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Industrial Noise Measurement and Noise Contour Mapping: A Case Study in Power Plant, Rayong Province, Thailand

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ABSTRACT

Introduction: This study aimed to assess the noise level in a working environment and to illustrate noise contour maps to define areas for wearing personal protective equipment in the electricity production process of the power plant in Rayong province.

Methods: The measurement of noise levels was divided into all areas, a total of 1,700 points, using the sound level meter model NL-42EX (Class2) standardized by IEC61672 Type2, ANSI S1.4, JISC1509-1. Then, the results were illustrated to create the noise contour map and define areas for wearing personal protective equipment.

Results: Compared to the standard noise levels that allowed employees to average receive throughout a day's work in 2018 from the Department of Labor Protection and Welfare, 45 points were detected over the standard level at 85 dB(A) (2.5 %) at the areas of machinery works continuously, steam turbines, gas turbines, steam generators, etc. Protective equipment and measures must be implemented for electricity production workers. To prevent hearing impairment, one should initially wear personal protective equipment, which can reduce noise exposure by Ear Muff. The derated NRR is 24 dB(A), and the sound level of the employee when wearing an ear muff is 65.7 dB(A), which is a safe sound level.

Conclusion: Additionally, a hearing conservation program should be implemented to comply with the legislation and reduce risks to employees' hearing performance.

Keywords: Noise Measurement, Noise contour mapping, Power plant

Introduction

Noise is one harmful factor humans must experience in their daily lives and is important for living life because noise is essential for communication between humans, but touching a very loud sound over a long time, especially loud noises from construction work or noise from production processes in industrial plants, causes hearing loss [1] or a reduced ability to hear sounds compared to people with normal hearing [2]. It may cause accidents at work. This is because loud noise causes changes in personal behavior. For example, some people may feel slow to respond to various signals. It also disrupts communication. This causes the operator not to hear the danger signal that is loud enough to cause an accident. Exposure to loud noises that exceed legal standards for an excessively long time may cause a chance of hearing impairment, both temporary and permanent. In addition, noise affects the human ability to perceive high-frequency sounds. That means that audio masking in the workplace causes people to hear sounds but not effectively comprehend what others are saying during conversations. Interrupted conversations can affect workplace performance [3, 4].

According to the World Health Organization (WHO) estimates, roughly 16 percent of the world's population is deafened due to workplace noise exposure [4, 5]. Noise exposure is the leading cause of preventable hearing loss [4]. In Asia's manufacturing industry, noise-induced hearing loss (NIHL) is one of the most prevalent forms of workplace damage [5]. Prevention is crucial because NIHL is a sedentary disease that cannot be cured [6]. NIHL because noise happens while the noise intensity could be excessive, which results in mechanical harm to the cochlea [7]. The ordinary human ear and frightening system have their maximum quantity to accept and comprehend the sound level [8]. NIOSH suggests an excessive noise limit of 85 dB(A), depending on a time-weighted average of eight hours (8-hr TWA). Noise levels of this magnitude and above are deemed dangerous [9]. The Minister of Labour Protection and Welfare announced the subject of calculating the sound level felt in the ear when wearing personal safety equipment in 2018 [10].

In this case, the power plant uses noisy machines in its power plant process. Specialized machinery and equipment are gas turbines, steam turbines, and generator issues in processes. If such equipment is not maintained properly, it will generate dangerous noise within the workplace [11]. A secure and healthy place of work is crucial for workers. In current operating conditions, most manufacturing workers do not care about noise exposure, which may show their unwillingness to use hearing protection [12]. Hearing loss due to noise exposure and other physical aberrations can be avoided by reducing noise exposure in the workplace and improving noise-protection protocols. Workers exposed to noise must use proper earplugs or earmuffs [13]. The greatest method to increase the operation's quality while lowering the chance of an accident is to take safety management seriously. Although most risks and hazards can be avoided by employing accessible procedures, accidents can still occur due to a lack of understanding on the part of the personnel. Most accidents in business are caused by unsafe labor and working conditions [14].

Therefore, noise exposure is necessary to discuss in this research. In addition, it is based on the exposure length that exceeds the National Institute for Occupational Safety and Health (NIOSH) standard, which is 8 hours per day of exposure for a noise level of 85 dB(A). The purpose of this study was to investigate the noise levels that were present in the kernel recovery station during the power plant process. This study also shows the noise contour mapping of the measurement location to figure out how the noise is spread out.

Methodology

Study Design

A cross-sectional study was applied. Data were collected by measuring the process of power plants in all areas in Rayong Province of Thailand, collecting data between July and September 2023.

Tools and Equipment

By using sound level measurements were conducted in all areas. By measuring all 1,700 sound points, approximately an area of 55,500 m2 (Grid area 5x5 meter). Using the sound level meter model NL-42 EX (Class 2) standardized. Able to be detected during 25 to 141 dB, standard body IEC 61672 Type 2, ANSI S1.4, JISC 1509-1 and using sound calibrator model NC-74 IEC60942 standardized measure according to the criteria the announcement of the Department of Labor Protection and Welfare, Thailand on criteria and measurement methods and analysis of working conditions regarding levels of heat, light, or noise, including the duration and type of work that must be carried out B.E.2018.

Surfer software program version 12 was conducted by analyzing grid data based on a colored map of noise contours, in which safe, cautious, and dangerous areas were identified, with the last area requiring noise control measures.

Methods

The preliminary site survey was a survey of the working area of the power plant. To collect basic information by walking around and observing the work area in which employees may be exposed to loud noise, the nature of the loud noise, and the duration of exposure and selecting a measurement tool for convenience in recording data and planning measurement points. The researcher prepared a power plant diagram and the accompanying production process. To set the measurement points from the power plant process area. A grid was created to determine the distance from the measurement point by setting a grid of 5x5 meters per channel, as this was an area where no machines could work. A total of 1,700 were measurement points throughout the region.

Noise levels were measured using a sound levels meter. Carry out monitoring of the 5 minutes average (LAeq 5 minutes), maximum sound level (LAmax), and minimum sound level (LAmin) using the Integrated Sound Level Meter, a type 2 sound level standard required by IEC international standards 61672, before measuring, it was calibrated and rechecked for accuracy with a Sound Level Calibrator at a standard sound level of 94.0 dB, work areas that were monitored for sound level were divided to map the sound level lines. (Noise Contour Map) into a size of 5x5 meters.

Collecting the data obtained from each measurement point into the computer program SURFER Software Version 12. After measuring the sound level, the program displayed a map of the noise level in different ranges (Noise Contour Map). The information from all the analyses was then developed into a plan showing the noise levels in the power process, which could then be evaluated to determine measures to reduce and prevent noise levels.

Results

Noise measurement

After measuring 1,700 points, it was found that the noise ranges were 60.1 - 96.7 dB(A). Preparing a noise contour mapping could show the characteristics of the noise distribution in each area and be used for noise management plan development. The information could control the sound level and warning signs to be aware of the danger of noise hazards in each area, whereas a major source of noise, including steam turbine generators (STG), gas turbine generators (GTG), combustion inlet filter houses, the exhaust stack of heat recovery steam generator (HRSG), and cooling tower. This result found the top three of the lowest average noise, 60.1, 65.2, and 68.4 dB(A), in the non-process area, workshop, and water treatment process, respectively. In contrast, the highest averages, 95.2, 96.1, and 96.7 dB(A), were found at steam turbine generators No.1 and 2 and gas turbine generators, respectively (Table 1).

Table 1 Noise measuring results in the power plant process.

Area	Measurement points	Min. level of noise (dB(A))	Max. level of noise (dB(A))	Results	
				Meet the measurement points (%)	**Not meet the measurement points (%)**
Power Plant Process	1,700	60.1	96.7	1,655 (97.35)	45 (2.65)

Noise contour mapping

With the information on spatial variations and an understanding of noise distribution in power plant processes, we found that the noise risk zone (NRZ) criteria values on the map correlated with NRZ criteria (Table 2).

Noise measurements were used to create noise contour maps in loud areas of the power plant process area. Maps with information showing the sound levels were created using the software program SURFER Version12 (Figure 1, 2). Areas in green, light green, blue, purple, and light purple represent noise levels below the Threshold Limit Value (TLV), indicating safe zones, whereas the yellow, orange, and red areas exceed this threshold [17].

Figure 1 Noise Contour Mapping in power plant process

Figure 2 Noise Contour Mapping in power plant process (Spot Map)

Table 2 Noise Risk Zone Classification of Study Area

Intensity of noise in dB(A)	Zones
< 60	Safe
60-65	Tolerable
66-70	Low Risk
71-75	Moderate Risk
76-80	High Risk
>85	Extremely High Risk

Determining areas for wearing hearing protection

The noise level in the electricity production process area is relatively constant throughout the day. To prevent risks to employees who continuously work for 8 hours, the standard value is compared with 8 hours of operation, so the obtained value is compared with the standard value, which is set not to exceed 85 dB(A) in 8 hours. According to setting the noise contour mapping, it was found that the area was safe and has a noise level equal to or less than 85 dB(A), such as the boundary outside the machine enclosure and as for machines that are continuously working, where a sound level measurement result in greater than 85 dB(A). Therefore, in these areas, measures were required to put in place to prevent and reduce noise impacts, such as installing warning signs and hearing protection to prevent impacts on employees' hearing, together with measures to reduce noise levels at the source. Employers must arrange for employees to wear personal protective equipment while working to reduce the sound level that is felt in the ears when wearing personal protective equipment which exceeds the standards set by law.

