by Search tool for the retrieval of interacting gene/proteins (STRING) algorithm to explore the protein-protein interactions and cellular pathways. I found that transit peptide and mitrochondrion were up-regulated in low salt group. (Fig. 4A) Which might show the upregulation of the translocation of the channels in the kidney tissue especially NCC and ENaC in order to maintained serum osmolality within normal range. Previous study showed that vasopressin-increased NCC expression might be via inhibition of Nedd4-2 by PKA activation. [15] In high sodium treated rat tissue, 105 Significantly Up-regulated proteins were illustrated, then proteins that involved in Serine/Threonine metabolism, Phosphoprotein binding and intracellular membrane trafficking were found. (Fig. 4B) Several proteins involved in ENaC regulatory complex (ERC) were found significant increased consist of NHERF-1, NHERF-2, Adenosyl homocysteinase (AdoHcyase) that might involve in lessen ubiquitination process of both ENaC and NCC from apical membrane then allow channel to continue an action. [16]

CONCLUSION

Urine volume and urine electrolytes were tightly regulated to maintain serum osmolality when rats were treated with low salt diet, high potassium diet or combination of low salt with high potassium diet. Under low salt condition, rats can control serum osmolality via modulation of NCC and ENaC expression and possibly posttranslational modifications. The predominant signaling pathway that regulate ENaC found in this study is ERC. These proteins regulate cell surface expression and activities of ENaC. The predominant signaling pathways that regulate NCC found in this study are involved in serine/threonine metabolism.

Conflicts of Interest: The author has no conflict of interest to declare.

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Original Article

Reliability of the Test of Gross Motor Development Second Edition for Children with Down Syndrome

Myo Thein Tun[1*], Thanda Aye[1], Thwe Zar Chi Htut[1], Wai Mar Tin[2], Myo Thuzar Khin[1]

1 *Department of Physiotherapy, University of Medical Technology, Yangon, Myanmar*
2 *Medical Unit-3, Yangon Children Hospital, Myanmar*

Objectives: To investigate the test of gross motor development second edition (TGMD-2) test-retest, inter-rater, and intra-rater reliability for children with Down syndrome (DS).

Materials and Methods: Fifty children with DS from the School for Disabled Children, Yangon were participated in this reliability research. Before the assessment, all participants received an explanation of the TGMD-2 and saw all the skills in action. Each FMS had to be used twice for actual scoring, and each participant received one practice trial. The principal researcher videotaped and documented each participant's performance. The three raters watched and independently rated the recorded videos to assess inter-rater reliability. Test-retest reliability was assessed a second time two weeks later. For intra-rater reliability, the principal researcher reevaluated the identical video recordings from the initial evaluation four weeks later. Reliability was assessed using intraclass correlation coefficients (ICC) and Cronbach's alpha.

Results: The gross motor quotient, object control raw scores, and locomotor raw scores showed high reliability coefficients.

Conclusion: The TGMD-2 is an appropriate and highly reliable method to measure the FMS of children with DS, it can be inferred from the current findings.

Keywords: Children with Down syndrome; Reliability; TGMD-2

*** Correspondence to**:
Myo Thein Tun
Department of Physiotherapy, University of Medical Technology, Yangon, Myanmar 11012
Tel (+95)1-645-745
E-mail: umyotheintun@gmail.com
ORCID: 0000-0002-9444-6569

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INTRODUCTION

The fundamental motor skills (FMS), which include stability skills, object control skills, and locomotor skills, are the building blocks for movement and sophisticated sports and leisure activities that include the activation of muscles or muscle groups [1-5]. The FMS must possess the necessary expertise to promote the individual's holistic development, including their cognitive, social, and psychological growth [5-7]. The children's sociocultural, physical, and racial backgrounds all have an impact on their FMS development [8-10]. Children from developing countries may have a different level of FMS proficiency [10, 11]. Because there are sociocultural, economic, and environmental differences in these countries, it should be evaluated using standardized, valid, and reliable tools [11, 12].

To evaluate a child's FMS, whether they have proficiency or not, a variety of tools are available. Among these, the test of gross motor development second edition (TGMD-2) is frequently utilized because of its

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superior psychometric features, normative values, and simplicity of use [1-5, 13]. The TGMD-2 is a process-oriented test that can be utilized as a criterion- or norm-referenced test [1]. The TGMD-2 can be used to determine whether an individual has FMS delay and to create interventional programs as well as to evaluate them [1]. Additionally, the TGMD-2 is a trustworthy, accurate, and well-standardized assessment tool to evaluate the FMS proficiency of children with and without disabilities [14]. However, without enough confirmation through other sociocultural activities, such as traditional games, cultural dances, and sports, the results from the TGMD-2 may not be suitable. Therefore, reliability and validity should be researched in emerging countries.

Several cross-cultural studies were conducted in Australia [15], Belgium [16], Brazil [17], Netherlands [18], Myanmar [19], Portugal [20], Philippines [21], and South Korea [22], to support the evidence that the TGMD-2 was a reliable tool for children with or without disabilities. According to the research that is currently available for children with Down syndrome (DS), the reliability of TGMD-2 appears to have minimal evidence.

Pediatric physiotherapists frequently face DS, the most prevalent chromosomal condition caused by an extra copy of chromosome 21 rather than chromosome 46 [23, 24]. Approximately 0.1% of live births are thought to be affected globally, and it can have an impact on people of various races, ethnicities, and socioeconomic classes [24, 25]. Children with DS and typically developing children (TDC) differed slightly in how their motor skills developed [26, 27]. Children with DS have delayed motor skill development that has been linked to phenotypic impairments like low muscle tone, hyperextensibility of the joints, poor postural control, poor balance, congenital heart disease, and obesity [24, 28]. Additionally, FMS acquired by children with DS through compensatory movements was connected to these deficits [29, 30]. The FMS proficiency level of children with DS should be assessed with standardized and reliable assessment tools. Therefore, reliability tools to assess the FMS level of children with DS were needed.

A number of studies on the reliability of the TGMD-2 in children with special needs, such as intellectual and visual impairments, have also been conducted [16, 18, 21]. Furthermore, the reliability of the TGMD-2 for Myanmar's healthy children has been investigated, while the reliability of the TGMD-2 for Myanmar's DS children has not been evaluated. Only an interrater reliability study of the children with DS was conducted as a pilot study in Myanmar [31]. Therefore, the FMS proficiency level of children with DS should be assessed with standardized and reliable assessment tools. For children with special needs, the TGMD-2's reliability and validity were outstanding, and it has received approval in a number of nations. Although the TGMD-2 has been shown to be reliable throughout the globe, socioeconomic and cultural differences in children should be considered when using this test. Additionally, a recent systematic review advised that it was crucial to look at the reliability of TGMD for children with special needs [14]. Therefore, it is essential to look into the TGMD-2's reliability for children with DS. Thus, this study aimed to determine the inter-rater reliability, test-retest reliability, and intra-rater reliability of the children with DS in Myanmar.

MATERIALS AND METHODS

The School for Disabled Children (SDC), Yangon, served as the study area for the institutional-based observational (reliability) study. Fifty children with DS between the ages of 7 and 10 years (35 boys, 15 girls) were included in this study. Participants who could exhibit all 12 of the TGMD-2 items and who could follow two-step commands were considered for inclusion. Participants with serious neurological or medical illnesses or musculoskeletal issues were not allowed to participate. Participants who met inclusion criteria were chosen with a simple random sampling method to participate in this study. Prior to data collection, the Institutional Review Board of the University of Medical Technology, Yangon, granted the study ethical approval after taking participants' human values into account. Additionally, formal approval was also gotten from the research area's authorities. Moreover, verbal consent was obtained from the children with DS, and written informed consent was obtained from their parents or guardians.

The evaluation process for the FMS was carried out in accordance with the TGMD-2's standard operating procedures [1]. The principal researcher clarified and showed each FMS to the participants. Before beginning the evaluation, participants were given one practice trial, and they had to complete each FMS twice after that. Each FMS test was followed by a brief period of relaxation. For an accurate evaluation of all performance parameters, each child's performance was videotaped. To be able to adjust the camera's angle and orientation while recording the complete FMS performance for the assessment of locomotor skills, the camera was fixed to a tripod. The camera was placed where it would record the child's performance for the evaluation of object control skills. The principal researcher observed each

participant's FMS performance in the study area and documented it. Each participant was given 10 to 20 minutes to complete the TGMD-2 assessment.

The performance requirements for the TGMD-2 were 3-5 criteria, and it comprises 12 skills (six locomotor skills and six object control skills). The participant received a score of 1 if they were successful in doing the skill, and a score of 0 if they were unsuccessful. A skill score was calculated by adding the sum of the performance criteria's total criteria scores. Six skill scores were summed to obtain subtest raw scores. The maximum raw score for the locomotor and object control abilities subtest was 48. Standard scores were generated from the subtest's raw score (locomotor and object control standard scores). The subtest standard scores were also summed and converted to the gross motor quotient (GMQ), and the maximum GMQ was 160.

The participant's performance in this study was evaluated by three raters (physiotherapists) individually. The TGMD-2 was administered and scored by one rater who had more than seven years of experience doing it, and the other two raters were the principal researcher and another novice physiotherapist. The principal researcher had little prior experience of how to administer the TGMD-2 (having conducted pilot studies as well as having already finished training for the TGMD-2). The novice physiotherapist had already completed the TGMD-2 course but had no prior experience administering the test. For inter-rater reliability, the three raters watched and evaluated the video recordings separately. The participants performed all 12 motor skills for the second time two weeks after the first assessment. The second performance of each youngster was again captured on camera, and the principal researcher only evaluated it for test-retest reliability. After four weeks had passed since the initial evaluation, the principal researcher re-watched the identical video recordings and rated them in order to determine the intra-rater reliability.

Statistical analysis was performed by utilizing the Statistical Package for the Social Sciences (SPSS) software version (22.0) for Windows. Normality was checked by utilizing the Kolmogorov-Smirnov test. The reliability was calculated using the intra-class correlation coefficients (ICC) and Cronbach's alpha. The GMQ and locomotor and object control raw scores were calculated for the reliability testing. The significance level of 0.05 was approved. The reliability coefficient criteria were taken from Portney and Watkin, who said that ICCs of less than 0.50, between 0.50 and 0.75, and greater than 0.75 were categorized as low reliability, moderate reliability, and good reliability, respectively [32]. Cronbach's alpha was classified by George and Malery as follows: >0.9 - Excellent, >0.8 - Good, >0.7 - Acceptable, >0.6 - Questionable, >0.5 - Poor, and 0.5 - Unacceptable for the coefficient alpha size [33]. George and Malery's coefficient alpha size criterion were used in the current investigation. This manuscript follows the GRRAS guidelines [34].

RESULTS

Seventy percent of the participants were boys, accounting up the majority of the study's participants. The participants' average age was 9.44 ± 0.92 years. Almost half of the individuals (48%) were overweight.

Inter-rater reliability

Three raters evaluated the TGMD-2 for children with DS's inter-rater reliability. The inter-rater reliability statistics of the TGMD-2 are summarized in Table 1. For TGMD-2, the Cronbach's alpha and ICC values indicated excellent inter-rater reliability. The ICC for the GMQ was 0.96, the locomotor raw scores were 0.97, and the object control raw scores were 0.97. These findings showed "high" reliability when compared to the adopted criteria.

Test-retest reliability

After two weeks following the initial evaluation, the principal researcher evaluated the TGMD-2 for children with DS for test-retest reliability. Table 2 presents the data of the raw scores of the locomotor and object control skills, and the GMQ, Cronbach's alpha, and ICC for the test-retest reliability. The test-retest reliability findings showed excellent Cronbach's alpha values and good ICC values for agreement between Day 1 and Day 2 assessments.

Intra-rater reliability

After 4 weeks of initial assessment, the principal researcher evaluated the TGMD-2's intra-rater reliability for children with DS. Table 3 presents the data for the GMQ, Cronbach's alpha, and ICC for the test-retest reliability as well as the raw scores of the locomotor and object control skills as well as the mean values for these variables. The intra-rater reliability result showed strong agreement values for ICC between Assessments 1 and 2, as well as high Cronbach's alpha values. These results demonstrate "high" reliability when measured against the established standards.

Table 1. Results of inter-rater reliability test (Cronbach's alpha and ICC) n=50

FMS	Rater A Mean ±SD	Rater B Mean ±SD	Rater C Mean ±SD	Cronbach's alpha	ICC	95% CI		p-value
						Lower bound	Upper bound	
LRS	17.7±11.1	18.8±10.0	17.0±10.5	0.98	0.97	0.96	0.98	<0.001
OCRS	22.1±9.9 1	23.3±8.44	21.1±9.10	0.98	0.97	0.95	0.98	<0.001
GMQ	53.6±11.0	53.3±10.1	52.0±9.60	0.96	0.96	0.94	0.98	<0.001

FMS: Fundamental Motor Skills, ICC: Intraclass Correlation Coefficient, CI: Confidence Interval, LRS: Locomotor Raw Scores, OCRS: Object Control Raw Scores, GMQ: Gross Motor Quotient

Table 2. Results of test-retest reliability (Cronbach's alpha and ICC) n=50

FMS	Day 1 Mean ±SD	Day 2 Mean ±SD	Cronbach's alpha	ICC	95% CI		p-value
					Lower bound	Upper bound	
LRS	18.9±10.0	24.9±7.70	0.94	0.92	0.90	0.96	<0.001
OCRS	23.3±8.44	27.6±6.79	0.95	0.94	0.91	0.97	<0.001
GMQ	53.3±10.1	57.3±11.1	0.95	0.94	0.90	0.96	<0.001

FMS: Fundamental Motor Skills, ICC: Intraclass Correlation Coefficient, CI: Confidence Interval, LRS: Locomotor Raw Scores, OCRS: Object Control Raw Scores, GMQ: Gross Motor Quotient

Table 3 Results of intra-rater reliability (Cronbach's alpha and ICC) n=50

FMS	Assessment 1 Mean ±SD	Assessment 2 Mean ±SD	Cronbach's alpha	ICC	95% CI		p-value
					Lower bound	Upper bound	
LRS	18.9±10.0	24.7±7.80	0.85	0.87	0.73	0.91	<0.001
OCRS	23.3±8.44	20.7±9.93	0.84	0.86	0.73	0.91	<0.001
GMQ	53.3±10.1	53.7±10.2	0.99	0.99	0.98	0.99	<0.001

FMS: Fundamental Motor Skills, ICC: Intraclass Correlation Coefficient, CI: Confidence Interval, LRS: Locomotor Raw Scores, OCRS: Object Control Raw Scores, GMQ: Gross Motor Quotient

DISCUSSION

The TGMD-2 is one of the most widely used process-oriented, norm-referenced, as well as criterion-referenced tools for assessing the FMS proficiency of children, whether they have disabilities or not [1-5, 35]. Moreover, the TGMD-2 is only evaluating the children's gross motor skills between the ages of 3 and 10 years. It consists of six locomotor skills and six object control skills. Clinicians, physiotherapists, physical educators, and scholars needed reliable, valid, and practical FMS competency evaluation tools to give valuable evidence for clinical, educational, and research objectives [1, 14, 36]. Reliability is the core of measurement, or the measurement is how much error- and consistency-free [32]. Determining the reliability (inter-rater, intra-rater, and test-retest reliability) of the TGMD-2 for children with DS aged 7 to 10 years old was the study's main goal.