Calculations using the noise reduction rating (NRR) values listed on the product with the average noise level measurement value throughout the working time were calculated according to the equation below:

Protected dB(A) = Sound Level dB(A) – [NRRadj – 7] (1)
For Earmuff NRRadj = NRR x 0 (2)

Where, protected dBA is the level of sound felt in the ears when wearing personal protective equipment, Sound Level dBA is the noise level obtained from the measurement was averaged over an 8-hour working time, and NRRadj is the noise reduction value specified on the label must be adjusted according to the nature and type of personal protective equipment. In the case of earmuffs, reduce the noise by 25 percent of the noise reduction value specified on the label or product.

NRR of earmuff identified on label = 32, NRRadj = 32 x 0.75 = 24
Calculate the sound level felt in the ears when wearing sound-reducing earmuffs.
Protected dB(A) = Sound Level dB(A) – NRRadj – 7
Protected dB(A) = 96.7 – 24 – 7 = 65.7

In areas where the sound measurement point has a noise level higher than 85 dB(A), personal protection equipment is to be provided with earmuffs. When calculating the level of sound felt in the ears when wearing personal protection equipment, it was found that noise exposure could be reduced from the highest level measured from 90 dB(A) to 59 dB(A), and measures for hearing conservation program should be established in the workplace. Further preventive measures and surveillance should be provided.

Conclusions and Discussions

All noise levels in the power plant process were measured at a total number of 1,700 points. The noise level was found to be in the range between 60.1 - 96.7 decibels (A). Using the Sound Level Meter, model NL-42EX (Class2), that meets the standards of the standard unit IEC61672 Type2, ANSI S1.4, JISC1509-1 and use the measurement results to create a noise contour mapping and specify areas for wearing personal protective equipment.

The study found that when the measurement results were compared with the standards announced by the Department of Labor Protection and Welfare, Thailand [13,19]. The subject of Noise level standards that employees are allowed to receive on average throughout their daily working hours, B.E. 2018 [19]. It was found that the machinery areas that are continuously operating include steam turbine generators, gas turbine generators, combustion inlet filter houses, the exhaust stack of heat recovery steam generators (HRSG), and cooling towers.

Moreover, the production process area is a closed building on all four sides, so the noise level in the work area is higher than the standard [2, 6]. In addition, it was found that the power plant had provided personal protective equipment such as earmuffs and earplugs [2, 6, 9]. When used to calculate the NRR value, it was found that the type of earmuffs reduces noise when worn while working in noisy areas. The sound level in the ear is 59 dB(A). It is more effective than wearing personal protective equipment such as earplugs to reduce noise with a sound pressure level that can be felt in the ear at 75.5 dB(A). Therefore, measures must be established in the electricity production process to prevent and reduce the noise impact on employees working in the said area [12, 14] to prevent hearing impairment. Initially, personal protective equipment must be specified, including noise-reducing earmuffs and earplugs that can reduce exposure to loud noises, and must carry out measures to preserve hearing to comply with the law [3, 5, 8, 14, 17].

Competing interests

The authors declare that there is no conflict of interest.

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References

[1] Rattanarak A. Situation of hearing loss from exposure to loud noise in occupations in Thailand and abroad. Journal of Public Health Research. 2017; 10 (1): 1-10.

[2] Bunprom P, Chaiyanan S, Phungkat Y, Sirijaroonwong U. The measurement of sound levels in the washing department at a jeans dyeing factory in Samut Sakhon Province, Thailand. Journal of Kanchanaburi Rajbhat University. 2020; 9(2), 316-27.

[3] Workplace Health and Safety. Managing noise and preventing hearing loss at work. Available from: https://www.worksafe.qld.gov.au/safety-and prevention /hazards/hazardous-exposures/noise).

[4] National Occupational Research Agenda. Hearing loss. Available from: http://www.cdc.gov/noish/nr-hear.html

[5] National Institute for Occupational Safety and Health. Preventing occupational hearing loss: a practical guide. Available from: http://www.cdc.gov/niosh/docs-/96-110/pdfs

[6] Bunprom P, Chaiyanan S, Phungkat U, Sirijaroonwong U. The noise contour map in bleaching and dyeing process to determine the standard of hearing conservation program of a factory in Samut Sakhon Province, Thailand. Journal of Public Health. 2022; 17(2), 1-11.

[7] Sari MA, Adnan A, Munir D, Eyanoer PC. The correlation of smoking and noise induced hearing loss on workers at a palm oil factory X in Medan-Indonesia. Bali Medical Journal. 2017; 6(3), 637-40.

[8] Balazikova M, Andrejiová M, Wysoczanska B. Methodology for Risk Assessment of Noise Effects at Workplace. MM Science Journal. 2019; (05):3426-30.

[9] Juwarna W, Adnan A, Haryuna TS. Noise induced hearing loss in begerpang palm oil mill workers. An International Journal of Otorhinolaryngology Clinics. 2018; 10(2): 56-60.

[10] Situngkir D, Ayu IM, Sipahutar L. Respondent’s characteristic and noise intensity as predicting factors of noise induced hearing loss. The Indonesian Journal of Occupational Safety and Health. 2020; 9(3): 239-47.

[11] Subramaniam M, Hassan M Z, Sadali MF, Ibrahim I, Daud MY, Aziz S, et al. Evaluation and analysis of noise pollution in the manufacturing industry. Journal of Physics: Conference Series. 2019; 1150 (1): 012019

[12] Zaw AK, Myat AM, Thandar M, Htun YM, Aung TH, Tun M, et al. Assessment of noise exposure and hearing loss among workers in textile mill (Thamine), Myanmar: a cross-sectional study. Safety and Health at Work. 2020; 11(2): 199-206.

[13] Announcement from the Department of Labour Protection and Welfare Regarding calculating the sound level felt in the ear when wearing personal safety equipment B.E.2561 (A.D.2018). The Royal of Thai Government Gazette of The Kingdom of Thailand 2018:135 (Pt 33 ng): 9-10.

[14] Hassanvand D, Zare S, Ghotbi-Ravandi MR. Noise assessment and sound map projection using surfer and noise at work tools in a tire manufacturing complex in Iran, 2018. Journal of Occupational Health and Epidemiology. 2019; 8(2): 109-17.

[15] Cahyadi B, Timang GA. Mapping of noise levels made by drilling machines on project x using contour zone method. Materials Science and Engineering. 2019; 528(1): 012066.

[16] Li X, Dong Q, Wang B, Song H, Wang S, Zhu B. The influence of occupational noise exposure on cardiovascular and hearing conditions among industrial workers. Scientific Reports. 2019; 9(1): 11524.

[17] Panjaitan N, Panggabean UN. Analysis noise level in production the palm oil: a case study. Journal Teknik Industri. 2022; 23(2): 121-32.

[18] Hasrul N, Ngadiman A, Mansur R, Sirat R, Mohd MF. Safety and risk evaluation using HIRARC model at palm oil mill. Int J Innov Technol Explor Eng. 2019; 8(11): 790-7.

[19] Announcement of the Department of Labour Protection and Welfare on criteria and measurement methods and analysis of working conditions regarding levels of heat, light, or noise, including the duration and type of work that must be carried out B.E.2561 (A.D.2018). The Royal of Thai Government Gazette of The Kingdom of Thailand 2018:135 (Pt 57 ng): 11-16.

[20] Panjaitan N, Panggabean UN. Analysis noise level in production the palm oil: a case study. Jurnal Teknik Industri. 2022; 23(2): 121-32.

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Original Article Open Access

Effects of Futsal Sports-Specific Training on Neuromuscular Coordination in Youth Male Futsal Players

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ABSTRACT

Introduction: The studying neuromuscular coordination is integral to futsal training as it provides valuable insights into performance enhancement, injury prevention, optimized training strategies, and talent identification and development. By integrating knowledge of neuromuscular coordination into coaching and training practices, futsal teams can strive for higher levels of success on the court while minimizing the risk of injuries and maximizing the potential of their athletes. This pre-experimental research aimed to evaluate the effect of futsal sports-specific training on neuromuscular coordination in youth male futsal athletes, both before and after 4 and 8 weeks of training.

Methods: The sample was obtained by calculating the sample size to estimate the average population size as the population size was known, totaling 26 youth male futsal athletes, by using a systematic random sampling method. The experiment instrument was a futsal sports-specific one that combined specific futsal training and plyometrics three days a week for eight weeks, finding the Index of item objective congruence (IOC = 1.0). The instruments used to collect data were the FAF's slalom test to assess the change of direction and the eye-body movement test to assess the reaction time. Descriptive statistics include percentages, means, standard deviations, and inferential statistics, including one-way analysis of variance with repeated measures and the Bonferroni test, with statistical significance set at the 0.05 level.

Results: The results found that the futsal athletes had a mean resting heart rate of 75.54 bpm, their heart rate during exercise was 150.16 bpm, and their RPE during exercise was 13.36. When conducting a one-way ANOVA with repeated measures, it was found that only reaction time was significantly different before, the 4th week and after the 8th week of training. Comparing the mean pair, it was found that reaction time decreased significantly both before and after the 4th week, before and after the 8th week, and after the 4th week and after the 8th week.

Conclusion: Futsal sports-specific training is a complex program that influences futsal players' performance, specifically depending on neuromuscular characteristics such as reaction time, agility, and change of direction.

Keywords: Futsal sports-specific training, neuromuscular coordination, futsal player

Introduction

Futsal is officially licensed by the Fédération Internationale de Football Association (FIFA) and is becoming more popular around the world; according to Barbero-Alvarez et al [1], futsal is a team sport that uses running with maximum speed and intensity over a shorter distance than other sports such as football [2], basketball [3], and handball [4]. It is clear from the above that this is futsal exercise at its most intense level. For futsal athletes, the running-to-rest ratio is roughly 1:1; running is defined as covering a distance at a moderate, fast, or quickest speed; resting is the player strolling or running slowly. Barbero-Alvarez et al. [1] stated that futsal players use low intensity in playing (50-60% of HRmax) every 14 seconds, moderate intensity (60-70% of HRmax) every 37 seconds, and high intensity (70-80% of HRmax) every 43 seconds, and the highest level of intensity in playing (which will be 80-90% of HRmax) every 56 seconds. While playing, players will change direction every 3.3 seconds. From this evidence, it can be concluded that futsal is constantly evolving and is a type of sport that uses anaerobic running at maximum speed, more than football and other types of speed sports [5].