Inter-rater reliability

Inter-rater reliability is known as the consistency or agreement in measuring scores between two or more raters of an identical group of individuals examined in similar situations [14, 32]. For evaluating the children's motor skill proficiency, the TGMD-2's inter-rater reliability was an essential psychometric property [15]. In the current study's evaluation of inter-rater reliability, the raw scores of the TGMD-2 locomotor and object control were found to have high or excellent ICC values among the three raters. The TGMD-2 was a good-to-excellent reliable tool to assess the FMS proficiency of children

with DS in Myanmar since Cronbach's Alpha for all individual TGMD-2 skills and subtest raw scores remained above 0.8. For both the locomotor and object control raw scores in the current study, the inter-rater reliability coefficient was 0.98, indicating high or excellent reliability.

The results of this study were in line with those of other previous studies, which showed good to excellent ICC values and satisfactory inter-rater reliability for the TGMD-2 in TDC or children with special needs such as VI, and ID [15, 16, 18, 19, 21, 31, 37].

Simons and colleagues discovered that the locomotor and object control subtests had excellent inter-rater reliability and agreement between two raters in their study on Flemish children with ID [16]. For Dutch children with VI, Houwen and associates reported a comparable result. They stated that the inter-rater reliability of the locomotor subtest and the object control subtest was 0.93 [18]. Additionally, Capio and coworkers showed that in the locomotor and object control subtests of Filipino children with ID, the inter-rater reliability was 0.99, which was similar to the results of the current study [21]. In addition, the results of the current study were in keeping with the previous reliability study [19]. In a study of Myanmar kindergarten children, Aye and colleagues found that the inter-rater reliability for locomotor raw scores was 0.95 and for object control raw scores was 0.88 [19].

The results of the current study were consistent with the results of the pilot study, which assessed the TGMD-2's inter-rater reliability (between two raters) in children with DS (n = 41), and that study was conducted at the SDC in 2019 [31]. Additionally, a recent systematic review found that in 19 out of 23 studies that evaluated the TGMD's inter-rater reliability, the raw scores of locomotor and object control as well as the GMQ showed good-to-excellent levels [14]. The results of the current study are in line with those of other investigations on children with or without disabilities because all of the studies had excellent inter-rater reliability.

Test-retest reliability

The temporal stability scores of assessment tools between two measures obtained by the same assessment tool on the same participant under the same circumstances are used to determine test-retest reliability [20, 32, 38]. It means that the test results and the retest results agree. Repeated testing will produce the same results when using a reliable tool [32].

Over time, the durability of TGMD-2 was evaluated (test-retest). For the GMQ, the raw scores of locomotor and object control had ICC values > 0.8, indicating high reliability. These results were similar to previous research, which showed high test-retest reliability in a variety of study populations, including TDC, children with ID, and VI [16, 18–20, 22].

According to Simon and colleagues, test-retest reliability in Flemish children with ID was 0.98 for the GMQ, 0.90 for the locomotor subset, and 0.92 for the object control subset [16]. The subjects in their study, which had a two-week test-retest reliability interval, ranged in age from 7 to 10 years old. Eight randomly selected children with ID participated in their study [16].

The test-retest reliability of the locomotor raw scores and the object control raw scores (ICC = 0.86 and 0.87, respectively) in children with VI in the Netherlands was reported by Houwen et al. [18]. Twenty-three children (6–12 years old) took part in the study, and there was a 2-week interval between the first and second assessments [18]. The results of the current study also reflected those of Aye and coworkers, who also found high test-retest reliability for the TGMD-2 for kindergarten children in Myanmar. They described that the ICC for all the FMS in their study was more than 0.75, which indicated high reliability in the test-retest reliability for Myanmar TDC [19].

Before measuring their performance, each participant should be familiar with the assessment procedures, as these could affect the validity and reliability of the results [39]. Children must first do familiarization trials for each skill before assessment trials, according to the TGMD-2 examiner's manual [1]. These results revealed that the TGMD-2's test-retest reliability was temporally stable despite various research populations and a short familiarization interval [14].

Additionally, 10 out of 15 studies that tested the TGMD-2's test-retest reliability were included in a recent systematic review. The TGMD-2 verified good to excellent test-retest reliability in their systematic review for the overall score, object control skills scores, and GMQ, and moderate to excellent test-retest reliability for the locomotor skills scores [14]. As a result, the TGMD-2 test-retest reliability values obtained in the current study were comparable to those found in other previous studies.

Intra-rater reliability

The degree of agreement measured by the same rater across two or more subsequent trials conducted under the same conditions is known as intra-rater reliability [14, 38]. Inter-rater reliability testing will improve measurement instrument accuracy and research conclusions [32]. For the raw scores of both locomotor

and object control, the ICC values of intra-rater reliability were higher than 0.8 and at acceptable levels in the current study. These findings were consistent with other research studies that were carried out on several study populations, including TDC, children with ID, and VI. These results of high intra-rater reliability are in line with previous studies that investigated the reliability of TGMD-2 in children with and without disabilities. High or excellent intra-rater reliability was present in each of these studies [14, 18, 19, 21].

The results of this study supported those of Houwen and colleagues, who found that the TGMD-2 had good intra-rater reliability in Dutch children with VI. They discovered that for the locomotor subtest, the intra-rater ICC value was 0.85, for the object control subtest, it was 0.93, and for the GMQ, it was 0.95 [18]. In their investigation, one month passed between the initial test and the follow-up examination, and this period was considered sufficient to reduce the examiners' bias to favor memory [18].

The results of the current study also substantially confirmed the findings of a previous study carried out in the Philippines by Capio and colleagues [21]. In the intra-rater reliability testing of 10 children with ID, they conveyed that for the locomotor subtest, the ICC was 0.99, for the GMQ, it was 0.99, and for the object control subtest, it was 0.99, all of which show high reliability [21]. The results of the current study were also in line with a previous study conducted by Aye et al. that demonstrated high reliability in the intra-rater reliability testing of 12 kindergarten children in Myanmar. They reported that the intra-rater ICC value for the locomotor subtest was 0.98, the object control subtest was 0.95, and the GMQ was 0.97 [19]. The time interval between the test and retest in their study was six weeks [19].

Additionally, the results of the current investigation supported the conclusions of another recent systematic review [14]. Six out of the 13 studies that looked into the TGMD-2's intra-rater reliability were determined by Rey and colleagues, to have good-to-excellent intra-rater reliability [14]. Since all of the studies had strong intra-rater reliability, the results of the current study were matched with those seen in previous studies for children with or without disabilities.

The limitations of the current study were that the participants came only from one special school, and only the principal investigator tested the test-retest and intra-rater reliability. As a result, future research should be carried out with larger sample size, different special schools in Myanmar, test-retest reliability assessments, and intra-rater reliability assessments of all raters.

CONCLUSION

The findings of this study support that the TGMD-2 has a high or excellent reliability for assessing the FMS proficiency of children with DS. The TGMD-2 is an appropriate and acceptable tool for evaluating the FMS of children with DS in Myanmar, it can be deduced from this study.

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Original Article

Reliability of the Test of Gross Motor Development Second Edition for Children with Down Syndrome

Myo Thein Tun[1*], Thanda Aye[1], Thwe Zar Chi Htut[1], Wai Mar Tin[2], Myo Thuzar Khin[1]

1 *Department of Physiotherapy, University of Medical Technology, Yangon, Myanmar*
2 *Medical Unit-3, Yangon Children Hospital, Myanmar*

Objectives: To investigate the test of gross motor development second edition (TGMD-2) test-retest, inter-rater, and intra-rater reliability for children with Down syndrome (DS).

Materials and Methods: Fifty children with DS from the School for Disabled Children, Yangon were participated in this reliability research. Before the assessment, all participants received an explanation of the TGMD-2 and saw all the skills in action. Each FMS had to be used twice for actual scoring, and each participant received one practice trial. The principal researcher videotaped and documented each participant's performance. The three raters watched and independently rated the recorded videos to assess inter-rater reliability. Test-retest reliability was assessed a second time two weeks later. For intra-rater reliability, the principal researcher reevaluated the identical video recordings from the initial evaluation four weeks later. Reliability was assessed using intraclass correlation coefficients (ICC) and Cronbach's alpha.

Results: The gross motor quotient, object control raw scores, and locomotor raw scores showed high reliability coefficients.

Conclusion: The TGMD-2 is an appropriate and highly reliable method to measure the FMS of children with DS, it can be inferred from the current findings.

Keywords: Children with Down syndrome; Reliability; TGMD-2

*** Correspondence to**:
Myo Thein Tun
Department of Physiotherapy, University of Medical Technology, Yangon, Myanmar 11012
Tel (+95)1-645-745
E-mail: umyotheintun@gmail.com
ORCID: 0000-0002-9444-6569

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INTRODUCTION

The fundamental motor skills (FMS), which include stability skills, object control skills, and locomotor skills, are the building blocks for movement and sophisticated sports and leisure activities that include the activation of muscles or muscle groups [1-5]. The FMS must possess the necessary expertise to promote the individual's holistic development, including their cognitive, social, and psychological growth [5-7]. The children's sociocultural, physical, and racial backgrounds all have an impact on their FMS development [8-10]. Children from developing countries may have a different level of FMS proficiency [10, 11]. Because there are sociocultural, economic, and environmental differences in these countries, it should be evaluated using standardized, valid, and reliable tools [11, 12].

To evaluate a child's FMS, whether they have proficiency or not, a variety of tools are available. Among these, the test of gross motor development second edition (TGMD-2) is frequently utilized because of its

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superior psychometric features, normative values, and simplicity of use [1-5, 13]. The TGMD-2 is a process-oriented test that can be utilized as a criterion- or norm-referenced test [1]. The TGMD-2 can be used to determine whether an individual has FMS delay and to create interventional programs as well as to evaluate them [1]. Additionally, the TGMD-2 is a trustworthy, accurate, and well-standardized assessment tool to evaluate the FMS proficiency of children with and without disabilities [14]. However, without enough confirmation through other sociocultural activities, such as traditional games, cultural dances, and sports, the results from the TGMD-2 may not be suitable. Therefore, reliability and validity should be researched in emerging countries.

Several cross-cultural studies were conducted in Australia [15], Belgium [16], Brazil [17], Netherlands [18], Myanmar [19], Portugal [20], Philippines [21], and South Korea [22], to support the evidence that the TGMD-2 was a reliable tool for children with or without disabilities. According to the research that is currently available for children with Down syndrome (DS), the reliability of TGMD-2 appears to have minimal evidence.

Pediatric physiotherapists frequently face DS, the most prevalent chromosomal condition caused by an extra copy of chromosome 21 rather than chromosome 46 [23, 24]. Approximately 0.1% of live births are thought to be affected globally, and it can have an impact on people of various races, ethnicities, and socioeconomic classes [24, 25]. Children with DS and typically developing children (TDC) differed slightly in how their motor skills developed [26, 27]. Children with DS have delayed motor skill development that has been linked to phenotypic impairments like low muscle tone, hyperextensibility of the joints, poor postural control, poor balance, congenital heart disease, and obesity [24, 28]. Additionally, FMS acquired by children with DS through compensatory movements was connected to these deficits [29, 30]. The FMS proficiency level of children with DS should be assessed with standardized and reliable assessment tools. Therefore, reliability tools to assess the FMS level of children with DS were needed.

A number of studies on the reliability of the TGMD-2 in children with special needs, such as intellectual and visual impairments, have also been conducted [16, 18, 21]. Furthermore, the reliability of the TGMD-2 for Myanmar's healthy children has been investigated, while the reliability of the TGMD-2 for Myanmar's DS children has not been evaluated. Only an interrater reliability study of the children with DS was conducted as a pilot study in Myanmar [31]. Therefore, the FMS proficiency level of children with DS should be assessed with standardized and reliable assessment tools. For children with special needs, the TGMD-2's reliability and validity were outstanding, and it has received approval in a number of nations. Although the TGMD-2 has been shown to be reliable throughout the globe, socioeconomic and cultural differences in children should be considered when using this test. Additionally, a recent systematic review advised that it was crucial to look at the reliability of TGMD for children with special needs [14]. Therefore, it is essential to look into the TGMD-2's reliability for children with DS. Thus, this study aimed to determine the inter-rater reliability, test-retest reliability, and intra-rater reliability of the children with DS in Myanmar.