In addition, Chaddock et al [6] stated that futsal is unique in that it is a sport that involves exercising at the highest level of intensity (80-90% of HRmax). It is noteworthy that in recent years, the number of futsal-related studies has increased significantly, and it has been described that the performance characteristics of futsal athletes while competing for maximum efficiency must include [7], physiological factors [8], neuromuscular coordination [9], or biochemical responses [7]. In addition, many sports scientists have suggested that what is especially interesting about futsal athletes is their anatomy and physiology [2]. In particular, neuromuscular properties play an important role in futsal, such as running speed, agility, and changing directions [9]. If athletes have better neuromuscular coordination than other athletes, they will tend to use speed and change direction faster than other athletes. [10]. In addition, there are studies by Milanez et al [9] and Ribeiro et al [4] that investigated the relationship between neuromuscular coordination. It was found that there were important changes in muscle function after futsal matches [10, 4], especially the decrease in force and muscle work. This may be due to the fatigue that occurs after the competition.

Moreover, it has a reduced running speed that is statistically significant [11]. For this reason, the nervous system, muscle speed, and agility of athletes are important things that should be developed and promoted [12]. Agility performance is a complex test that combines reactive agility, change of direction speed (CODs), and straight running [13]. It can be seen that futsal is a complex sport to practice for body movement. Futsal sports-specific training is a high-intensity workout that combines muscle strengthening exercises followed by plyometric exercises to increase the activity of the central nervous system (CNS) and increase the strength of type IIb muscle fibers, resulting in maximal explosive force [13]. Barbero-Álvarez, et al [15] found that combined training that will affect the maximum physical performance of athletes, especially running speed, must consist of two main factors: the number of steps and the length of the stride. The maximum force occurs during the stride length; therefore, the main factor in increasing running speed is that athletes should train to increase lower limb strength regularly, three days a week. A study by Jason et al [16] also studied the long-term effects of complex training and found that complex training affects the explosive power of muscles, such as jumping and speed. Freeman's study [17] found that combined exercise is the interaction of the neuromuscular system, specifically the relationship between the contraction of type 2a and type 2b muscle fibers, and develops to maximum strength, also known as explosive power. In summary, it was found that complex training has been used with many different types of athletes with great success.

From the above studies, it has been shown that futsal is considered a sport that combines strength, speed, change of direction, and the coordination of the neuromuscular systems. Most literature reviews discussed game analysis or players' physiological needs during playing and training [1]. Despite the popularity of futsal, there may be a lack of scientific research, especially focusing on the effects of sports-specific training on neuromuscular coordination in youth male players. Addressing this gap in the literature can advance our understanding of futsal's unique physiological and biomechanical demands and inform evidence-based coaching practices. However, few studies have examined the effectiveness of futsal sports-specific training on neuromuscular coordination in futsal athletes.

For this reason, futsal players with higher neuromuscular coordination might be more likely than players with lower neuromuscular coordination to play in accordance with the coach's playing style [18], thoroughly covering the relationship between strength, speed, change of direction, and the neuromuscular system. Therefore, the researcher was interested in studying the effects of futsal sports-specific training on neuromuscular coordination before and after the 4th and 8th weeks in youth male futsal athletes. The hypothesis that futsal sports-specific training results in the neuromuscular coordination of youth male futsal athletes in Sakon Nakhon Province before, after the 4th week and after the 8th week was different. Despite the importance of developing knowledge, there is still a need for personnel who need to study and understand every aspect of knowledge continuously and thoroughly. So that sports personnel, especially futsal, can apply it appropriately.

Methodology

Participants

This study was approved by the Institutional Review Board of Thailand National Sports University No. 081/2565 in Thailand and was conducted in accordance with the Declaration of Helsinki.

Twenty-six youth futsal players aged between 15 and 17 were registered as athletes of the Sakon Nakhon Province Sports Association. In summary, selecting youth futsal players aged 15 to 17 as the target population allows researchers to investigate the intersection of neuromuscular coordination. By focusing on this age group, the study can provide valuable insights for improving training strategies, reducing injury risks, and maximizing the athletic potential of young futsal players. Systematic random sampling from this formula $k = \frac{240}{16}$ = 15; therefore, athletes with numbers 1, 16 (1+15), 31 (16+15), 46 (31+15), and 61 (46+16) will be the sample and the samples will be randomly drawn systematically until the number is reached, derived from the calculation formula, is used to estimate the mean population size in cases where the population size is known [19]. $NZ^2_{\alpha/2}$ is the specified confidence (1.96) [19], σ^2 is the variance (0.60) [20], ***d*** is the effect size value (2.54) [20], with an estimated influence size value (0.5) [21], and *n* is the population (313). The calculation formula is as follows:

$d = \frac{\overline{x_1} - \overline{x_2}}{s}$; $\overline{x_1} =$ mean of pre-test, $\overline{x_2} =$ mean of post-test, $s =$ standard deviation of pre-test [20]

$$n = \frac{NZ^2{}_{\partial/2}\sigma^2}{d^2(N-1) + Z_{\partial/2}\sigma^2}$$

$$n = \frac{313(1.96^2)6^2}{2.54^2(313-1) + 1.96^2(6^2)}$$

To prevent dropout, the researcher increased the sample size by 30 percent (n = 26).

Intervention

The futsal sports-specific program training was performed thrice weekly for eight weeks (Monday, Wednesday, and Friday). Initially, players were warmed up at 50–60% of HRmax and 6–8 of rating of perceived exertion (RPE) for 10 minutes, then week 1–2 they performed futsal sports-specific program training at 60–70% of HRmax and 9–11 of RPE, and week 3–8 they performed futsal sports-specific training at 70–80% of HRmax and 12–16 of RPE for 40 minutes and cooled down for 10 minutes. The RPE scale presented of the perceived exertion scale (Borg RPE 15 points, 6–20) [20]. The minimum effort should elicit a rating of 6 (absence of any effort), while the RPE rating of 19 should elicit the maximum effort required to perform maximum repetitions (extremely hard).

On Monday of each week, players performed program 1 (20 minutes), followed by program 2 (20 minutes), divided into four groups (6-7 players each). Stand at designated points X1, X2, X3, and X4.

Program 1: Firstly, starting with Y1, the first player passes the ball to player 1 of group 2 (Y2) with his inside foot and moves it to the left following the arrow, then maximum speed to X5, performs explosive step-ups three times (A1), then maximum speed to position X3, and lines up to wait for the next round of training. Finally, player 1 of the next group (X2, X3, and X4) in each group does the same as player 1 of group 1 (Y1) until everyone is complete and within the specified time (Figure 1a), resting for 5 minutes.

Program 2: First, starting with player 1 of group 1 (Y1) passing the ball inside his foot to the left to player 1 of group 2 (Y2) following the arrow. Maximum speed to A1, performing drop jumps three times, then maximum speed to X4, and line up to wait for the next round of training. Finally, player 1 of the next group (X2, X3, and X4) in each group does the same as player 1 of group 1 (Y1) until everyone is complete and within the specified time (Figure 1b).

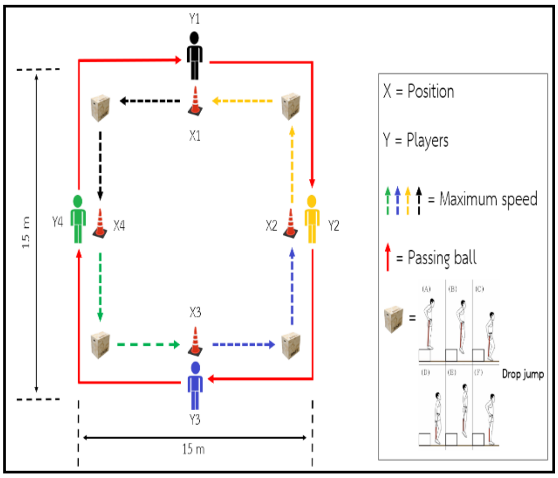

Figure 1a

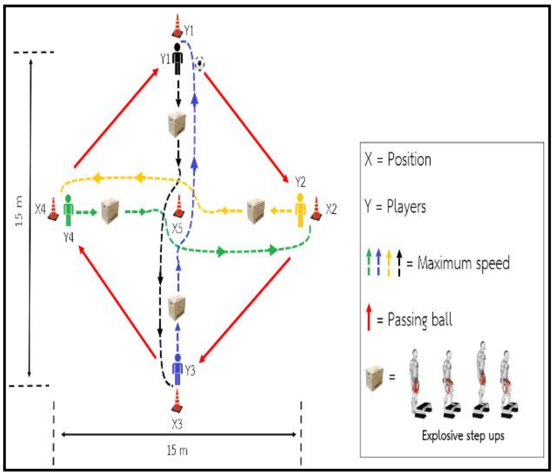

Figure 1b

On Wednesday and Friday of each week, players perform programming 1 (20 minutes), followed by program 2 (20 minutes), divided into two groups of 13 players each to train thoroughly and reduce the rest period of the athletes (both groups performed the same). Each group is represented by the symbols Y1–Y13 and lines up at position X1.

Wednesday, program 1: First, start with player 1 of each group (Y1) dribbling the ball with maximum speed around the cones at positions X1, X2, and X3, then stop the ball at position X4 and pass the ball back to the next player (Y2) at position X1, then speed to position X5, performing skater hops. After that, maximum speed to position X6, performing high knee raises, then maximum speed to position X7, and returning to the end of the line to wait for the next round of training. Finally, the next players (Y2-Y13) perform the same as player Y1 until everyone is complete and within the specified time (Figure 2a).

Program 2: Program 2: First, start with player 1 of each group (Y1) dribbling the ball with maximum speed around the cones at positions X1, X2, and X3, then stop the ball at position X4 and pass the ball back to the next player (Y2) at position X1, then speed to position X5, performing burpee. After that, maximum speed to position X6, performing high knee raises, then maximum speed to position X7, and return to the end of the line to wait for the next round of training. Finally, the next players (Y2-Y13) perform the same as player Y1 until everyone is complete and within the specified time (Figure 2b).

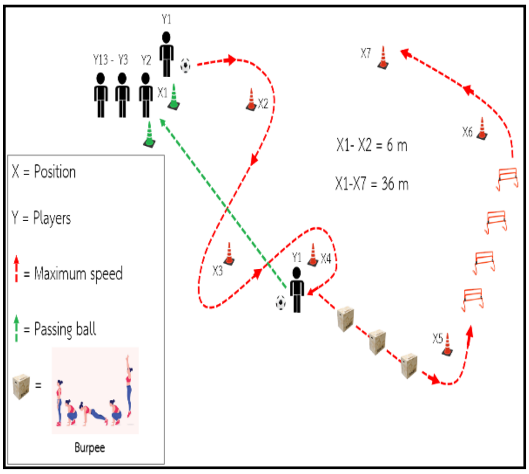

Figure 2a

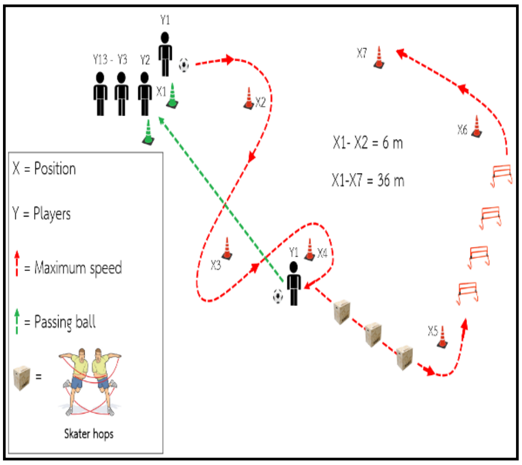

Figure 2b

On Friday, program 1: First, start with player 1 of each group (Y1) performing skater hops, then use maximum speed to pick up the ball from player Y13 to score a goal. After scoring a goal, player Y1 moves to replace player Y13, and player Y13 moves to the end of the line to wait for the next round of training (X1). Finally, the next players (Y2-Y13) perform the same as player Y1 until everyone is complete and within the specified time (Figure 3a).

Program 2: Each group is represented by the symbols Y1–Y13 for group 1 and lines up at position X1, and Y14–Y26 for group 2 and lines up at position X3. Firstly, starting with all players moving together (Y1 and Y14), player Y1 has maximum speed to position X2, performs a burpee, then speeds to position X5, while player Y14 dribbles ball to X6 and dribbles ball back to X5, then dribbles ball to X7 and dribbles ball back to X5, then dribbles ball to X8 and dribbles ball back to X5 and dribbles ball to X4. When both players complete the action together, player Y14 passes the ball to player Y1 to score a goal. Finally, player Y1 moves to the line of group 2 to wait for the next round of training, and player Y14 moves to the line of group 1 to wait for the next round of training. The next players of each group perform the same as the first player of the group (Y1 and Y14) until all are complete and within the specified time (Figure 3b).

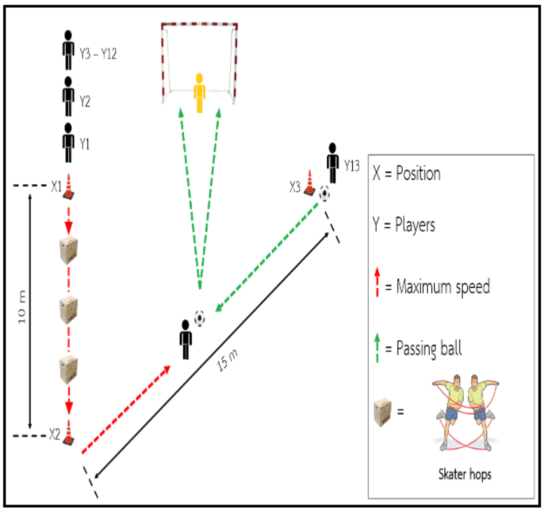

Figure 3a

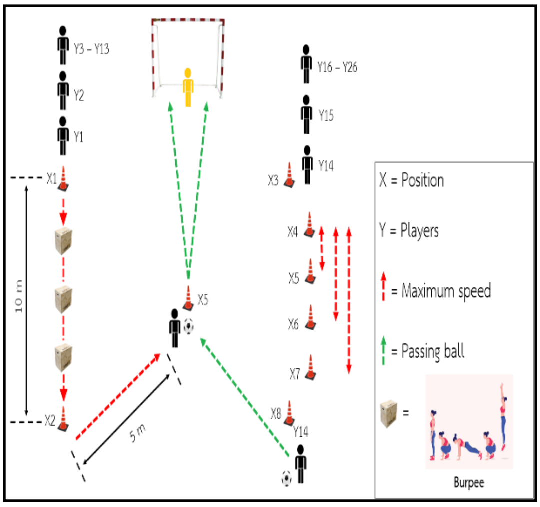

Figure 3b

Outcome measurement

Initially, the participants were evaluated for change of direction and reaction time at before experiment. Across all variables, the participants took measurements using standardized protocols (pre-test) and re-evaluated all variables at 4th weeks and 8th weeks.

(i) Change of direction (COD) was assessed using the standard FAF's slalom test. The simple correlation of Pearson's correlation coefficient (r) with FAF's slalom test is 0.912. Each player performed maximum effort in two trials interspersed with a 5-minute passive rest, and the fastest time (second) was used for statistical analysis (Figure 4).

(ii) Reaction time was assessed using the standard eye-body movement test. The simple correlation of Pearson's correlation coefficient (r) with the eye-body movement test is 0.892. The player standing at the starting point when the lights come on will sprint into the light position for 4.5 meters and return to the starting position in no more than 5 seconds, repeated 15 times. Cut out the fastest value three times and the slowest value three times, and find the average (second) (Figure 5).

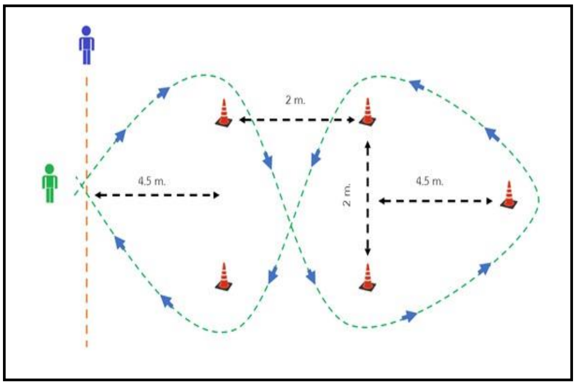

Figure 4 Change of direction test

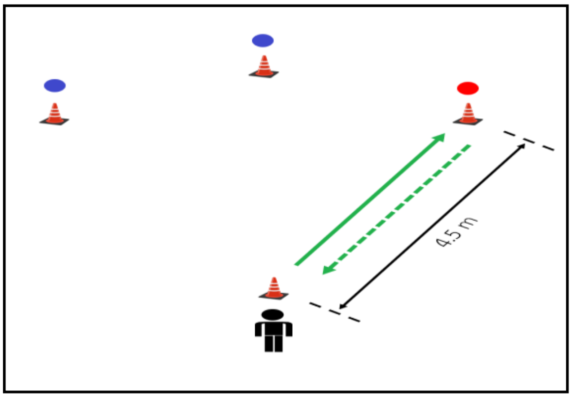

Figure 5 Reaction time test

Statistical analysis

Statistical analysis used STATA 13 (Texas, USA, 2007). The S-Wilk test was used to test the normal distribution of values. Descriptive statistics included frequency, percentage, mean, and standard deviation to express age, body mass index (BMI), and futsal experience. The inferential statistic was a one-way ANOVA with repeated measures and a Bonferroni test to compare change of direction and reaction time between before, after the 4th week, and after the 8th week of training (post-test) at a 95% confidence interval. We used α = 0.05 as the cut-off point for statistical significance.

Results

The results of the assumption test found that both the change of direction and reaction time data have a normal distribution (p-value= 0.74 and 0.14, respectively), which is in accordance with the assumption on the use of parametric statistics (Table 1).

Table 1 Shapiro-wilk test (n=26)

Variables	n	Shapiro-wilk test		
		statistic	df	p-value
Change of direction	26	0.97	26	0.74
Reaction time	26	0.94	26	0.14

Characteristics

The players had an average age of 16.81 (SD=0.40), an average weight of 60.66 kilograms (SD=4.76), an average height of 169.92 centimeters (SD=5.61), an average body mass index of 20.99 (SD=0.98), and 3.46 years of experience playing futsal (SD=0.51) (Table 2).

Table 2 Characteristics (n=26)

Measure	Mean (SD)	Min-Max
Weight (kg)	60.66 (4.76)	(51.75 - 75.96)
Height (kg)	169.92 (5061)	(161.00 - 182.00)
Age (year)	16.81 (0.40)	(16 - 17)
BMI	20.99 (0.98)	(19.97 - 22.93)
Futsal experience	3.46 (0.51)	(3.00 - 4.00)

Heart rate and rating of perceived exertion

During exercise, players had their heart rate increase accordingly, from 149 to 163 beat per minute (bpm) (63.90 - 64.1% of HRmax) in weeks 1-2 and in weeks 3–8, the average heart rate while exercising was 163–176 times per minute (75.18 - 76.69% of HRmax) (Figure 6). They had a rating of perceived exertion of

9.80 - 10.07 in weeks 1 - 2, and in weeks 3 - 8, the average rating of perceived exertion while exercising was 12.88 -15.11 (Figure 7).