MATERIALS AND METHODS

The School for Disabled Children (SDC), Yangon, served as the study area for the institutional-based observational (reliability) study. Fifty children with DS between the ages of 7 and 10 years (35 boys, 15 girls) were included in this study. Participants who could exhibit all 12 of the TGMD-2 items and who could follow two-step commands were considered for inclusion. Participants with serious neurological or medical illnesses or musculoskeletal issues were not allowed to participate. Participants who met inclusion criteria were chosen with a simple random sampling method to participate in this study. Prior to data collection, the Institutional Review Board of the University of Medical Technology, Yangon, granted the study ethical approval after taking participants' human values into account. Additionally, formal approval was also gotten from the research area's authorities. Moreover, verbal consent was obtained from the children with DS, and written informed consent was obtained from their parents or guardians.

The evaluation process for the FMS was carried out in accordance with the TGMD-2's standard operating procedures [1]. The principal researcher clarified and showed each FMS to the participants. Before beginning the evaluation, participants were given one practice trial, and they had to complete each FMS twice after that. Each FMS test was followed by a brief period of relaxation. For an accurate evaluation of all performance parameters, each child's performance was videotaped. To be able to adjust the camera's angle and orientation while recording the complete FMS performance for the assessment of locomotor skills, the camera was fixed to a tripod. The camera was placed where it would record the child's performance for the evaluation of object control skills. The principal researcher observed each

participant's FMS performance in the study area and documented it. Each participant was given 10 to 20 minutes to complete the TGMD-2 assessment.

The performance requirements for the TGMD-2 were 3-5 criteria, and it comprises 12 skills (six locomotor skills and six object control skills). The participant received a score of 1 if they were successful in doing the skill, and a score of 0 if they were unsuccessful. A skill score was calculated by adding the sum of the performance criteria's total criteria scores. Six skill scores were summed to obtain subtest raw scores. The maximum raw score for the locomotor and object control abilities subtest was 48. Standard scores were generated from the subtest's raw score (locomotor and object control standard scores). The subtest standard scores were also summed and converted to the gross motor quotient (GMQ), and the maximum GMQ was 160.

The participant's performance in this study was evaluated by three raters (physiotherapists) individually. The TGMD-2 was administered and scored by one rater who had more than seven years of experience doing it, and the other two raters were the principal researcher and another novice physiotherapist. The principal researcher had little prior experience of how to administer the TGMD-2 (having conducted pilot studies as well as having already finished training for the TGMD-2). The novice physiotherapist had already completed the TGMD-2 course but had no prior experience administering the test. For inter-rater reliability, the three raters watched and evaluated the video recordings separately. The participants performed all 12 motor skills for the second time two weeks after the first assessment. The second performance of each youngster was again captured on camera, and the principal researcher only evaluated it for test-retest reliability. After four weeks had passed since the initial evaluation, the principal researcher re-watched the identical video recordings and rated them in order to determine the intra-rater reliability.

Statistical analysis was performed by utilizing the Statistical Package for the Social Sciences (SPSS) software version (22.0) for Windows. Normality was checked by utilizing the Kolmogorov-Smirnov test. The reliability was calculated using the intra-class correlation coefficients (ICC) and Cronbach's alpha. The GMQ and locomotor and object control raw scores were calculated for the reliability testing. The significance level of 0.05 was approved. The reliability coefficient criteria were taken from Portney and Watkin, who said that ICCs of less than 0.50, between 0.50 and 0.75, and greater than 0.75 were categorized as low reliability, moderate reliability, and good reliability, respectively [32]. Cronbach's alpha was classified by George and Malery as follows: >0.9 - Excellent, >0.8 - Good, >0.7 - Acceptable, >0.6 - Questionable, >0.5 - Poor, and 0.5 - Unacceptable for the coefficient alpha size [33]. George and Malery's coefficient alpha size criterion were used in the current investigation. This manuscript follows the GRRAS guidelines [34].

RESULTS

Seventy percent of the participants were boys, accounting up the majority of the study's participants. The participants' average age was 9.44 ± 0.92 years. Almost half of the individuals (48%) were overweight.

Inter-rater reliability

Three raters evaluated the TGMD-2 for children with DS's inter-rater reliability. The inter-rater reliability statistics of the TGMD-2 are summarized in Table 1. For TGMD-2, the Cronbach's alpha and ICC values indicated excellent inter-rater reliability. The ICC for the GMQ was 0.96, the locomotor raw scores were 0.97, and the object control raw scores were 0.97. These findings showed "high" reliability when compared to the adopted criteria.

Test-retest reliability

After two weeks following the initial evaluation, the principal researcher evaluated the TGMD-2 for children with DS for test-retest reliability. Table 2 presents the data of the raw scores of the locomotor and object control skills, and the GMQ, Cronbach's alpha, and ICC for the test-retest reliability. The test-retest reliability findings showed excellent Cronbach's alpha values and good ICC values for agreement between Day 1 and Day 2 assessments.

Intra-rater reliability

After 4 weeks of initial assessment, the principal researcher evaluated the TGMD-2's intra-rater reliability for children with DS. Table 3 presents the data for the GMQ, Cronbach's alpha, and ICC for the test-retest reliability as well as the raw scores of the locomotor and object control skills as well as the mean values for these variables. The intra-rater reliability result showed strong agreement values for ICC between Assessments 1 and 2, as well as high Cronbach's alpha values. These results demonstrate "high" reliability when measured against the established standards.

Table 1. Results of inter-rater reliability test (Cronbach's alpha and ICC) n=50

FMS	Rater A Mean ±SD	Rater B Mean ±SD	Rater C Mean ±SD	Cronbach's alpha	ICC	95% CI		p-value
						Lower bound	Upper bound	
LRS	17.7±11.1	18.8±10.0	17.0±10.5	0.98	0.97	0.96	0.98	<0.001
OCRS	22.1±9.9 1	23.3±8.44	21.1±9.10	0.98	0.97	0.95	0.98	<0.001
GMQ	53.6±11.0	53.3±10.1	52.0±9.60	0.96	0.96	0.94	0.98	<0.001

FMS: Fundamental Motor Skills, ICC: Intraclass Correlation Coefficient, CI: Confidence Interval, LRS: Locomotor Raw Scores, OCRS: Object Control Raw Scores, GMQ: Gross Motor Quotient

Table 2. Results of test-retest reliability (Cronbach's alpha and ICC) n=50

FMS	Day 1 Mean ±SD	Day 2 Mean ±SD	Cronbach's alpha	ICC	95% CI		p-value
					Lower bound	Upper bound	
LRS	18.9±10.0	24.9±7.70	0.94	0.92	0.90	0.96	<0.001
OCRS	23.3±8.44	27.6±6.79	0.95	0.94	0.91	0.97	<0.001
GMQ	53.3±10.1	57.3±11.1	0.95	0.94	0.90	0.96	<0.001

FMS: Fundamental Motor Skills, ICC: Intraclass Correlation Coefficient, CI: Confidence Interval, LRS: Locomotor Raw Scores, OCRS: Object Control Raw Scores, GMQ: Gross Motor Quotient

Table 3 Results of intra-rater reliability (Cronbach's alpha and ICC) n=50

FMS	Assessment 1 Mean ±SD	Assessment 2 Mean ±SD	Cronbach's alpha	ICC	95% CI		p-value
					Lower bound	Upper bound	
LRS	18.9±10.0	24.7±7.80	0.85	0.87	0.73	0.91	<0.001
OCRS	23.3±8.44	20.7±9.93	0.84	0.86	0.73	0.91	<0.001
GMQ	53.3±10.1	53.7±10.2	0.99	0.99	0.98	0.99	<0.001

FMS: Fundamental Motor Skills, ICC: Intraclass Correlation Coefficient, CI: Confidence Interval, LRS: Locomotor Raw Scores, OCRS: Object Control Raw Scores, GMQ: Gross Motor Quotient

DISCUSSION

The TGMD-2 is one of the most widely used process-oriented, norm-referenced, as well as criterion-referenced tools for assessing the FMS proficiency of children, whether they have disabilities or not [1-5, 35]. Moreover, the TGMD-2 is only evaluating the children's gross motor skills between the ages of 3 and 10 years. It consists of six locomotor skills and six object control skills. Clinicians, physiotherapists, physical educators, and scholars needed reliable, valid, and practical FMS competency evaluation tools to give valuable evidence for clinical, educational, and research objectives [1, 14, 36]. Reliability is the core of measurement, or the measurement is how much error- and consistency-free [32]. Determining the reliability (inter-rater, intra-rater, and test-retest reliability) of the TGMD-2 for children with DS aged 7 to 10 years old was the study's main goal.

Inter-rater reliability

Inter-rater reliability is known as the consistency or agreement in measuring scores between two or more raters of an identical group of individuals examined in similar situations [14, 32]. For evaluating the children's motor skill proficiency, the TGMD-2's inter-rater reliability was an essential psychometric property [15]. In the current study's evaluation of inter-rater reliability, the raw scores of the TGMD-2 locomotor and object control were found to have high or excellent ICC values among the three raters. The TGMD-2 was a good-to-excellent reliable tool to assess the FMS proficiency of children

with DS in Myanmar since Cronbach's Alpha for all individual TGMD-2 skills and subtest raw scores remained above 0.8. For both the locomotor and object control raw scores in the current study, the inter-rater reliability coefficient was 0.98, indicating high or excellent reliability.

The results of this study were in line with those of other previous studies, which showed good to excellent ICC values and satisfactory inter-rater reliability for the TGMD-2 in TDC or children with special needs such as VI, and ID [15, 16, 18, 19, 21, 31, 37].

Simons and colleagues discovered that the locomotor and object control subtests had excellent inter-rater reliability and agreement between two raters in their study on Flemish children with ID [16]. For Dutch children with VI, Houwen and associates reported a comparable result. They stated that the inter-rater reliability of the locomotor subtest and the object control subtest was 0.93 [18]. Additionally, Capio and coworkers showed that in the locomotor and object control subtests of Filipino children with ID, the inter-rater reliability was 0.99, which was similar to the results of the current study [21]. In addition, the results of the current study were in keeping with the previous reliability study [19]. In a study of Myanmar kindergarten children, Aye and colleagues found that the inter-rater reliability for locomotor raw scores was 0.95 and for object control raw scores was 0.88 [19].

The results of the current study were consistent with the results of the pilot study, which assessed the TGMD-2's inter-rater reliability (between two raters) in children with DS (n = 41), and that study was conducted at the SDC in 2019 [31]. Additionally, a recent systematic review found that in 19 out of 23 studies that evaluated the TGMD's inter-rater reliability, the raw scores of locomotor and object control as well as the GMQ showed good-to-excellent levels [14]. The results of the current study are in line with those of other investigations on children with or without disabilities because all of the studies had excellent inter-rater reliability.

Test-retest reliability

The temporal stability scores of assessment tools between two measures obtained by the same assessment tool on the same participant under the same circumstances are used to determine test-retest reliability [20, 32, 38]. It means that the test results and the retest results agree. Repeated testing will produce the same results when using a reliable tool [32].

Over time, the durability of TGMD-2 was evaluated (test-retest). For the GMQ, the raw scores of locomotor and object control had ICC values > 0.8, indicating high reliability. These results were similar to previous research, which showed high test-retest reliability in a variety of study populations, including TDC, children with ID, and VI [16, 18–20, 22].

According to Simon and colleagues, test-retest reliability in Flemish children with ID was 0.98 for the GMQ, 0.90 for the locomotor subset, and 0.92 for the object control subset [16]. The subjects in their study, which had a two-week test-retest reliability interval, ranged in age from 7 to 10 years old. Eight randomly selected children with ID participated in their study [16].

The test-retest reliability of the locomotor raw scores and the object control raw scores (ICC = 0.86 and 0.87, respectively) in children with VI in the Netherlands was reported by Houwen et al. [18]. Twenty-three children (6–12 years old) took part in the study, and there was a 2-week interval between the first and second assessments [18]. The results of the current study also reflected those of Aye and coworkers, who also found high test-retest reliability for the TGMD-2 for kindergarten children in Myanmar. They described that the ICC for all the FMS in their study was more than 0.75, which indicated high reliability in the test-retest reliability for Myanmar TDC [19].

Before measuring their performance, each participant should be familiar with the assessment procedures, as these could affect the validity and reliability of the results [39]. Children must first do familiarization trials for each skill before assessment trials, according to the TGMD-2 examiner's manual [1]. These results revealed that the TGMD-2's test-retest reliability was temporally stable despite various research populations and a short familiarization interval [14].

Additionally, 10 out of 15 studies that tested the TGMD-2's test-retest reliability were included in a recent systematic review. The TGMD-2 verified good to excellent test-retest reliability in their systematic review for the overall score, object control skills scores, and GMQ, and moderate to excellent test-retest reliability for the locomotor skills scores [14]. As a result, the TGMD-2 test-retest reliability values obtained in the current study were comparable to those found in other previous studies.

Intra-rater reliability

The degree of agreement measured by the same rater across two or more subsequent trials conducted under the same conditions is known as intra-rater reliability [14, 38]. Inter-rater reliability testing will improve measurement instrument accuracy and research conclusions [32]. For the raw scores of both locomotor

and object control, the ICC values of intra-rater reliability were higher than 0.8 and at acceptable levels in the current study. These findings were consistent with other research studies that were carried out on several study populations, including TDC, children with ID, and VI. These results of high intra-rater reliability are in line with previous studies that investigated the reliability of TGMD-2 in children with and without disabilities. High or excellent intra-rater reliability was present in each of these studies [14, 18, 19, 21].

The results of this study supported those of Houwen and colleagues, who found that the TGMD-2 had good intra-rater reliability in Dutch children with VI. They discovered that for the locomotor subtest, the intra-rater ICC value was 0.85, for the object control subtest, it was 0.93, and for the GMQ, it was 0.95 [18]. In their investigation, one month passed between the initial test and the follow-up examination, and this period was considered sufficient to reduce the examiners' bias to favor memory [18].

The results of the current study also substantially confirmed the findings of a previous study carried out in the Philippines by Capio and colleagues [21]. In the intra-rater reliability testing of 10 children with ID, they conveyed that for the locomotor subtest, the ICC was 0.99, for the GMQ, it was 0.99, and for the object control subtest, it was 0.99, all of which show high reliability [21]. The results of the current study were also in line with a previous study conducted by Aye et al. that demonstrated high reliability in the intra-rater reliability testing of 12 kindergarten children in Myanmar. They reported that the intra-rater ICC value for the locomotor subtest was 0.98, the object control subtest was 0.95, and the GMQ was 0.97 [19]. The time interval between the test and retest in their study was six weeks [19].

Additionally, the results of the current investigation supported the conclusions of another recent systematic review [14]. Six out of the 13 studies that looked into the TGMD-2's intra-rater reliability were determined by Rey and colleagues, to have good-to-excellent intra-rater reliability [14]. Since all of the studies had strong intra-rater reliability, the results of the current study were matched with those seen in previous studies for children with or without disabilities.

The limitations of the current study were that the participants came only from one special school, and only the principal investigator tested the test-retest and intra-rater reliability. As a result, future research should be carried out with larger sample size, different special schools in Myanmar, test-retest reliability assessments, and intra-rater reliability assessments of all raters.

CONCLUSION

The findings of this study support that the TGMD-2 has a high or excellent reliability for assessing the FMS proficiency of children with DS. The TGMD-2 is an appropriate and acceptable tool for evaluating the FMS of children with DS in Myanmar, it can be deduced from this study.

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Original Article

How to Conduct the Joint Replacement Surgery in Many Patients During "Happy Walk Operation Project" by New Joint for Life Foundation

Warin Prucksikanont MD[1*], Phawana Reeriang BSN[2], Supatsara Jieyjaew BSN[3]

1 *Department of orthopaedics Srisangworn Sukothai Hospital, Thailand*
2 *General surgical ward Srisangworn Sukothai Hospital, Thailand*
3 *Orthopaedics Outpatient Department Srisangworn Sukothai Hospital, Thailand*

Background: New Joint for Life Foundation (NJFL) was founded since 2014 and provided the joint replacement surgery regularly with using the project name as "Happy walk operation". In each project, many patients were recruited and underwent the joint replacement operation. So, the most important thing to concern was the safety and good outcomes of the patients.

Objectives: To review the working process, outcomes and problems that arise during the 12th and 13th happy walk operation projects at Srisangworn Sukhothai Hospital. And then took the information gathered to analyze and learn for development of the further project.

Materials and Methods: Data was collected from the 12th and 13th happy walk operation projects in 25th-27th February 2021 and 19th September 2021, respectively. The 30 patients (47 procedures) and 11 patients (16 procedures) were retrospectively reviewed from the projects, respectively. The collected data was examined using a quantitative approach descriptive-analytical design.

Results: Surgery for many patients at once like the foundation done has the benefit of reducing the waiting rate for surgery. From both projects, reducing the hospital joint replacement surgery waiting list by about 10 months. The mean age of the patients was 60.4 ± 9.1 years, 75.61%of them had underlying disease. The most common procedure was simultaneous bilateral TKA (51.2%) followed by unilateral TKA (22.0%) and unilateral THA (22.0%). One bilateral THA and one revision tibial component of TKA were performed in this study. There were no serious complications. No incidences related to patient identification. 90.48% of simultaneous bilateral total knee arthroplasty and 66.67% of total hip arthroplasty in this study required blood transfusion while in 22.22% of single total knee arthroplasty need blood transfusion. After finished surgery in one patient, it was able to start the operation in the next patient in 34.85 minutes on average.

Conclusion: The HWO project of the NJFL is the great project that helps many patients to have a better quality of life. It also gives the coordinating hospital the benefit of learning to improve their work. A successful project implementation requires good planning and patient preparation considering the patient safety.

Keywords: Happy walk operation project; Joint replacement; New joint for life foundation

*** Correspondence to**:
Warin Prucksikanont
Department of Orthopaedics Srisangworn Sukothai Hospital, 1 Moo 8, Charodwithithong road, Tambon Khlong Tan, Amphoe Sri Samrong, Sukhothai City, Thailand. 64120
Tel: (+66)081 5309010
E-mail: warinssw@gmail.com

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INTRODUCTION

New Joint for Life Foundation (NJFL) was founded since 2014 with the objective of performing hip and knee replacement surgery for patients in remote area. The NJFL was registered as a foundation in 2016. This foundation provided the joint replacement surgery regularly with using the project name as "Happy walk operation (HWO)". In the cooperation with Srisangworn Sukhothai Hospital, NJFL conducted the 12th and 13th HWO in February and November 2021, respectively.

In each HWO project, many patients were recruited and underwent the joint replacement operation. For example, 41 patients (63 joints) were enrolled in the 12th and 13th HWO projects. Most of them were elderly with the underlying diseases. When performed the joint replacement surgery in many patients like this, the most important thing was the way to keep the safety and offer the good outcomes for the patients.

Therefore, this study was conducted to review the working process, outcomes and problems that arise during the 12th and 13th HWO projects at Srisangworn Sukhothai Hospital. The study results might be beneficial for the other hospitals to improve the working process when conducting the HWO project.

The most important thing that the foundation give precedence is the good results and patient safety. For both 12th and 13th project, 41 patients were performed arthroplasty for 63 joints, and more than half of them having simultaneous bilateral total knee arthroplasty. Each project had many patients and preformed complex surgery therefore the important thing was patient safety. Careful patients' preparation had been emphasized such as ASA classification assessment, underlying disease assessment and patient's identification. Planning to prioritize patients for surgery was discussed. Elderly patients with underlying disease should be have surgery first. The patients were sorted accordingly suitable for the prepared and limited instrument. After operation, closed monitoring was done and the patients were induced to walk the day of surgery.

MATERIALS AND METHODS

This study was approved by our institutional review board. In cooperation with Srisangworn Sukhothai Hospital, Sukhothai province, the NJFL foundation conducted the 12th and 13th HWO projects in 25th-27th February 2021 and 19th September 2021, respectively. The 30 patients (47 procedures) and 11 patients (16 procedures) were retrospectively reviewed from the 12th and 13th HWO project, respectively. The working process of the project was explained as the followings;

Preoperative preparation process

The amount of available operating rooms was considered for determining the number of cases. Srisangworn hospital had 4 operating rooms. Three rooms were planned to use in the project. The remaining room was reserved for emergency patients. In 12th project, 30 patients (47 joints) were operated within 2 days. While, in 13th project, 11 patients (16 joints) were operated within 1 day.

For patients' safety, the medical comorbidities were assessed and controlled by internal medicine physicians. Laboratory investigations, echocardiogram and chest radiograph were basically evaluated in all patients. The high-risk patients had to be excluded and referred to the tertiary care hospital. The blood transfusion components and necessitous medications were prepared for all patients.

To evaluate the complexity of orthopedic condition, the orthopedists of Srisangworn hospital and NJFL collected the data from history taking, physical examination and radiographic investigations. Then, they planned together for preparing the instrumentation and prostheses. In terms of people management, the amount of staff (including orthopedists, anesthesiologists, nurses, physiotherapist, medical device company, etc.) was planned and arranged for taking care of many patients in HWO project. Furthermore, the hospital and the NJFL team were cooperated to prepare the medical equipment and sterilization process that needed to use during HWO project.

In-hospital process

In the morning one day before surgery, the staffs of Srisangworn hospital and NJFL conducted the meeting to educated the patients. Perioperative comprehension could help the patients to reduce the anxiety and encourage the postoperative rehabilitation. In the evening, when all NJFL staffs arrived, both teams had the final meeting and got to know each other. All preoperative processes were reviewed again. The prioritization of patients in each operative room was discussed and arranged according to medical comorbidities and age. Knowledge about joint replacement surgery and patient care was shared with each other [1,2].

Intraoperative process

All procedures were performed under spinal anesthesia without the use of opioid. Peripheral nerve block including adductor canal block and fascia iliaca block were done for total knee arthroplasty (TKA) and total hip arthroplasty (THA), respectively [3,4].

Prophylactic antibiotics including cefazolin or clindamycin was administrated before surgery. [5,6,7] The thigh tourniquet with a pressure of 300 mmHg was used in all knee replacement [8]. Temporary drain clamping technique combined with intravenous tranexamic acid injection were used for reducing blood loss [9,10]. Periarticular analgesic injection including ketorolac 30 mg and 0.25% bupivacaine 20 mL was performed in each patient [11,12].

Postoperative process

Postoperative pain control regimen including non-steroidal anti-inflammatory drug, paracetamol with orphenadrine, and gabapentinoid drug was prescribed in all cases [13,14]. Intravenous morphine injection was used as the rescue drug. The intermittent pneumatic compressive device was applied for venous thromboembolism (VTE) prophylaxis [15,16]. Ankle pumping exercise and ambulate training with walker under physiotherapist control were encouraged within 12 hours after operation [17]. The vacuum drain was removed at 48 hours after surgery. Postoperative hematocrit (Hct) level was measured at 24 hours after surgery. Blood transfusion was given if the Hct level was less than 30% or the compromised clinical criteria (such as, tachycardia, hypotension, or anemic symptoms) occurred. The patient was discharged to home if the following criteria were met; 1) Ambulate with walker at least 10 meters, 2) Able to upstairs and downstairs, 3) No fever, 4) Not required intravenous analgesic medication, and 5) no postoperative complications.

Outcome measurement

Patients characteristics including age, gender, weight, height, body mass index (BMI), underlying diseases, American Society of Anesthesiologist (ASA) classification and type of surgery were collected. Operative time, time interval between cases, intraoperative blood loss, drained blood loss, total blood loss, preoperative and postoperative Hct level at 24 hours after surgery, the change of Hct level, blood transfusion requirement and amount of transfusion unit, visual analogue pain score (VAPS, range 0-10) at the 1st and 3rd postoperative day, hospital stay and complications within 30 days were recorded as the perioperative outcomes.

Data processing and analysis

For statistical analysis, the continuous data were descripted as mean ± standard deviation (SD) and range. While the categorical data were described as number and percentage.

RESULTS

A total of 41 patients with 63 procedures were recruited in this study. The mean age of the patients was 60.4 ± 9.1 years. The majority of cases was female (73.2%). For the type of surgery, the most common procedure was simultaneous bilateral TKA (51.2%) followed by unilateral TKA (22.0%) and unilateral THA (22.0%). One bilateral THA and one revision tibial component of TKA were performed in this study. Patients characteristics were shown in Table 1.

Table 1. Socio-demographic (SD) characteristics of new blood donors.

Characteristics	n=41
Age (year)	60.4 ± 9.1 (38-81)
Female (%)	30 (73.2%)
Weight (kg)	62.6 ± 8.5 (45-79)
Height (cm)	157.1 ± 7.3 (150-175)
Body mass index (kg/m^2)	25.4 ± 3.2 (18.7-30.2)
Underlying diseases (%)	
None	10 (24.4%)
Hypertension alone	14 (34.0%)
Diabetes alone	0
Dyslipidemia alone	2 (4.9%)
Hypertension and diabetes	2 (4.9%)
Hypertension and dyslipidemia	8 (19.5%)
Hypertension, diabetes and dyslipidemia	5 (12.2%)
American Society of Anesthesiologist (ASA) (%)	
Class 1	8 (19.5%)
Class 2	22 (53.7%)
Class 3	11 (26.8%)
Type of surgery (%)	
Unilateral total knee arthroplasty	9 (22.0%)
Bilateral total knee arthroplasty	21 (51.2%)
Unilateral total hip arthroplasty	9 (22.0%)
Bilateral total hip arthroplasty	1 (2.4%)
Revision tibial component	1 (2.4%)

For the perioperative data, the overall mean operative time and time interval between cases were 97.3±28.5 (55-178) and 33.9±9.7 (15-60) minutes,

respectively. The details of perioperative outcomes in each type of surgery were shown in Table 2.

In unilateral TKA, the mean operative time was 71.7±14.1 minutes. The mean intraoperative and postoperative blood loss were 13.9±8.9 and 427.2±259.5 mL, respectively. The mean reduction of Hct level was 4.1±2.6% and 22.2% of patients required blood transfusion. Postoperative VAPS at the 1st and 3rd day were 2.8±0.4 and 1.7±0.9, respectively. The mean hospital stay was 7.4±1.3 days. In simultaneous bilateral TKA, the mean operative time was 104.6±26.8 minutes. The mean intraoperative and postoperative blood loss were 35.7±26.9 and 941.0±289.6 mL, respectively. The mean reduction of Hct level was 10.4±5.0 % and 90.5% of patients required blood transfusion. Postoperative VAPS at the 1st and 3rd day were 2.7±1.0 and 2.4±1.3, respectively. The mean hospital stay was 6.5±1.5 days.

In unilateral THA, the mean operative time was 99.7±22.6 minutes. The mean intraoperative and postoperative blood loss were 627.8±462.6 and 375.6±251.0 mL, respectively. The mean reduction of Hct level was 6.4±6.2 % and 66.7% of patients required blood transfusion. Postoperative VAPS at the 1st and 3rd day were 3.7±1.9 and 2.1±0.8, respectively. The mean hospital stay was 5.7±1.9 days. The perioperative outcomes of staged bilateral THA and revision tibial component cases were demonstrated in Table 2. No complications within 30 days including surgical site infection, VTE, periprosthetic fracture, stroke and myocardial infarction was found in this study.