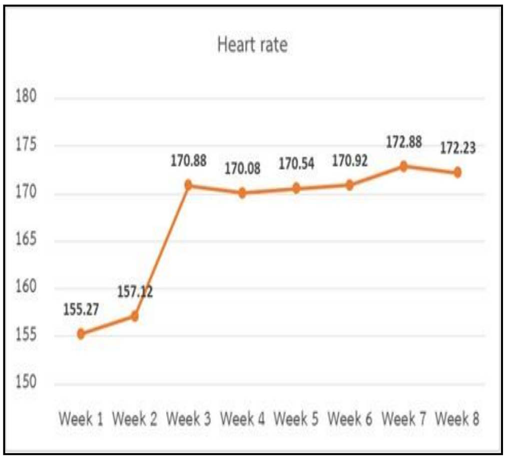

Figure 6 Heart rate

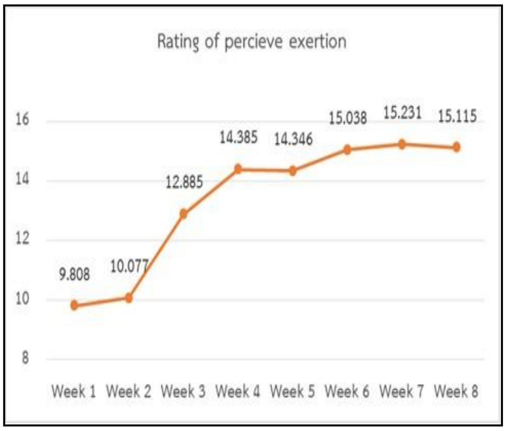

Figure 7 rating of perceived exertion

Change of direction and reaction time

The average change of directions before training was 8.26 s, after the 4th week was 8.21 s, and after the 8th week was 8.15 s (Figure 8), and the average reaction time before training was 3.5 s, after the 4th week was 3.22 s, and after the 8th week was 3.03 s (Figure 9).

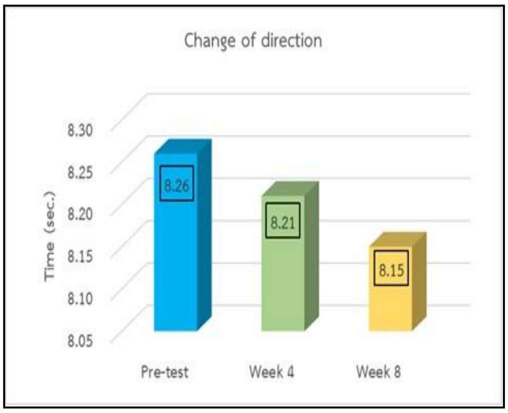

Figure 8 Change of direction

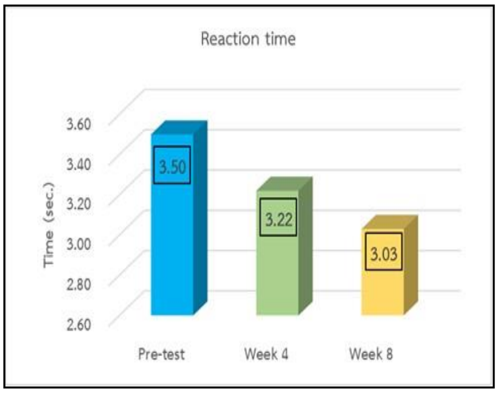

Figure 9 reaction time

Comparison of one-way ANOVA with repeated measures change of direction and reaction time

A one-way repeated-measures comparison of variance found that only the reaction times between before training, after training week 4, and after training week 8 were significantly different (Table 3). Therefore, the means had to be compared for each pair using the Bonferroni test.

Table 3 Change of direction and reaction time

Source	SS	df	MS	F	p-value
change of directions					
Within group	0.18	2	0.09	0.17	0.84
Error	38.49	75	0.51		
Total	38.66	77			
Reaction time					
Within group	2.91	2	1.46	23.53	0.000
Error	4.64	75	.062		
Total	7.55	77			

The Bonferroni test of reactime

Comparing the mean pair by the Bonferroni test found that, both pre-test and after week 4, pre-test and after week 8, and after week 4 and after week 8, reaction time decreased significantly (3.50, 3.22, and 3.03 seconds, respectively) (Figure 10).

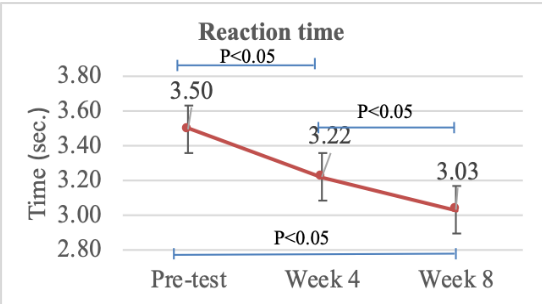

Figure 10 The Bonferroni test of reaction time

Discussion

The results of a one-way ANOVA with repeated measures on the change of direction before, after the 4th week, and after the 8th week of training showed no statistically significant difference. This may be because the training program is not a competitive situation and there may be some disparity among the athletes, so there are moments when they lose control, including muscle fatigue because change of direction mostly requires the work of muscle groups. Therefore, this muscle group becomes fatigued from working hard, which has a direct effect on the muscle command system, also called the neuromuscular system. This will result in a change of direction for the athlete as well. Considering these factors can help researchers interpret the results of the study and identify areas for improvement in future research or training interventions aimed at enhancing change of direction performance in athletes.

The results of the one-way ANOVA with repeated measures on reaction time before, after the 4th week, and after the 8th week of training were significantly different. Therefore, the average values must be pair-compared using Bonferroni's method. It was found that reaction time between before and after week 4, before and after week 8, after week 4, and after week 8 decreased statistically significantly. This is because the study involved a total of six futsal sport-specific training programs, with each program emphasizing athletes' ability to make quick decisions when passing the ball and their quick-fire ability to score goals. Reaction to evade an opponent's movement, including the fast reaction time, allows athletes to predict their opponent's moves and make split-second decisions. This quick reaction time allows athletes to quickly respond to situations, giving an advantage to the opponent. It also helps increase the accuracy of athletes' movements, all of which are said to develop the relationship between movement skills (Coordination motor skills; CMS) [22]. This is an important factor that influences athletes' performance during competition [23].

According to Ljach and Witkowski [24], increasing the level of training to develop movement skills is one of the important factors that result in athletes being successful. Additionally, Dane et al. [25] also explained that an important factor in sports is the assessment of each athlete's ability level, one of which is the assessment of movement skills, which can be divided into two types: application ability or application of movement. It refers to the ability to quickly develop a style of movement or change movements when encountering constantly changing situations [24]. This ability occurs in approximately 26.07 percent of male futsal players: ability to all parts of the body: 16.7%; ability to move towards the ball: 13.9%; and ability to balance: 9.3%. Another one is a wide range of reaction times, meaning the ability to quickly respond to stimuli or the response to movement in a short period of time in various parts of the body, both knowing and not knowing the stimulus before [25]. According to Colzato et al. [26], athletes have better simple reaction times than non-athletes. Additionally, training efficiency has a positive effect on both reaction time [26] and speed, especially futsal, which is a combination of speed and lower limb strength [27].

Overall, improvements in reaction time can translate into tangible benefits for futsal players, enhancing their efficiency, effectiveness, and competitive advantage during gameplay. By honing their reactive abilities through targeted training interventions, athletes can elevate their performance levels and contribute to their team's success on the futsal court. Additionally, some studies have reported that reaction time during competition depends on the fine motor skills of the lower limbs, especially in futsal [28]. While many studies have studied reaction times across both dominant and non-dominant sides, it has been found that non-athletes have poorer reaction times than athletes [29]. There is also a study by Welford [30] that studies the mechanisms of the human motor nervous system, including perception, decision-making, planning, and control. The process of perception is receiving information from outside; the decision-making process depends on the basis of exposure to stimuli; and planning is the act or decision to do something. All of this is a result of the operation of the command mechanism of the perception process through sensory input, decision-making, action mechanisms, and administrative mechanisms.

In addition, the study by Land [31] found that the response mechanism through visual perception depends on three nervous systems, as follows: The visual response perception system, the command system of the motor skills of the limbs for that type of work, and the visual perception system will respond to the information received. Recent studies have found that visual movement skills that can benefit specific sports are a result of the athlete's motor nervous system. Proprioceptive neuromuscular is the interrelationship between all body processes that play an important role in movement planning; for example, mechanisms work quickly to achieve effective change during planning [32]. The Pacific Sports Visual Performance Profile (PSVPP) consists of 23 tests that assess visual perception performance related to sporting events. It is also a basic assessment of refractive perception and eye health, as well as a test of cognitive performance in relation to many sports [33].

One of the tests was to test the athletes' reaction times to evaluate the athletes' rapid reflexes generated by visual perception through the perceptual system before motor skills begin [34]. This is measured in milliseconds [35]. The reaction time for touch is approximately 110 milliseconds. This is due to hearing at 150 milliseconds and vision at 200 milliseconds. Reaction time is caused by the work of the brain areas called the primary somatosensory cortex and the posterior parietal cortex. The integration of the motor nervous system sends information to the motor cortex in all six parts of the brain. This is the area where movement is planned-the so-called pre-order reaction times. During a command, information from part 6 of the brain is sent to part 4 of the motor cortex to initiate movement. The cerebellum then plays an important role in the movement of various parts of the body, depending on the quality of the cortical excitability, which determines whether the reaction time is fast or slow [36].