Table 2. Perioperative outcomes in this study

Outcomes	Overall (n=41)	Unilateral TKA (n=9)	Simultaneous bilateral TKA (n=21)	Unilateral THA (n=9)	Staged bilateral THA (n=1)	Revision tibial component (n=1)
Operative time (min)	97.3 ± 28.5 (55-178)	71.7 ± 14.1 (55-95)	104.6 ± 26.8 (65-178)	99.7 ± 22.6 (62-135)	135.0 ± 56.6 (95-175)	80.0
Blood loss (ml)						
• Intraoperative blood loss	198.9 ± 350.1 (5-1500)	13.9 ± 8.9 (5-30)	35.7 ± 26.9 (10-100)	627.8 ± 462.6 (200-1,500)	900.0 ± 141.4 (800-1000)	30
• Drained blood loss	672.0 ± 375.7 (50-1440)	427.2 ± 259.5 (70-440)	941.0 ± 289.6 (380-1440)	375.6 ± 251.0 (50-880)	405.0 ± 360.6 (150-660)	430
• Total blood loss	871.0 ± 415.0 (90-1730)	441.1 ± 258.1 (90-1040)	976.7 ± 296.3 (390-1460)	1003.3 ± 511.8 (250-1730)	2610	460
Hct level (%)						
• Preoperative	38.4 ± 4.1 (29.9-45.5)	37.9 ± 4.1 (29.9-43.6)	37.6 ± 4.1 (30.1-44.1)	39.2 ± 4.2 (33.3-45.3)	42.8 ± 3.9 (40-45.5)	43
• At 24 hours	30.5 ± 5.6 (20-44.2)	33.8 ± 4.4 (27-40)	27.3 ± 3.6 (20-36)	32.9 ± 6.3 (25.7-44.2)	33.5 ± 9.2 (27-40)	40
• Change of Hct	7.9 ± 5.4 (0.6-20.7)	4.1 ± 2.6 (1.7-7.2)	10.4 ± 5.0 (0.6-20.7)	6.4 ± 6.2 (0.6-14.2)	9.3 ± 5.3 (5.5-13)	3
Blood transfusion						
• Number of patients (%)	28 (68.3%)	2 (22.2%)	19 (90.5%)	6 (66.7%)	1 (100.0%)	0 (0.0%)
• Amount (unit)	1.3 ± 1.3 (0-7)	0.3 ± 0.7 (0-2)	1.6 ± 0.9 (0-3)	1.0 ± 0.9 (0-2)	4.0 ± 4.2 (1-7)	0
VAPS (score)						
• Day 1	3.0 ± 1.2 (1-7)	2.8 ± 0.4 (1-3)	2.7 ± 1.0 (1-5)	3.7 ± 1.9 (2-7)	2.5 ± 0.7 (2-3)	4
• Day 3	2.4 ± 1.0 (1-5)	1.7 ± 0.9 (2-3)	2.4 ± 1.3 (1-5)	2.1 ± 0.8 (1-3)	2.5 ± 0.7 (2-3)	4
Hospital stay (day)	6.8 ± 2.7 (4-20)	7.4 ± 1.3 (7-11)	6.5 ± 1.5 (4-10)	5.7 ± 1.9 (4-9)	20	4

TKA, total knee arthroplasty; THA, total hip arthroplasty; Hct, hematocrit; VAPS, visual analogue pain score

DISCUSSION

The HWO project was accomplished by the NJFL in order to deliver joint replacement surgery for many arthritic patients in remote area of Thailand. To provide the most comprehensive care to the patients, the NJFL recruited several medical professions. The public relations team visited the patients' homes before surgery. They assessed the living environment and supposed the patients' need after surgery. The nurses in outpatient's clinic and ward prepared and take care of the patients during perioperative period. The scrub nurses coordinated with medical device company organized medical equipment used during operation. The experienced anesthesiologists provided spinal anesthesia, peripheral nerve block and perioperative pain control. The experienced arthroplasty surgeons performed the well-planned surgery. Physiotherapists were involved in pre and postoperative period for training the rehabilitative program.

In our experience, there were several advantages of HWO project. First, because of systematic planning and perioperative care by multidisciplinary team, this project could provide the joint replacement operation for many patients without any complication. Second, there was knowledge sharing between NJFL and Srisangworn hospital team in the HWO project. Both teams learned together about surgical technique, anesthetic technique, working process and perioperative care. Lastly, the joint replacement for many patients in the HWO project had the indirect benefit for Srisangworn hospital in terms of reducing the waiting time for surgery. The operation for 41 patients in both projects could reduce the hospital joint replacement surgery waiting time for 10 months.

Considering on each step of process, the main focus of HWO project was patient safety. Patient preparation was the most important factor for the project success, so there was collaboration between hospital and the foundation for preoperative preparation including history taking, physical exam and investigation. These data were sent to the NJFL's anesthesiologists for reassessing and preparing the patients for surgery. In this series, the mean age of patients was 60.4±9.1 years. Approximately three-quarters of them had underlying diseases. With carefully planning, there was no serious perioperative complication in our projects. Before surgery, preoperative interactive education was conducted by orthopedists, nurses and physiotherapists. Understanding about perioperative process could reduce the anxiety and encourage the postoperative rehabilitative status of the patients.

At the day of surgery, the patient's identification was important because there were the operations on many patients. at the same time to avoid misidentify organs or misidentify sides. The name of the patient, underlying diseases, operated queue, type of procedure and surgical mark site were checked preoperatively. All data were rechecked in the operating room before starting the procedure. In our projects, no incidence of wrong patient or wrong side operation were found. When performing the operations in many patients, the management of the operating rooms and equipment were very important. To address this job, the NJFL assigned two scrub nurses as the managers who worked with the chief of Srisangworn scrub nurse. One of the managers monitored the surgery and managed patients' transferring among ward, operating room and recovery room. While the others managed the equipment and its sterilization for supporting all operative rooms. Based on our data, the mean time interval between cases was 33.9 + 9.7 minutes.

In postoperative period, the NJFL's physiotherapist encouraged all patients to walk by using walking aids at the day of surgery. Patients would see people who were able to walk well, making efforts to walk and physically do the same. Almost all patients could walk from the first day after surgery. In the 12th project, there was one patient who was unable to walk on the first day because he was bed ridding for a long time so there was muscle atrophy and weakness. Project 13th one patient was unable to walk on the first day because of benign paroxysmal positional vertigo symptoms.

In terms of blood loss and transfusion, the patient with the most blood loss was those who had bilateral staged THA, which was a difficult case. The patient was suffered from severe secondary hip osteoarthritis from avascular necrosis and steroid abused, very limited range of motion, being a bedridden and unable to get out of bed. The first surgery blood loss was 1,000 ml and another 800 ml of blood loss from the second surgery. His Hct level was reduced from 45.5% to 27.0% and required 8 units of blood transfusion. If the mentioned case is not included, from this study have shown that the surgery that requires the most blood transfusions were simultaneous bilateral TKA (90.48%,19 from 21 cases) followed by unilateral THA (66.67%,7 from 10 cases). Simultaneous bilateral TKA required an average of 1.6±0.9 units of blood transfusion while in THA required an average of 1.0±0.9 units of blood transfusion. In unilateral TKA and revision tibial component, there is minimal blood loss in most patients and do not need blood transfusion. Therefore, in simultaneous bilateral TKA, it is necessary to prepare at least 2 transfusion units

per person and in THA should prepared 1 transfusion unit per person.

In addition to the surgical care of patients, there was also a NJFL's public relations team to visit patients' homes to assess the patient's difficulty to determine if further assistance is needed. In the 12th Project, there were the patient with bilateral severe hip osteoarthritis, stuck in bed unable to pursue a career. His accommodation is a shed without walls. There for after the project, the NJFL donated money to renovate the house and make a career capital.

However, there were several problems encountered in the implementation of the project as the followings:

1. The situation of covid-19 during the project had an outbreak. The measures of the Ministry of Public Health have been strictly followed. And there was an Antigen Test Kit screening in both the NJFL and the hospital team. The reverse transcription polymerase chain reaction was checked in all patients who underwent surgery.
2. Procurement Act and government supplies management, 2017 stipulated that if the procured parcel was worth more than 500,000 baht, it had to be procured by electronic bidding. Therefore, after e-bidding the hospital had to provide equipment from the winner only. This could cause problems if there were too many patients that the winner company could not provide enough equipment, the hospital could not provide from other companies because they were against the terms.

CONCLUSION

The HWO project of the NJFL is the great project that helps many patients to have a better quality of life. It also gives the coordinating hospital the benefit of learning to improve their work. A successful project implementation requires good planning and patient preparation considering the patient safety.

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Review Article

Implications of Ergonomic Health Risks on Workers and Ergonomic Risk Assessment: A Review Study Based on Different Industry Contexts

Jishin Jayan Thrippunath[1], BTech, MTech, Myo Zin Oo[1*], MBBS, MPH, PhD, Rattanathorn Intarak[1], BSc, BPH, MSc

1 *Faculty of Public Health, St Theresa International College, Nakhon Nayok, Thailand*

Abstract

Ergonomics and health are two disciplines that have a similar emphasis on how individuals interact with their surroundings. Ergonomic health risks can have serious implications for workers, including increased risk of musculoskeletal disorders, such as back pain, tendonitis, and carpal tunnel syndrome. The objective of this review study is to review the implications of ergonomic health risks on workers based on different industry contexts and ergonomic risk assessment. Musculoskeletal diseases were found to be the most commonly reported health outcomes among industrial workers, with the highest frequency among those working in manufacturing, construction, the healthcare sector, and transportation. The prevalence of musculoskeletal disorders was found to be reduced by ergonomic interventions such workstation design and equipment modifications, it also contributes to improving the workforce's health and wellness.

Keywords: Ergonomic health risks, Ergonomic risk assessment, Musculoskeletal disorders, Work related musculoskeletal disorders, Workers

*** Correspondence to**:
Myo Zin Oo
Faculty of Public Health, St Theresa International College, Nakhon Nayok, Thailand, 26120
Tel: (+66) 65-119-3324
E-mail: dr.myozinoo@gmail.com
ORCID: 0000-0001-9980-6343

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INTRODUCTION

Ergonomics is an interdisciplinary field that studies how individuals interact with their working environment, in order to create tasks, jobs, and products that are safe, efficient, and comfortable. Ergonomics draws on several disciplines, including physiology, psychology, anthropology, engineering, and design, to comprehend the human body's potentials and constraints and how it interacts with the working environment. According to the Occupational Safety and Health Administration (OSHA), ergonomics is "the science of designing the job to fit the worker, instead of forcing the worker to fit the job" [1].

Ergonomics is important in a wide range of fields, including manufacturing, construction, healthcare, and office work. Implementing good ergonomic practices in these fields can lower the risk of musculoskeletal disorders (MSD) and other health issues, enhance productivity, and promote job satisfaction. A group of diseases known as MSD have implications on the body's joints, muscles, and bones, especially, back pain and carpal tunnel syndrome, are common among workers who perform physically demanding tasks or work in awkward or uncomfortable positions. By designing work environments and equipment to support proper posture and reduce excessive force and repetition, employers can

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help to prevent these disorders and improve the overall health and well-being of their workers. In addition, ergonomic design can improve worker productivity and efficiency by reducing fatigue and discomfort, which can help to improve overall job performance and satisfaction.

Ergonomic health risks can arise when workers are required to perform tasks that are not well-suited to their bodies or the equipment they are using. Work-related musculoskeletal disorders (WMSD) are exacerbated by a number of ergonomic health risk factors in the workplace, including (i) Repetitive tasks: Performing the same task over and over can lead to muscle fatigue and strain; (ii) Poor posture: Working in awkward positions or with poor posture can lead to muscle strain and other MSD; (iii) Forceful movements: Lifting heavy objects or performing tasks that require a lot of force can lead to injuries; (iv) Vibration: Using equipment that vibrates can lead to hand-arm vibration syndrome (HAVS) and other MSD; (v) Poorly designed workstations: Workstations that are not set up properly can lead to ergonomic problems [2].

In order to minimize physical strain and operator fatigue in workers, a study on occupational ergonomics has shown how occupational ergonomics can be integrated with activities related to the Safety, Health, and Environment pillars (including minimizing operator movement between machines and enhancing workplace design) and, as a result of this integration, possibility of achieving zero operator accidents is increased, operator safety, and morale are all improved [3].

A thorough review of various studies with an industrial focus was done among the healthcare, transportation, construction, and manufacturing industries in order to identify the implications of ergonomic health risks on workers based on different industry contexts and ergonomic risk assessment.

ERGONOMICS IN HEALTHCARE INDUSTRY

The healthcare is rigorous, entails long working hours, drawn-out procedures, constant posturing, and MSD are highly prevalent among healthcare workers [4]. In the healthcare industry, ergonomics is used to design medical equipment and procedures in a way that minimizes the risk of injury to patients and healthcare workers. For instance, hospital beds, surgical instruments, and medical imaging equipment may all be designed with ergonomics in consideration. The best practices in terms of the methodologies and approaches necessary to obtain the complete range of user needs, as well as guidance for developers on the issues to consider throughout the design and development of medical equipment, are discussed in a study on the challenge for ergonomics in the development of medical devices [5].

Most WMSD are considered to affect nurses more than any other type of healthcare professionals. Previous studies on MSD in healthcare professionals have found that nurses are disproportionately at risk (over 90%) [6, 7, 8, 9]. The work of the nursing staff is complicated, and they are under a lot of pressure to do a variety of clinical responsibilities in a short time frame. Lifting, stooping, working in uncomfortable positions, hunching over, and repeated actions are some of the most common physical demands of nursing that have been shown to raise the risk of WMSD [10]. According to several studies, the level of the medical facility, job satisfaction, workload, working hours, stress at work, physical work environment and support, physical demands of individual employees, gender, job tenure and lifestyle factors all have an impact on the increased incidence of MSD, which typically affect the neck, shoulders and lower back [11, 12, 13, 14].

The sonographers, dentists and surgeons are the other group of healthcare professionals other than nurses they also reported high rates of WMSD in upper limb body area [15, 16]. The most efficient ways to lessen upper limb work-related pain were found to be to encourage micro breaks throughout lengthy processes and to employ wider, lighter instrument handles. These ergonomics measures helped the sonographers, dentists and surgeons to reduce their pain on upper limb and help to increase their productivity [17].

ERGONOMICS IN TRANSPORTATION INDUSTRY

In the transportation industry, ergonomics is used to design vehicles and transportation systems in a way that maximizes safety and comfort for passengers and operators. This can include everything from designing ergonomic seats and controls in cars and buses to implementing ergonomic workstation layouts and adjusting the lighting and ventilation in a workspace. The health and quality of life of drivers can be significantly impacted by the transportation system's poor working conditions as well as unfavorable traffic circumstances [18]. Workplace ergonomic risk factors, such as poor posture and repeated movements, as well as psychosocial risk factors, such as a high labor demand and job dissatisfaction, can affect the health of the workers [19].

Bus drivers had the highest prevalence of WMSD in the transportation sector [20]. According to many studies on work-related musculoskeletal disorders in bus drivers, a higher number of MSD in the neck, shoulder, back,

thigh and knee areas was found [21, 22, 23]. Another study on bus drivers in the private transportation sector conducted in Brazil, knee and back ergonomic discomfort is more common among bus drivers [24]. Ergonomic work analysis process was applied in that study and several recommendations like adaptation of workstation, changing the driver's routine and doing stretches during work shifts were suggested to reduce the ergonomic discomfort thereby improving their health condition [24].

ERGONOMICS IN CONSTRUCTION INDUSTRY

Construction workers are at a high risk of injuries and illnesses due to the physically demanding nature of their work [25]. Poor ergonomics can exacerbate these risks, leading to decreased productivity and increased healthcare costs. The most major ergonomic risk factors for construction workers include awkward posture while handling jobs, force, and repetition of specific actions, including vibration. Additional ergonomic risk factors include inconvenient stable postures, muscle and tendon contact pressure, and even excessive temperatures [26].

Construction companies can lower the likelihood of illnesses and injuries occurring to their workers by implementing preventive measures into place, which will also increase their productivity and general well-being. Many construction companies have implemented ergonomic interventions to improve the safety and comfort of their workers. This can include a wide range of measures, such as:

- Providing workers with ergonomically designed personal protective equipment (PPE) such as gloves, hard helmets, and safety glasses to prevent injury
- Implementing safe lifting practices and tools to minimize the risk of back injuries
- Providing ergonomic tools and equipment with comfortable handles and grips to reduce strain on the hands and wrists
- Implementing regular breaks and rotation of tasks to reduce the risk of repetitive strain injuries
- Providing training on ergonomics and safe work practices to help workers understand and prevent ergonomic risks

Implementing ergonomic principles on-site is both unique and challenging in the dynamic and hazardous building and construction industry. As a result, there are many regulating elements that may be taken into account while adopting ergonomics and reducing the risk of ergonomic injuries on the building site. To improve ergonomics application in the workplace and lower risk factors, a number of strategies and actions can be used, such as organization training and education, ergonomic tool and machine design. These measures can be carried out through a variety of monitoring channels, including written ergonomics plans, management controls, ergonomic design issues, training and education, and communication [27].

ERGONOMICS IN MANUFACTURING INDUSTRY

MSD are common in today's manufacturing industry and affect a sizable portion of the workforce. These diseases can cause pain, discomfort, and restricted movement by affecting the body's tendons, ligaments, muscles and nerves. Occupational health issues are currently most prevalent in the European Union with WMSD [28]. Enhancing workplace productivity, health, and safety as well as lowering the prevalence of WMSD requires the implementation of ergonomic principles. Some other examples of health risks in the manufacturing industry include exposure to hazardous chemicals, noise-induced hearing loss, and slips, trips, and falls.

In response to the increased incidence of WMSD, the manufacturing sectors have started a number of projects to restructure their workplaces using ergonomic standards. This may therefore result in increased productivity and lower absenteeism. The risk factors for WMSD in the frame assembly workstation of a prominent Portuguese furniture manufacturing facility were explored and WMSD risk was decreased by redesigning the workstation based on the findings of the ergonomic assessment [29]. The findings demonstrated the importance of ergonomic interventions in reducing the physical mismatch between workers and workstations, supporting postural correction, and preventing WMSD. In a review study, the effect of the ergonomic approach in the automobile manufacturing sector was investigated and the findings showed that adding an ergonomic approach to the industrial production system can lower errors and improve manufacturing process quality [30].

ERGONOMIC RISK ASSESSMENT

An ergonomic risk assessment is a systematic evaluation of a task, environment, or system to identify potential ergonomic hazards and risks, and to develop strategies to mitigate those risks. The goal of an ergonomic risk assessment is to prevent injuries and

illnesses, and to improve the safety, comfort, and productivity of workers.

Rapid upper limb assessment (RULA) and Rapid entire body assessment (REBA) are widely used methods to assess the postural ergonomics of the workers and identify potential risks to the musculoskeletal health of workers. A technique for assessing the ergonomics of tasks requiring the use of the upper limbs is called RULA [31]. REBA, in contrast, is a technique for evaluating the ergonomics of tasks that require the use of the full body [32]. Both methods employ a scoring system to assess the likelihood of developing MSD and offer recommendations for changing the workstation to minimize those risks.

Sue Hignett and Lynn McAtamney of Nottingham Hospital in the United Kingdom developed the REBA method, which was then disseminated in 2000 [33]. The advantages of utilizing REBA are that it is cost effective, simple to use, and provides individual scores after assessing each body area [32]. Only a few of the risk factors for MSD, including inappropriate posture, load/force, coupling, and repetitive and immobile tasks, are assessed by REBA [32]. The assessment of forced postures is the primary application of the REBA method. For evaluating repetitive movements, it is not applicable.

The RULA method was developed by McAtamney and Corlett in 1993 with the objective to determine whether workers are exposed to MSD risk factors in the upper extremities while performing their jobs [34]. The RULA method has the following advantages: it may be used with software to be applied, the assessor does not need experience to use it during the observation phase for repeated actions, primarily in the upper limbs [35]. The RULA score can be automatically calculated from snapshots or digital video using computer vision and machine learning techniques, according to a study on the ergonomic risk assessment method [36]. They were able to analyze a variety of worker postures under difficult conditions that are frequently present in real-world working situations, particularly in outdoor workplaces.

CONCLUSION

The disciplines of ergonomics and health are closely related since they both studies how people and their environment interact. The relationship between ergonomics and health can be illustrated through the following measures in different industrial context:

- To prevent musculoskeletal diseases and other injuries among workers, as well as to advance their general health and wellbeing, manufacturing industry create assembly lines with ergonomically adjusted workstations, tools, and equipment.
- To minimize the risk of illnesses and injuries among healthcare workers and to enhance their health and well-being, medical equipment and procedures should be designed according to ergonomic principles, such as adjustable beds and ergonomic surgical instruments.
- To create comfortable, ergonomic seats and controls for their vehicles, such as cars and buses, in order to reduce accidents and advance the health and comfort of both drivers and passengers.
- To make lifting techniques and the use of ergonomic principles on tools and jobs possible for the construction industry in order to reduce accidents and promote health.

Overall, the relationship between ergonomics and health is one of mutual support and enhancement. The health and well-being of those who utilize products, systems, and surroundings can be improved by designing them with the best ergonomics practicable. Employers must apply ergonomic interventions to reduce these risks, including modifying workstations and equipment, offering ergonomic training, and promoting frequent breaks and stretching. In order to detect and resolve potential risk concerns in the workplace, employers can also undertake ergonomic assessments. By resolving ergonomic issues, employers can increase overall productivity, reduce costs related to absenteeism and lost productivity, and protect the health and well-being of their employees.

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Original Article

How to Conduct the Joint Replacement Surgery in Many Patients During "Happy Walk Operation Project" by New Joint for Life Foundation

Warin Prucksikanont MD[1*], Phawana Reeriang BSN[2], Supatsara Jieyjaew BSN[3]

1 *Department of orthopaedics Srisangworn Sukothai Hospital, Thailand*
2 *General surgical ward Srisangworn Sukothai Hospital, Thailand*
3 *Orthopaedics Outpatient Department Srisangworn Sukothai Hospital, Thailand*

Background: New Joint for Life Foundation (NJFL) was founded since 2014 and provided the joint replacement surgery regularly with using the project name as "Happy walk operation". In each project, many patients were recruited and underwent the joint replacement operation. So, the most important thing to concern was the safety and good outcomes of the patients.

Objectives: To review the working process, outcomes and problems that arise during the 12th and 13th happy walk operation projects at Srisangworn Sukhothai Hospital. And then took the information gathered to analyze and learn for development of the further project.

Materials and Methods: Data was collected from the 12th and 13th happy walk operation projects in 25th-27th February 2021 and 19th September 2021, respectively. The 30 patients (47 procedures) and 11 patients (16 procedures) were retrospectively reviewed from the projects, respectively. The collected data was examined using a quantitative approach descriptive-analytical design.

Results: Surgery for many patients at once like the foundation done has the benefit of reducing the waiting rate for surgery. From both projects, reducing the hospital joint replacement surgery waiting list by about 10 months. The mean age of the patients was 60.4 ± 9.1 years, 75.61%of them had underlying disease. The most common procedure was simultaneous bilateral TKA (51.2%) followed by unilateral TKA (22.0%) and unilateral THA (22.0%). One bilateral THA and one revision tibial component of TKA were performed in this study. There were no serious complications. No incidences related to patient identification. 90.48% of simultaneous bilateral total knee arthroplasty and 66.67% of total hip arthroplasty in this study required blood transfusion while in 22.22% of single total knee arthroplasty need blood transfusion. After finished surgery in one patient, it was able to start the operation in the next patient in 34.85 minutes on average.

Conclusion: The HWO project of the NJFL is the great project that helps many patients to have a better quality of life. It also gives the coordinating hospital the benefit of learning to improve their work. A successful project implementation requires good planning and patient preparation considering the patient safety.

Keywords: Happy walk operation project; Joint replacement; New joint for life foundation

*** Correspondence to**:
Warin Prucksikanont
Department of Orthopaedics Srisangworn Sukothai Hospital, 1 Moo 8, Charodwithithong road, Tambon Khlong Tan, Amphoe Sri Samrong, Sukhothai City, Thailand. 64120
Tel: (+66)081 5309010
E-mail: warinssw@gmail.com

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INTRODUCTION

New Joint for Life Foundation (NJFL) was founded since 2014 with the objective of performing hip and knee replacement surgery for patients in remote area. The NJFL was registered as a foundation in 2016. This foundation provided the joint replacement surgery regularly with using the project name as "Happy walk operation (HWO)". In the cooperation with Srisangworn Sukhothai Hospital, NJFL conducted the 12th and 13th HWO in February and November 2021, respectively.

In each HWO project, many patients were recruited and underwent the joint replacement operation. For example, 41 patients (63 joints) were enrolled in the 12th and 13th HWO projects. Most of them were elderly with the underlying diseases. When performed the joint replacement surgery in many patients like this, the most important thing was the way to keep the safety and offer the good outcomes for the patients.

Therefore, this study was conducted to review the working process, outcomes and problems that arise during the 12th and 13th HWO projects at Srisangworn Sukhothai Hospital. The study results might be beneficial for the other hospitals to improve the working process when conducting the HWO project.

The most important thing that the foundation give precedence is the good results and patient safety. For both 12th and 13th project, 41 patients were performed arthroplasty for 63 joints, and more than half of them having simultaneous bilateral total knee arthroplasty. Each project had many patients and preformed complex surgery therefore the important thing was patient safety. Careful patients' preparation had been emphasized such as ASA classification assessment, underlying disease assessment and patient's identification. Planning to prioritize patients for surgery was discussed. Elderly patients with underlying disease should be have surgery first. The patients were sorted accordingly suitable for the prepared and limited instrument. After operation, closed monitoring was done and the patients were induced to walk the day of surgery.

MATERIALS AND METHODS

This study was approved by our institutional review board. In cooperation with Srisangworn Sukhothai Hospital, Sukhothai province, the NJFL foundation conducted the 12th and 13th HWO projects in 25th-27th February 2021 and 19th September 2021, respectively. The 30 patients (47 procedures) and 11 patients (16 procedures) were retrospectively reviewed from the 12th and 13th HWO project, respectively. The working process of the project was explained as the followings;

Preoperative preparation process

The amount of available operating rooms was considered for determining the number of cases. Srisangworn hospital had 4 operating rooms. Three rooms were planned to use in the project. The remaining room was reserved for emergency patients. In 12th project, 30 patients (47 joints) were operated within 2 days. While, in 13th project, 11 patients (16 joints) were operated within 1 day.

For patients' safety, the medical comorbidities were assessed and controlled by internal medicine physicians. Laboratory investigations, echocardiogram and chest radiograph were basically evaluated in all patients. The high-risk patients had to be excluded and referred to the tertiary care hospital. The blood transfusion components and necessitous medications were prepared for all patients.

To evaluate the complexity of orthopedic condition, the orthopedists of Srisangworn hospital and NJFL collected the data from history taking, physical examination and radiographic investigations. Then, they planned together for preparing the instrumentation and prostheses. In terms of people management, the amount of staff (including orthopedists, anesthesiologists, nurses, physiotherapist, medical device company, etc.) was planned and arranged for taking care of many patients in HWO project. Furthermore, the hospital and the NJFL team were cooperated to prepare the medical equipment and sterilization process that needed to use during HWO project.

In-hospital process

In the morning one day before surgery, the staffs of Srisangworn hospital and NJFL conducted the meeting to educated the patients. Perioperative comprehension could help the patients to reduce the anxiety and encourage the postoperative rehabilitation. In the evening, when all NJFL staffs arrived, both teams had the final meeting and got to know each other. All preoperative processes were reviewed again. The prioritization of patients in each operative room was discussed and arranged according to medical comorbidities and age. Knowledge about joint replacement surgery and patient care was shared with each other [1,2].