Reaction time is a movement skill that can be difficult to master depending on the athlete's genetics. However, reaction time can be increased by 10–20 percent through visual perception training [36]. Professional athletes have faster reaction times than trained or untrained athletes [37], and when athletes are very focused on the activity, their reaction time will be faster [38]. Factors affecting reaction time and response speed include age between 20 and 30 years and type of training, physical fitness of athletes, fatigue level, and intelligence level of athletes [34]. Reaction time is important for some sports, especially futsal. The study by Nascimento et al. [38] confirmed that after futsal athletes received visual perception training, they had better reaction times than the control group, thus resulting in athletes being more efficient while competing.

Improvements in reaction time are mediated by complex neuromuscular mechanisms involving various brain areas responsible for perception, movement planning, and proprioceptive neuromuscular feedback. Here's an overview of the key processes involved: Perception and Sensory Processing: Reaction time begins with the perception of a stimulus, such as a visual cue or auditory signal [35]. Sensory information from the environment is transmitted to the brain through specialized sensory receptors (e.g., photoreceptors in the eyes for visual stimuli, and hair cells in the inner ear for auditory stimuli). The primary sensory cortices in the brain, such as the visual cortex for visual stimuli and the auditory cortex for auditory stimuli, process this sensory information. Integration and Decision Making: Once sensory information reaches the brain, it undergoes integration and interpretation [38]. Higher-order brain areas, including the prefrontal cortex, parietal cortex, and supplementary motor area, are involved in integrating sensory inputs, assessing their significance, and making decisions about the appropriate motor response. These areas are crucial for movement planning and initiating the appropriate motor commands based on the perceived stimulus.

Motor Planning and Execution: After the decision-making process, motor commands are generated and transmitted from the motor areas of the cerebral cortex (such as the primary motor cortex and premotor cortex) to the spinal cord. These motor commands initiate muscle contractions and coordinate movement sequences required to execute the desired response [34]. The corticospinal tract is the primary pathway through which motor commands travel from the cortex to the spinal cord. Proprioceptive Neuromuscular Feedback: Proprioception refers to the sense of the body's position and movement in space. Proprioceptive feedback plays a crucial role in rapid reflex generation and fine-tuning motor responses [35]. Proprioceptive receptors located in muscles, tendons, and joints provide continuous feedback about the body's position, muscle length, and tension. This feedback is integrated with motor commands in the spinal cord through reflex circuits, such as the monosynaptic stretch reflex and the reciprocal inhibition reflex, to modulate muscle activity and ensure smooth and coordinated movements.

Conclusion

Futsal-specific training combined with plyometrics results in an increase in neuromuscular reaction-time coordination. In summary, the observed improvements in reaction time among futsal players are likely driven by a combination of neural adaptations, skill acquisition processes, and enhanced proprioceptive feedback mechanisms. Through targeted training interventions and practice regimes, athletes can systematically enhance their reactive abilities, ultimately translating into improved performance and competitive success in the sport of futsal.

Limitations

The limitation of this research is that there was no control group to compare the effects of futsal sports-specific training on neuromuscular coordination. By addressing these considerations and implementing a rigorous study design with appropriate control measures, future research can provide more robust evidence regarding the effects of futsal sports-specific training on neuromuscular coordination in youth male futsal players.

References

[1] Barbero-Alvarez J, Soto V, Barbero-Alvarez V. Match analysis and heart rate of futsal players during competition. J Sports Sci. 2021; 26(1): 63-73.

[2] López-Fernández J, García-Unanue J, Sánchez-Sánchez J, Colino E, Hernando E, Gallardo L. Bilateral asymmetries assessment in elite and sub-elite male futsal players. Int J Environ Res Public Health. 2020; 17(3169): 1-11.

[3] Walton SR, Broshek DK, Freeman JR, Hertel J, Meyer JP, Erdman NK, et al. Institutionally based impact test® normative values may differ from manufacturer-provided normative values. Archives of Clinical Neuropsychology. 2020; 35(3): 275-82.

[4] Ribeiro JN, Gonçalves B, Coutinho D, Brito J, Sampaio J, Travassos B. Activity profile and physical performance of match play in elite futsal players. Front Psychol. 2020; 11(1709): 1-9.

[5] Barbero-Álvarez JC, Castagna C. Activity pat-terns in professional futsal players using global position tracking system. Journal of Sports Science and Medicin. 2020; 6(10): 208–9.

[6] Chaddock-Heyman L, Erickson KI, Voss MW, Knecht AM, Pontifex MB, Castelli DM, et al. The effects of physical activity on functional MRI activation associated with cognitive control in children: a randomized controlled intervention. J International Neuropsychological Society. 2018; 7(72), 1-13.

[7] Bekris E, Gioldasis A, Gissis I, Katis A, Mitrousis I, Mylonis E. Effects of a futsal game on metabolic, hormonal, and muscle damage indicators of male futsal players. J Strength Cond Res. 2020; 34(1): 1-11.

[8] Yiannaki C, Barron DJ, Collins D, and Carling C. Match performance in a reference futsal team during an international tournament - implications for talent development in soccer. Biol Sport. 2020; 37(7): 147–56.

[9] Milanez VF, Bueno MJDO, Caetano FG, Chierotti P, De Moraes, SMF, Moura, FA. Relationship between number of substitutions, running performance and passing during under-17 and adult official futsal matches. Int J Perform Anal Sport. 2020; 20(12): 470–82.

[10] Freitas TT, Pereira LA, Alcaraz PE, Arruda AFS, Guerriero A, Azevedo PHSM, Loturco I. Influence of strength and power capacity on change of direction speed and deficit in elite team-sport athletes. J Hum Kinet. 2019; 68(113): 167–76.

[11] Milioni F, Vieira LH, Barbieri RA, Zagatto AM, Nordsborg NB, et al. Futsal match-related fatigue affects running performance and neuromuscular parameters but not finishing kick speed or accuracy. Front. Physiol. 2016; 7(518): 1-10.

[12] Mohr M, Krustrup P, Bangsbo J. Match performance of high-standard soccer players with special reference to development of fatigue. J Sports Sci. 2018; 3(21): 519-28.

[13] Rodrigues VM, Ramos GP, Mendes TT, Cabido CE, Melo ES, Condessa LA, Coelho DB, Garcia ES. Intensity of official futsal matches. J Strength Cond Res. 2018; 25(9): 2482-87.

[14] Ebben WP. Complex training: a brief review. J Sports Sci Med.2021; 1(2): 42–6.

[15] Barbero-Álvarez JC, Soto V, Granda J. (Effort profiling during indoor soccer competition. Journal of Sports Science. 2017; 22(231): 500-1.

[16] Bennie JA, Shakespear-Druery J, De Cocker K. Muscle-strengthening Exercise Epidemiology: a New Frontier in Chronic Disease Prevention. Sports Medicine. 2020; 6(40): 1-8.

[17] Freeman D. Teacher learning in language teaching. Cambridge University Press. 2021.

[18] Ward P, Williams AM. Perceptual and cognitive skill development in soccer: The multidimensional nature of expert performance. J Sport and Exercise Psychology. 2020; 25(1): 93-111.

[19] Jirawatkul A. Biostatistics for health sciences, 3th ed. Klangnana press: Khon Kean, Thailand. 2017.

[20] Cohen J. Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers. 1988.

[21] Borg DN, Bach AJE, O'Brien JL, Sainani KL. Calculating sample size for reliability studies. PM&R; 14(8): 1018-25.

[22] Nascimento H, Alvarez-Peregrina C, Martinez-Perez C, Sánchez-Tena MÁ. Vision in futsal players: coordination and reaction time. Int J Environ Res Public Health. 2021; 18(3): 9069.

[23] Atmojo MB. Test and measurement in physical education and sport; UNS Press: Surakarta, Indonesia. 2010.

[24] Jaakkola J, Watt A, Kalaja S. Differences in the motor coordination abilities among adolescent gymnasts, swimmers and ice hockey players. Hum Mo.2017; 1(9): 44-50.

[25] Malhotra V, Goel N, Ushadhar, Tripathi Y, Garg R. Exercise and reaction times. Journal of Evolution of Medical and Dental Sciences. 2015; 4(25): 4277-4281.

[26] Dane S, Hazar F, Tan Ü. Correlations between eye-hand reaction time and power of various muscles in badminton players. Int J Neurosci. 2015; 118(5): 349-54.

[27] Colzato LS, Nitsche MA, and Kibele A. Noninvasive brain stimulation and neural entrainment enhance athletic performance—a review. J Cogn Enhanc.2017; 1(3): 73-9.

[28] Little T, Williams AG. Specificity of acceleration, maximum speed, and agility in professional soccer players. J Strength Cond Res.2005; 19(4): 77-8.

[27] Davranche K, Burle B, Audiffren M, and Hasbroucq T. Physical exercise facilitates motor processes in simple reaction time performance: an electromyographic analysis. Neurosci Lett. 2006; 396(9): 54-5.

[29] Laby DM, Kirschen DG, Govindarajulu U, DeL P. The hand-eye coordination of professional baseball players: the relationship to batting. Optom Vis Sci. 2018; 95(6): 557–67.

[30] Welford AT. Skilled Performance: Perceptual and Motor Skills, 1st ed.; Scott & Foresman: Northbrook, IL, USA. 1976.

[31] Land MF. Vision, eye movements, and natural behavior. Vis. Neurosci. 2007; 26(5): 51–62.

[32] Riemann BL, Lephart SM. The Sensorimotor System, Part II: The role of proprioception in motor control and functional joint stability. J Athl Train. 2002; 37(6) 80–84.

[33] Zago M, Piovan AG, Annoni I, Ciprandi D, Iaia FM, Sforza C. Dribbling determinants in sub-elite youth soccer players. J Sport Sci. 2016; 34(3): 411–419.

[34] Iteya M, Gabbard C. Laterality patterns and visual-motor coordination of children. Percept Mot Ski. 1996; 83(3): 31–34.

[35] Schmidt R, Bancroft I. Genetics and genomics of the brassicaceae, 1st ed.; Springer: New York, NY, USA. 2006.

[36] Byrne JH. Concise learning and memory, 6th ed.; Academic Press: San Diego, CA, USA. 2002.

[37] Knudson DV. Qualitative diagnosis of human movement: improving performance in sport and exercise, 3rd ed.; Human Kinetics: Champaign, IL, USA. 1997

[38] Nascimento H, Alvarez-Peregrina C, Martinez-Perez C, Sánchez-Tena MÁ. Vision in futsal players: coordination and reaction time. Int J Environ Res Public Health. 2021; 18(17): 9069.

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Original Article | Open Access

Ergonomic Risk-Related Musculoskeletal Disorders Among Farmers in Nakhon Sawan, Thailand

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ABSTRACT

Introduction: Farmers are a major group who encounter health problems from their work, particularly musculoskeletal disorders. The musculoskeletal problems of farmers are related to ergonomics in every step of their work. The study aimed to understand ergonomic problems among farmers living in Nakhon Sawan Province.

Methods: A cross-sectional study design was applied to identify risks of musculoskeletal disorders related to ergonomic risk among farmers who had registered with the Ministry of Agriculture and Cooperatives system and lived in Thanamaoy Sub-district, Mueang District in Nakhon Sawan Province. The sample size was calculated using Krejcie and Morgan's formula, and 195 participants were required for the analysis. Participants were selected voluntarily. The rapid entire body assessment (REBA) assessment was used to assess ergonomics risk. Participants were interviewed about their body discomfort related to musculoskeletal disorders. Descriptive statistics were used to describe the characteristics of participants and risk factors.

Results: A total of 195 were recruited into the study; 69.20% were males. The total ergonomic risk was 8.55 REBA (±2.72), presented at a high risk. The mean REBA score in posture of ploughing was 8.33 (±2.75). The mean REBA score in sowing rice seeds and fertilizer was 8.42 (±2.78). The mean REBA score in a posture of the harvest was 8.91 (±2.93). It was found almost hard in the body discomfort assessment at 3.31 ±1.17. According to the total body discomfort, it was found that participants felt mostly in the lower back 4.83, ±.78), thigh 4.78, ±.92), and neck 4.41, ±.92).

Conclusion: Farmers who work on farms are suffering from ergonomic risks, particularly musculoskeletal systems. Effective public health interventions should be introduced to reduce the ergonomic problem among the farmers in Nakhon Sawan Province, Thailand.

Keywords: Ergonomics; Musculoskeletal; Farmers

Introduction

"Ergonomics" comes from the Greek "Ergon," meaning work, and "Nomos," which means law [1]. Ergonomics is the scientific discipline that deals with understanding the interaction between humans and other elements of a socio-technical system. In this definition, ergonomics is the profession that applies theory, principles, data, and design methods to optimize human well-being and the overall performance of a system. It is, in particular, responsible for designing and evaluating tasks, jobs, products, environments, and systems to make them compatible with people's abilities, needs, and limitations [2]. In Europe, the focus of ergonomics is to be found in industry, and it has been linked to an interest in improving worker performance and satisfaction. In this way, studies began on anthropometry, work medicine, architecture, lighting, etc. The definition of ergonomics is extended today to all human activities in which artifacts are implemented [1]. In Thailand, The Royal Institute [3] has coined the term ergonomics to mean the science of arranging work conditions so that people work in a comfortable state and have welfare resulting in good performance according to the set goals of a work system that produces effective results and working people have a good quality of life. Illnesses and accidents from work have been minimal, eventually, particularly work-related musculoskeletal disorders (WMSDs), which are a group of symptoms resulting from ergonomic risk factors. The WMSD has been reported to have a high prevalence every year.

Farmers are the main national economic drivers of Thailand. Many agricultural products have been contributed to world food product chains. Regarding farmer's health, it was reported that almost half of Thai farmers suffered from musculoskeletal system (45.%) [4]. The musculoskeletal problems of farmers are related to ergonomics in every step of their work. As Phanwong et al. [5] reported, several processes of farming were producing health problems for Thai farmers, including the process of harvesting the rice, followed by the process of maintaining the crop, the process of planting rice, and the process of preparing the area for rice cultivation, respectively. Considering the farming process, improper physical position while working in the field was the main source of physical health problems, particularly in preparing the area for rice cultivation. The majority of ergonomics and psychosocial risk factors among Thai farmers were found in the process of planting rice, the process of maintaining the crop, and the process of harvesting the rice. There are eight steps of rice farming; various steps are detected in different levels of occupational health hazards among Thai farmers, particularly presenting body pain after the field and musculoskeletal disorders caused by improper working positions [6]. A study conducted in Chiang Rai Province [7] reported that physical moving during farming was the source of health problems (80.3%), such as forward or sideway and lifting heavy materials.

Nakhon Sawan Provincial Agricultural Extension office reported that Nakhon Sawan Province currently has 4,716,060 rai (accounting for 79.18% of the overall province area) farming. The major crop is rice, which is the largest area in the northern region of Thailand [8]. Previous studies on farmers' health focused on the impacts of chemical use [9] and factors that affect the decision-making to purchase chemicals [10]. Therefore, in this study, we aim to investigate ergonomic problems among farmers living in Thanamaoy Sub-district, Phayuha Khiri District, Nakhon Sawan Province, where most people work in rice farming [8].

Methodology

Study design

A cross-sectional study design was applied to identify the risks of musculoskeletal ergonomics among farmers living in Thanamaoy Sub-district, Phayuha Khiri District, Nakhon Sawan Province, Thailand.

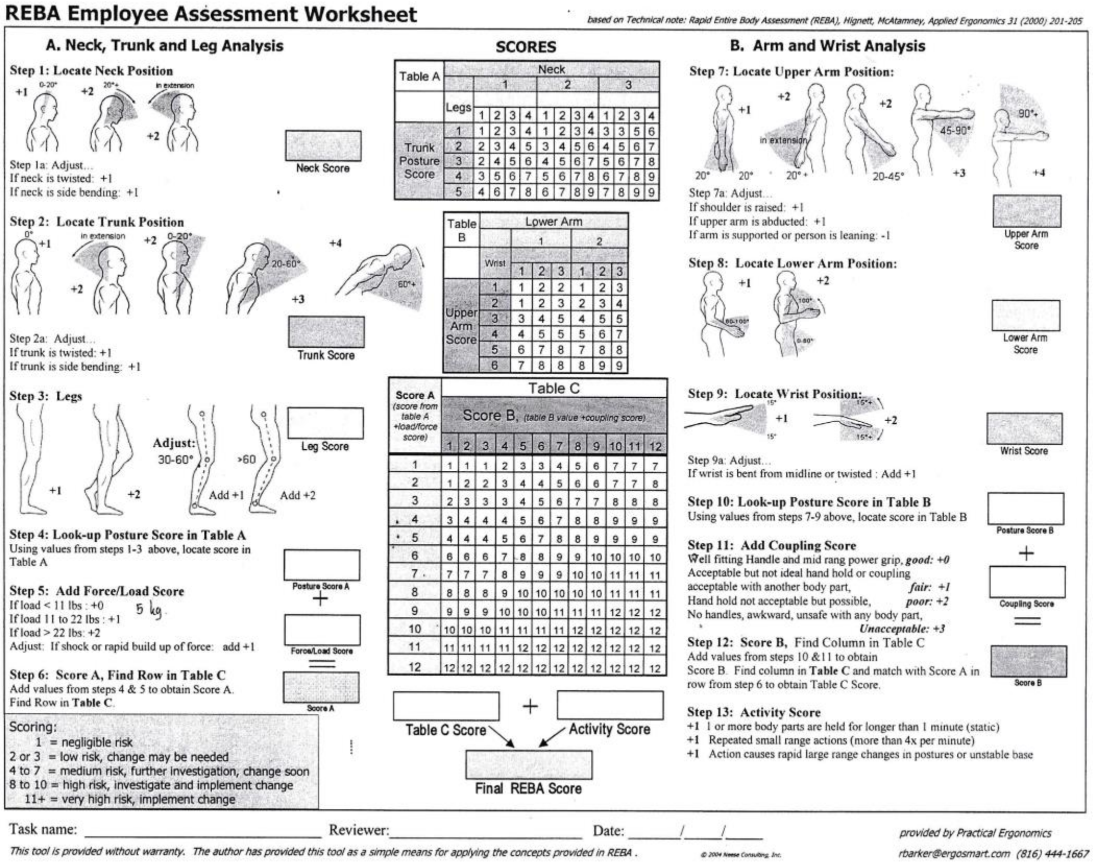
Study population and study sample

The study population was 386 farmers registered with the Ministry of Agriculture and Cooperatives Farmer System and lived in the Thanamaoy Sub-district. Mueang District in Nakhon Sawan Province. A sample size of 195 participants was determined using Krejcie and Morgan's formula. Participants were selected by random method.

Inclusion criteria: (i) able to participate in the study till to the end of the research; (ii) never experienced an accident that caused bone and muscle abnormalities previously; (iii) not less than three years in continuing working as a farmer; and (iv) aged 18 years and over.

Research instruments

Two research tools were used in the study. First, five experts in the field validated a rapid entire body assessment (REBA) (Fig.1) assessment to assess an ergonomics risk (IOC = 1.00). Second, the musculoskeletal discomfort questionnaire on the body parts of farmers was adapted from the Cornell Musculoskeletal Discomfort Questionnaire (Fig 2). The five scales were classified; 1= none, 2=easy, 3=medium, 4=hard and 5=maximal hard. The piloting was applied among 50 farmers, and Cronbach's alpha coefficient was found to be 0.84.