Intraoperative process

All procedures were performed under spinal anesthesia without the use of opioid. Peripheral nerve block including adductor canal block and fascia iliaca block were done for total knee arthroplasty (TKA) and total hip arthroplasty (THA), respectively [3,4].

Prophylactic antibiotics including cefazolin or clindamycin was administrated before surgery. [5,6,7] The thigh tourniquet with a pressure of 300 mmHg was used in all knee replacement [8]. Temporary drain clamping technique combined with intravenous tranexamic acid injection were used for reducing blood loss [9,10]. Periarticular analgesic injection including ketorolac 30 mg and 0.25% bupivacaine 20 mL was performed in each patient [11,12].

Postoperative process

Postoperative pain control regimen including non-steroidal anti-inflammatory drug, paracetamol with orphenadrine, and gabapentinoid drug was prescribed in all cases [13,14]. Intravenous morphine injection was used as the rescue drug. The intermittent pneumatic compressive device was applied for venous thromboembolism (VTE) prophylaxis [15,16]. Ankle pumping exercise and ambulate training with walker under physiotherapist control were encouraged within 12 hours after operation [17]. The vacuum drain was removed at 48 hours after surgery. Postoperative hematocrit (Hct) level was measured at 24 hours after surgery. Blood transfusion was given if the Hct level was less than 30% or the compromised clinical criteria (such as, tachycardia, hypotension, or anemic symptoms) occurred. The patient was discharged to home if the following criteria were met; 1) Ambulate with walker at least 10 meters, 2) Able to upstairs and downstairs, 3) No fever, 4) Not required intravenous analgesic medication, and 5) no postoperative complications.

Outcome measurement

Patients characteristics including age, gender, weight, height, body mass index (BMI), underlying diseases, American Society of Anesthesiologist (ASA) classification and type of surgery were collected. Operative time, time interval between cases, intraoperative blood loss, drained blood loss, total blood loss, preoperative and postoperative Hct level at 24 hours after surgery, the change of Hct level, blood transfusion requirement and amount of transfusion unit, visual analogue pain score (VAPS, range 0-10) at the 1st and 3rd postoperative day, hospital stay and complications within 30 days were recorded as the perioperative outcomes.

Data processing and analysis

For statistical analysis, the continuous data were descripted as mean ± standard deviation (SD) and range. While the categorical data were described as number and percentage.

RESULTS

A total of 41 patients with 63 procedures were recruited in this study. The mean age of the patients was 60.4 ± 9.1 years. The majority of cases was female (73.2%). For the type of surgery, the most common procedure was simultaneous bilateral TKA (51.2%) followed by unilateral TKA (22.0%) and unilateral THA (22.0%). One bilateral THA and one revision tibial component of TKA were performed in this study. Patients characteristics were shown in Table 1.

Table 1. Socio-demographic (SD) characteristics of new blood donors.

Characteristics	n=41
Age (year)	60.4 ± 9.1 (38-81)
Female (%)	30 (73.2%)
Weight (kg)	62.6 ± 8.5 (45-79)
Height (cm)	157.1 ± 7.3 (150-175)
Body mass index (kg/m^2)	25.4 ± 3.2 (18.7-30.2)
Underlying diseases (%)	
None	10 (24.4%)
Hypertension alone	14 (34.0%)
Diabetes alone	0
Dyslipidemia alone	2 (4.9%)
Hypertension and diabetes	2 (4.9%)
Hypertension and dyslipidemia	8 (19.5%)
Hypertension, diabetes and dyslipidemia	5 (12.2%)
American Society of Anesthesiologist (ASA) (%)	
Class 1	8 (19.5%)
Class 2	22 (53.7%)
Class 3	11 (26.8%)
Type of surgery (%)	
Unilateral total knee arthroplasty	9 (22.0%)
Bilateral total knee arthroplasty	21 (51.2%)
Unilateral total hip arthroplasty	9 (22.0%)
Bilateral total hip arthroplasty	1 (2.4%)
Revision tibial component	1 (2.4%)

For the perioperative data, the overall mean operative time and time interval between cases were 97.3±28.5 (55-178) and 33.9±9.7 (15-60) minutes,

respectively. The details of perioperative outcomes in each type of surgery were shown in Table 2.

In unilateral TKA, the mean operative time was 71.7±14.1 minutes. The mean intraoperative and postoperative blood loss were 13.9±8.9 and 427.2±259.5 mL, respectively. The mean reduction of Hct level was 4.1±2.6% and 22.2% of patients required blood transfusion. Postoperative VAPS at the 1st and 3rd day were 2.8±0.4 and 1.7±0.9, respectively. The mean hospital stay was 7.4±1.3 days. In simultaneous bilateral TKA, the mean operative time was 104.6±26.8 minutes. The mean intraoperative and postoperative blood loss were 35.7±26.9 and 941.0±289.6 mL, respectively. The mean reduction of Hct level was 10.4±5.0 % and 90.5% of patients required blood transfusion. Postoperative VAPS at the 1st and 3rd day were 2.7±1.0 and 2.4±1.3, respectively. The mean hospital stay was 6.5±1.5 days.

In unilateral THA, the mean operative time was 99.7±22.6 minutes. The mean intraoperative and postoperative blood loss were 627.8±462.6 and 375.6±251.0 mL, respectively. The mean reduction of Hct level was 6.4±6.2 % and 66.7% of patients required blood transfusion. Postoperative VAPS at the 1st and 3rd day were 3.7±1.9 and 2.1±0.8, respectively. The mean hospital stay was 5.7±1.9 days. The perioperative outcomes of staged bilateral THA and revision tibial component cases were demonstrated in Table 2. No complications within 30 days including surgical site infection, VTE, periprosthetic fracture, stroke and myocardial infarction was found in this study.

Table 2. Perioperative outcomes in this study

Outcomes	Overall (n=41)	Unilateral TKA (n=9)	Simultaneous bilateral TKA (n=21)	Unilateral THA (n=9)	Staged bilateral THA (n=1)	Revision tibial component (n=1)
Operative time (min)	97.3 ± 28.5 (55-178)	71.7 ± 14.1 (55-95)	104.6 ± 26.8 (65-178)	99.7 ± 22.6 (62-135)	135.0 ± 56.6 (95-175)	80.0
Blood loss (ml)						
• Intraoperative blood loss	198.9 ± 350.1 (5-1500)	13.9 ± 8.9 (5-30)	35.7 ± 26.9 (10-100)	627.8 ± 462.6 (200-1,500)	900.0 ± 141.4 (800-1000)	30
• Drained blood loss	672.0 ± 375.7 (50-1440)	427.2 ± 259.5 (70-440)	941.0 ± 289.6 (380-1440)	375.6 ± 251.0 (50-880)	405.0 ± 360.6 (150-660)	430
• Total blood loss	871.0 ± 415.0 (90-1730)	441.1 ± 258.1 (90-1040)	976.7 ± 296.3 (390-1460)	1003.3 ± 511.8 (250-1730)	2610	460
Hct level (%)						
• Preoperative	38.4 ± 4.1 (29.9-45.5)	37.9 ± 4.1 (29.9-43.6)	37.6 ± 4.1 (30.1-44.1)	39.2 ± 4.2 (33.3-45.3)	42.8 ± 3.9 (40-45.5)	43
• At 24 hours	30.5 ± 5.6 (20-44.2)	33.8 ± 4.4 (27-40)	27.3 ± 3.6 (20-36)	32.9 ± 6.3 (25.7-44.2)	33.5 ± 9.2 (27-40)	40
• Change of Hct	7.9 ± 5.4 (0.6-20.7)	4.1 ± 2.6 (1.7-7.2)	10.4 ± 5.0 (0.6-20.7)	6.4 ± 6.2 (0.6-14.2)	9.3 ± 5.3 (5.5-13)	3
Blood transfusion						
• Number of patients (%)	28 (68.3%)	2 (22.2%)	19 (90.5%)	6 (66.7%)	1 (100.0%)	0 (0.0%)
• Amount (unit)	1.3 ± 1.3 (0-7)	0.3 ± 0.7 (0-2)	1.6 ± 0.9 (0-3)	1.0 ± 0.9 (0-2)	4.0 ± 4.2 (1-7)	0
VAPS (score)						
• Day 1	3.0 ± 1.2 (1-7)	2.8 ± 0.4 (1-3)	2.7 ± 1.0 (1-5)	3.7 ± 1.9 (2-7)	2.5 ± 0.7 (2-3)	4
• Day 3	2.4 ± 1.0 (1-5)	1.7 ± 0.9 (2-3)	2.4 ± 1.3 (1-5)	2.1 ± 0.8 (1-3)	2.5 ± 0.7 (2-3)	4
Hospital stay (day)	6.8 ± 2.7 (4-20)	7.4 ± 1.3 (7-11)	6.5 ± 1.5 (4-10)	5.7 ± 1.9 (4-9)	20	4

TKA, total knee arthroplasty; THA, total hip arthroplasty; Hct, hematocrit; VAPS, visual analogue pain score

DISCUSSION

The HWO project was accomplished by the NJFL in order to deliver joint replacement surgery for many arthritic patients in remote area of Thailand. To provide the most comprehensive care to the patients, the NJFL recruited several medical professions. The public relations team visited the patients' homes before surgery. They assessed the living environment and supposed the patients' need after surgery. The nurses in outpatient's clinic and ward prepared and take care of the patients during perioperative period. The scrub nurses coordinated with medical device company organized medical equipment used during operation. The experienced anesthesiologists provided spinal anesthesia, peripheral nerve block and perioperative pain control. The experienced arthroplasty surgeons performed the well-planned surgery. Physiotherapists were involved in pre and postoperative period for training the rehabilitative program.

In our experience, there were several advantages of HWO project. First, because of systematic planning and perioperative care by multidisciplinary team, this project could provide the joint replacement operation for many patients without any complication. Second, there was knowledge sharing between NJFL and Srisangworn hospital team in the HWO project. Both teams learned together about surgical technique, anesthetic technique, working process and perioperative care. Lastly, the joint replacement for many patients in the HWO project had the indirect benefit for Srisangworn hospital in terms of reducing the waiting time for surgery. The operation for 41 patients in both projects could reduce the hospital joint replacement surgery waiting time for 10 months.

Considering on each step of process, the main focus of HWO project was patient safety. Patient preparation was the most important factor for the project success, so there was collaboration between hospital and the foundation for preoperative preparation including history taking, physical exam and investigation. These data were sent to the NJFL's anesthesiologists for reassessing and preparing the patients for surgery. In this series, the mean age of patients was 60.4±9.1 years. Approximately three-quarters of them had underlying diseases. With carefully planning, there was no serious perioperative complication in our projects. Before surgery, preoperative interactive education was conducted by orthopedists, nurses and physiotherapists. Understanding about perioperative process could reduce the anxiety and encourage the postoperative rehabilitative status of the patients.

At the day of surgery, the patient's identification was important because there were the operations on many patients. at the same time to avoid misidentify organs or misidentify sides. The name of the patient, underlying diseases, operated queue, type of procedure and surgical mark site were checked preoperatively. All data were rechecked in the operating room before starting the procedure. In our projects, no incidence of wrong patient or wrong side operation were found. When performing the operations in many patients, the management of the operating rooms and equipment were very important. To address this job, the NJFL assigned two scrub nurses as the managers who worked with the chief of Srisangworn scrub nurse. One of the managers monitored the surgery and managed patients' transferring among ward, operating room and recovery room. While the others managed the equipment and its sterilization for supporting all operative rooms. Based on our data, the mean time interval between cases was 33.9 + 9.7 minutes.

In postoperative period, the NJFL's physiotherapist encouraged all patients to walk by using walking aids at the day of surgery. Patients would see people who were able to walk well, making efforts to walk and physically do the same. Almost all patients could walk from the first day after surgery. In the 12th project, there was one patient who was unable to walk on the first day because he was bed ridding for a long time so there was muscle atrophy and weakness. Project 13th one patient was unable to walk on the first day because of benign paroxysmal positional vertigo symptoms.

In terms of blood loss and transfusion, the patient with the most blood loss was those who had bilateral staged THA, which was a difficult case. The patient was suffered from severe secondary hip osteoarthritis from avascular necrosis and steroid abused, very limited range of motion, being a bedridden and unable to get out of bed. The first surgery blood loss was 1,000 ml and another 800 ml of blood loss from the second surgery. His Hct level was reduced from 45.5% to 27.0% and required 8 units of blood transfusion. If the mentioned case is not included, from this study have shown that the surgery that requires the most blood transfusions were simultaneous bilateral TKA (90.48%,19 from 21 cases) followed by unilateral THA (66.67%,7 from 10 cases). Simultaneous bilateral TKA required an average of 1.6±0.9 units of blood transfusion while in THA required an average of 1.0±0.9 units of blood transfusion. In unilateral TKA and revision tibial component, there is minimal blood loss in most patients and do not need blood transfusion. Therefore, in simultaneous bilateral TKA, it is necessary to prepare at least 2 transfusion units

per person and in THA should prepared 1 transfusion unit per person.

In addition to the surgical care of patients, there was also a NJFL's public relations team to visit patients' homes to assess the patient's difficulty to determine if further assistance is needed. In the 12th Project, there were the patient with bilateral severe hip osteoarthritis, stuck in bed unable to pursue a career. His accommodation is a shed without walls. There for after the project, the NJFL donated money to renovate the house and make a career capital.

However, there were several problems encountered in the implementation of the project as the followings:

1. The situation of covid-19 during the project had an outbreak. The measures of the Ministry of Public Health have been strictly followed. And there was an Antigen Test Kit screening in both the NJFL and the hospital team. The reverse transcription polymerase chain reaction was checked in all patients who underwent surgery.
2. Procurement Act and government supplies management, 2017 stipulated that if the procured parcel was worth more than 500,000 baht, it had to be procured by electronic bidding. Therefore, after e-bidding the hospital had to provide equipment from the winner only. This could cause problems if there were too many patients that the winner company could not provide enough equipment, the hospital could not provide from other companies because they were against the terms.

CONCLUSION

The HWO project of the NJFL is the great project that helps many patients to have a better quality of life. It also gives the coordinating hospital the benefit of learning to improve their work. A successful project implementation requires good planning and patient preparation considering the patient safety.

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Review Article

Implications of Ergonomic Health Risks on Workers and Ergonomic Risk Assessment: A Review Study Based on Different Industry Contexts

Jishin Jayan Thrippunath[1], BTech, MTech, Myo Zin Oo[1*], MBBS, MPH, PhD, Rattanathorn Intarak[1], BSc, BPH, MSc

1 *Faculty of Public Health, St Theresa International College, Nakhon Nayok, Thailand*

Abstract

Ergonomics and health are two disciplines that have a similar emphasis on how individuals interact with their surroundings. Ergonomic health risks can have serious implications for workers, including increased risk of musculoskeletal disorders, such as back pain, tendonitis, and carpal tunnel syndrome. The objective of this review study is to review the implications of ergonomic health risks on workers based on different industry contexts and ergonomic risk assessment. Musculoskeletal diseases were found to be the most commonly reported health outcomes among industrial workers, with the highest frequency among those working in manufacturing, construction, the healthcare sector, and transportation. The prevalence of musculoskeletal disorders was found to be reduced by ergonomic interventions such workstation design and equipment modifications, it also contributes to improving the workforce's health and wellness.

Keywords: Ergonomic health risks, Ergonomic risk assessment, Musculoskeletal disorders, Work related musculoskeletal disorders, Workers

*** Correspondence to**:
Myo Zin Oo
Faculty of Public Health, St Theresa International College, Nakhon Nayok, Thailand, 26120
Tel: (+66) 65-119-3324
E-mail: dr.myozinoo@gmail.com
ORCID: 0000-0001-9980-6343

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INTRODUCTION

Ergonomics is an interdisciplinary field that studies how individuals interact with their working environment, in order to create tasks, jobs, and products that are safe, efficient, and comfortable. Ergonomics draws on several disciplines, including physiology, psychology, anthropology, engineering, and design, to comprehend the human body's potentials and constraints and how it interacts with the working environment. According to the Occupational Safety and Health Administration (OSHA), ergonomics is "the science of designing the job to fit the worker, instead of forcing the worker to fit the job" [1].

Ergonomics is important in a wide range of fields, including manufacturing, construction, healthcare, and office work. Implementing good ergonomic practices in these fields can lower the risk of musculoskeletal disorders (MSD) and other health issues, enhance productivity, and promote job satisfaction. A group of diseases known as MSD have implications on the body's joints, muscles, and bones, especially, back pain and carpal tunnel syndrome, are common among workers who perform physically demanding tasks or work in awkward or uncomfortable positions. By designing work environments and equipment to support proper posture and reduce excessive force and repetition, employers can

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help to prevent these disorders and improve the overall health and well-being of their workers. In addition, ergonomic design can improve worker productivity and efficiency by reducing fatigue and discomfort, which can help to improve overall job performance and satisfaction.

Ergonomic health risks can arise when workers are required to perform tasks that are not well-suited to their bodies or the equipment they are using. Work-related musculoskeletal disorders (WMSD) are exacerbated by a number of ergonomic health risk factors in the workplace, including (i) Repetitive tasks: Performing the same task over and over can lead to muscle fatigue and strain; (ii) Poor posture: Working in awkward positions or with poor posture can lead to muscle strain and other MSD; (iii) Forceful movements: Lifting heavy objects or performing tasks that require a lot of force can lead to injuries; (iv) Vibration: Using equipment that vibrates can lead to hand-arm vibration syndrome (HAVS) and other MSD; (v) Poorly designed workstations: Workstations that are not set up properly can lead to ergonomic problems [2].

In order to minimize physical strain and operator fatigue in workers, a study on occupational ergonomics has shown how occupational ergonomics can be integrated with activities related to the Safety, Health, and Environment pillars (including minimizing operator movement between machines and enhancing workplace design) and, as a result of this integration, possibility of achieving zero operator accidents is increased, operator safety, and morale are all improved [3].

A thorough review of various studies with an industrial focus was done among the healthcare, transportation, construction, and manufacturing industries in order to identify the implications of ergonomic health risks on workers based on different industry contexts and ergonomic risk assessment.

ERGONOMICS IN HEALTHCARE INDUSTRY

The healthcare is rigorous, entails long working hours, drawn-out procedures, constant posturing, and MSD are highly prevalent among healthcare workers [4]. In the healthcare industry, ergonomics is used to design medical equipment and procedures in a way that minimizes the risk of injury to patients and healthcare workers. For instance, hospital beds, surgical instruments, and medical imaging equipment may all be designed with ergonomics in consideration. The best practices in terms of the methodologies and approaches necessary to obtain the complete range of user needs, as well as guidance for developers on the issues to consider throughout the design and development of medical equipment, are discussed in a study on the challenge for ergonomics in the development of medical devices [5].

Most WMSD are considered to affect nurses more than any other type of healthcare professionals. Previous studies on MSD in healthcare professionals have found that nurses are disproportionately at risk (over 90%) [6, 7, 8, 9]. The work of the nursing staff is complicated, and they are under a lot of pressure to do a variety of clinical responsibilities in a short time frame. Lifting, stooping, working in uncomfortable positions, hunching over, and repeated actions are some of the most common physical demands of nursing that have been shown to raise the risk of WMSD [10]. According to several studies, the level of the medical facility, job satisfaction, workload, working hours, stress at work, physical work environment and support, physical demands of individual employees, gender, job tenure and lifestyle factors all have an impact on the increased incidence of MSD, which typically affect the neck, shoulders and lower back [11, 12, 13, 14].

The sonographers, dentists and surgeons are the other group of healthcare professionals other than nurses they also reported high rates of WMSD in upper limb body area [15, 16]. The most efficient ways to lessen upper limb work-related pain were found to be to encourage micro breaks throughout lengthy processes and to employ wider, lighter instrument handles. These ergonomics measures helped the sonographers, dentists and surgeons to reduce their pain on upper limb and help to increase their productivity [17].

ERGONOMICS IN TRANSPORTATION INDUSTRY

In the transportation industry, ergonomics is used to design vehicles and transportation systems in a way that maximizes safety and comfort for passengers and operators. This can include everything from designing ergonomic seats and controls in cars and buses to implementing ergonomic workstation layouts and adjusting the lighting and ventilation in a workspace. The health and quality of life of drivers can be significantly impacted by the transportation system's poor working conditions as well as unfavorable traffic circumstances [18]. Workplace ergonomic risk factors, such as poor posture and repeated movements, as well as psychosocial risk factors, such as a high labor demand and job dissatisfaction, can affect the health of the workers [19].

Bus drivers had the highest prevalence of WMSD in the transportation sector [20]. According to many studies on work-related musculoskeletal disorders in bus drivers, a higher number of MSD in the neck, shoulder, back,

thigh and knee areas was found [21, 22, 23]. Another study on bus drivers in the private transportation sector conducted in Brazil, knee and back ergonomic discomfort is more common among bus drivers [24]. Ergonomic work analysis process was applied in that study and several recommendations like adaptation of workstation, changing the driver's routine and doing stretches during work shifts were suggested to reduce the ergonomic discomfort thereby improving their health condition [24].

ERGONOMICS IN CONSTRUCTION INDUSTRY

Construction workers are at a high risk of injuries and illnesses due to the physically demanding nature of their work [25]. Poor ergonomics can exacerbate these risks, leading to decreased productivity and increased healthcare costs. The most major ergonomic risk factors for construction workers include awkward posture while handling jobs, force, and repetition of specific actions, including vibration. Additional ergonomic risk factors include inconvenient stable postures, muscle and tendon contact pressure, and even excessive temperatures [26].

Construction companies can lower the likelihood of illnesses and injuries occurring to their workers by implementing preventive measures into place, which will also increase their productivity and general well-being. Many construction companies have implemented ergonomic interventions to improve the safety and comfort of their workers. This can include a wide range of measures, such as:

- Providing workers with ergonomically designed personal protective equipment (PPE) such as gloves, hard helmets, and safety glasses to prevent injury
- Implementing safe lifting practices and tools to minimize the risk of back injuries
- Providing ergonomic tools and equipment with comfortable handles and grips to reduce strain on the hands and wrists
- Implementing regular breaks and rotation of tasks to reduce the risk of repetitive strain injuries
- Providing training on ergonomics and safe work practices to help workers understand and prevent ergonomic risks

Implementing ergonomic principles on-site is both unique and challenging in the dynamic and hazardous building and construction industry. As a result, there are many regulating elements that may be taken into account while adopting ergonomics and reducing the risk of ergonomic injuries on the building site. To improve ergonomics application in the workplace and lower risk factors, a number of strategies and actions can be used, such as organization training and education, ergonomic tool and machine design. These measures can be carried out through a variety of monitoring channels, including written ergonomics plans, management controls, ergonomic design issues, training and education, and communication [27].

ERGONOMICS IN MANUFACTURING INDUSTRY

MSD are common in today's manufacturing industry and affect a sizable portion of the workforce. These diseases can cause pain, discomfort, and restricted movement by affecting the body's tendons, ligaments, muscles and nerves. Occupational health issues are currently most prevalent in the European Union with WMSD [28]. Enhancing workplace productivity, health, and safety as well as lowering the prevalence of WMSD requires the implementation of ergonomic principles. Some other examples of health risks in the manufacturing industry include exposure to hazardous chemicals, noise-induced hearing loss, and slips, trips, and falls.

In response to the increased incidence of WMSD, the manufacturing sectors have started a number of projects to restructure their workplaces using ergonomic standards. This may therefore result in increased productivity and lower absenteeism. The risk factors for WMSD in the frame assembly workstation of a prominent Portuguese furniture manufacturing facility were explored and WMSD risk was decreased by redesigning the workstation based on the findings of the ergonomic assessment [29]. The findings demonstrated the importance of ergonomic interventions in reducing the physical mismatch between workers and workstations, supporting postural correction, and preventing WMSD. In a review study, the effect of the ergonomic approach in the automobile manufacturing sector was investigated and the findings showed that adding an ergonomic approach to the industrial production system can lower errors and improve manufacturing process quality [30].

ERGONOMIC RISK ASSESSMENT

An ergonomic risk assessment is a systematic evaluation of a task, environment, or system to identify potential ergonomic hazards and risks, and to develop strategies to mitigate those risks. The goal of an ergonomic risk assessment is to prevent injuries and

illnesses, and to improve the safety, comfort, and productivity of workers.

Rapid upper limb assessment (RULA) and Rapid entire body assessment (REBA) are widely used methods to assess the postural ergonomics of the workers and identify potential risks to the musculoskeletal health of workers. A technique for assessing the ergonomics of tasks requiring the use of the upper limbs is called RULA [31]. REBA, in contrast, is a technique for evaluating the ergonomics of tasks that require the use of the full body [32]. Both methods employ a scoring system to assess the likelihood of developing MSD and offer recommendations for changing the workstation to minimize those risks.

Sue Hignett and Lynn McAtamney of Nottingham Hospital in the United Kingdom developed the REBA method, which was then disseminated in 2000 [33]. The advantages of utilizing REBA are that it is cost effective, simple to use, and provides individual scores after assessing each body area [32]. Only a few of the risk factors for MSD, including inappropriate posture, load/force, coupling, and repetitive and immobile tasks, are assessed by REBA [32]. The assessment of forced postures is the primary application of the REBA method. For evaluating repetitive movements, it is not applicable.

The RULA method was developed by McAtamney and Corlett in 1993 with the objective to determine whether workers are exposed to MSD risk factors in the upper extremities while performing their jobs [34]. The RULA method has the following advantages: it may be used with software to be applied, the assessor does not need experience to use it during the observation phase for repeated actions, primarily in the upper limbs [35]. The RULA score can be automatically calculated from snapshots or digital video using computer vision and machine learning techniques, according to a study on the ergonomic risk assessment method [36]. They were able to analyze a variety of worker postures under difficult conditions that are frequently present in real-world working situations, particularly in outdoor workplaces.

CONCLUSION

The disciplines of ergonomics and health are closely related since they both studies how people and their environment interact. The relationship between ergonomics and health can be illustrated through the following measures in different industrial context:

- To prevent musculoskeletal diseases and other injuries among workers, as well as to advance their general health and wellbeing, manufacturing industry create assembly lines with ergonomically adjusted workstations, tools, and equipment.
- To minimize the risk of illnesses and injuries among healthcare workers and to enhance their health and well-being, medical equipment and procedures should be designed according to ergonomic principles, such as adjustable beds and ergonomic surgical instruments.
- To create comfortable, ergonomic seats and controls for their vehicles, such as cars and buses, in order to reduce accidents and advance the health and comfort of both drivers and passengers.
- To make lifting techniques and the use of ergonomic principles on tools and jobs possible for the construction industry in order to reduce accidents and promote health.

Overall, the relationship between ergonomics and health is one of mutual support and enhancement. The health and well-being of those who utilize products, systems, and surroundings can be improved by designing them with the best ergonomics practicable. Employers must apply ergonomic interventions to reduce these risks, including modifying workstations and equipment, offering ergonomic training, and promoting frequent breaks and stretching. In order to detect and resolve potential risk concerns in the workplace, employers can also undertake ergonomic assessments. By resolving ergonomic issues, employers can increase overall productivity, reduce costs related to absenteeism and lost productivity, and protect the health and well-being of their employees.

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