REBA Employee Assessment Worksheet

based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

A. Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position
+1 0-20°; +2 20°+; +2 in extension
Step 1a: Adjust...
If neck is twisted: +1
If neck is side bending: +1
Neck Score

Step 2: Locate Trunk Position
+1 0°; +2 in extension; +2 0-20°; +3 20-60°; +4 60°+
Step 2a: Adjust...
If trunk is twisted: +1
If trunk is side bending: +1
Trunk Score

Step 3: Legs
+1; +2; Adjust: 30-60° Add +1; >60 Add +2
Leg Score

Step 4: Look-up Posture Score in Table A
Using values from steps 1-3 above, locate score in Table A
Posture Score A
+

Step 5: Add Force/Load Score
If load < 11 lbs : +0
If load 11 to 22 lbs : +1
If load > 22 lbs: +2
Adjust: If shock or rapid build up of force: add +1
5 kg
Force/Load Score
=

Step 6: Score A, Find Row in Table C
Add values from steps 4 & 5 to obtain Score A.
Find Row in **Table C**.
Score A

Scoring:
1 = negligible risk
2 or 3 = low risk, change may be needed
4 to 7 = medium risk, further investigation, change soon
8 to 10 = high risk, investigate and implement change
11+ = very high risk, implement change

SCORES

Table A	Neck 1				Neck 2				Neck 3			
Trunk Posture Score / Legs	1	2	3	4	1	2	3	4	1	2	3	4
1	1	2	3	4	1	2	3	4	3	3	5	6
2	2	3	4	5	3	4	5	6	4	5	6	7
3	2	4	5	6	4	5	6	7	5	6	7	8
4	3	5	6	7	5	6	7	8	6	7	8	9
5	4	6	7	8	6	7	8	9	7	8	9	9

Table B	Lower Arm 1			Lower Arm 2		
Upper Arm Score / Wrist	1	2	3	1	2	3
1	1	2	2	1	2	3
2	1	2	3	2	3	4
3	3	4	5	4	5	5
4	4	5	5	5	6	7
5	6	7	8	7	8	8
6	7	8	8	8	9	9

Table C

Score A (score from table A +load/force score)	Score B, (table B value +coupling score) 1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table C Score + Activity Score → Final REBA Score

B. Arm and Wrist Analysis

Step 7: Locate Upper Arm Position:
+1 20°; +2 in extension 20°; +2 20°+; +3 45-90°; +4 90°+; 20-45°
Step 7a: Adjust...
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1
Upper Arm Score

Step 8: Locate Lower Arm Position:
+1 60-100°; +2 100°+; 0-60°
Lower Arm Score

Step 9: Locate Wrist Position:
+1 15°; +2 15°+
Step 9a: Adjust...
If wrist is bent from midline or twisted : Add +1
Wrist Score

Step 10: Look-up Posture Score in Table B
Using values from steps 7-9 above, locate score in Table B
Posture Score B
+

Step 11: Add Coupling Score
Well fitting Handle and mid rang power grip, *good: +0*
Acceptable but not ideal hand hold or coupling acceptable with another body part, *fair: +1*
Hand hold not acceptable but possible, *poor: +2*
No handles, awkward, unsafe with any body part, *Unacceptable: +3*
Coupling Score
=

Step 12: Score B, Find Column in Table C
Add values from steps 10 &11 to obtain Score B. Find column in **Table C** and match with Score A in row from step 6 to obtain Table C Score.
Score B

Step 13: Activity Score
+1 1 or more body parts are held for longer than 1 minute (static)
+1 Repeated small range actions (more than 4x per minute)
+1 Action causes rapid large range changes in postures or unstable base

Task name: ______ Reviewer: ______ Date: ___/___/___

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This tool is provided without warranty. The author has provided this tool as a simple means for applying the concepts provided in REBA.
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Figure 1 REBA employee assessment worksheet

The musculoskeletal discomfort questionnaire

Name……………………………......Surname………………………………………

Gender: ◯ Male ◯ Female

Age……………. years

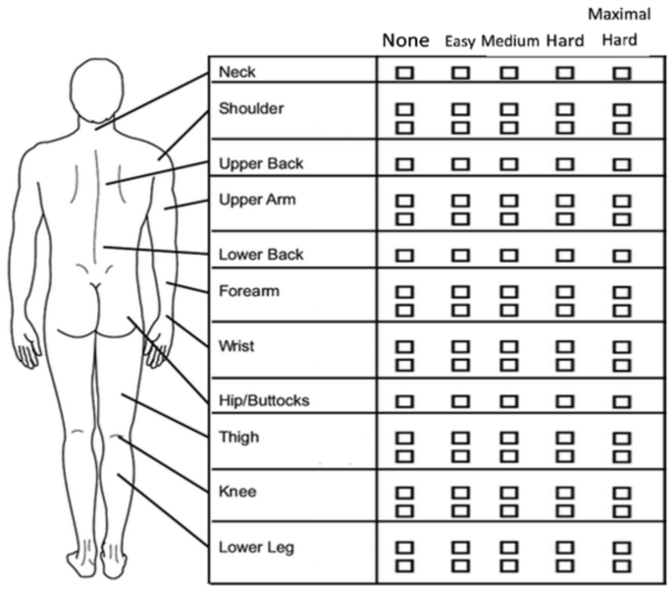

Figure 2 The musculoskeletal discomfort questionnaire

Data collection procedure

The letter for asking permission and cooperation from relevant organizations was sent out, including Thanam Oi Muang Hak Subdistrict Municipal. A random method was used to select the study samples based on inclusion-exclusion criteria. Before the interview commencement, all selected samples were provided with information about the study, including potential risks. Research tools were used as the main research materials for collecting data.

Statistical analysis

Descriptive statistics were used to present the general information of the participants in the forms of percentages (for categorical data) and means with standard deviation (SD) for continuous data.

Ethical considerations

The study was approved for its ethical research in human subjects by the Human Research Ethical Committee of Nakhonsawan Province (NSWPHO-028/65), which was approved on 8 December 2022.

Results

General information of participants

A total of 195 people were recruited into the analysis: 69.20 % were males, 47.7% were aged 36-45, and 38.50% were aged 46-55 (Table 1).

Table 1 General characteristics of participants.

Personal characteristics	n	%
Gender		
Male	135	69.20
Female	60	30.80
Age (years)		
26-35	9	4.60
36-45	93	47.70
46-55	75	38.50
56-65	18	9.20

Ergonomic risks from posture by Rapid Entire Body Assessment (REBA)

The total ergonomic risks result was detected at 8.55 (±2.72). This was informed that farmers were at high risk and needed to investigate, and behavior changes were required. The REBA scores on different working positions, ploughing, sowing rice seeds and fertilizer, and harvest are presented in Table 2

Posture of ploughing

The majority of the participants worked their farming on wheel ploughs. The ergonomic risks assessment showed in posture of ploughing; neck bent down and the trunk leaned to forward about 0-20 degrees; legs had continue movement and in unbalanced position; knees bent about 30-60 degrees and more than 22 pounds of force or workload used while moving; hands or upper arms were raised about 45-90 degrees; and the lower arms had angle between 60-100 degrees and the position of the wrists (palm bone line) had flexion and/or extension not more than 15 degrees. The hold, lift, or force positions were detected for over 1 minute. The mean REBA score was 8.33 (±2.75), which was detected as high risk, and more investigation and implementation changes were required.

Posture of sowing rice seeds and fertilizer

Most farmers used backpack gasoline seeds and fertilizer spreaders. The ergonomic risks assessment showed in a posture of sowing rice seeds and fertilizer; neck bent down and the trunk leaned forward about 0-20 degrees; legs were continued movement and in an unbalanced position; knees bent about 30-60 degrees and more than 22 pounds of force or workload used while moving; hands or upper arms were raised about 20-45 degrees; the posture of the lower arm has raised at an angle more than 100 degrees; the posture of the wrists (palm bone line) had flexion and/or extension more than 15 degrees, and it deviated (ulnar-Radial), and their body movement was repeated with small range action which was more than four times per minute. The mean REBA score was 8.42 (±2.78), which indicates a high risk that required more investigation and implementation of behavior change.

Posture of harvest

The ergonomic risks assessment showed in a posture of harvest; neck bent down more than 20 degrees. The trunk leaned forward more than 60 degrees; the legs continued movement and located unbalanced position; the knees bent more than 60 degrees; hands or upper arms were raised about 45-90 degrees; lower arms have been angle between 60-100 degrees; posture of the wrists (palm bone line) were flexion and/or extension more than 15 degrees and it twisted and deviated (ulnar-Radial), and The body movement was repeated small range action more than four times per minute. The mean REBA score was 8.91 (±2.93), which indicated that it was at a high-risk level requiring more investigation and behavior change implementation.

Table 2 Ergonomic risks by REBA assessment of participants.

REBA assessment	Mean o ergonomic risks (REBA score)	S.D.
Posture of ploughing	8.33	2.75
Posture of sowing rice seeds and fertilizer	8.42	2.78
Posture of harvest	8.91	2.93
Total ergonomic risks	8.55	2.72

Total body discomfort from working of farmers

Body discomfort assessment using the musculoskeletal discomfort questionnaire showed that the body discomfort was almost hard (3.31, ±1.17). It means that participants felt body discomfort mostly in the lower back (4.83, ±.78), thigh (4.78, ±.92), neck (4.41, ±.92), lower leg (2.68, ±1.33), and hip/buttocks (2.74, ±1.21) (Table 3).

Table 3 Total body discomfort reported by participants.

Body parts	**Level of body discomfort**	
	Mean	**S.D.**
Neck	4.41	0.92
Shoulder	3.89	1.11
Upper back	3.89	1.11
Upper arm	3.67	1.44
Lower back	4.83	0.78
Forearm	3.02	1.33
Wrist	3.33	1.32
Hip/Buttocks	2.74	1.21
Thigh	4.78	0.92
Knee	3.78	1.42
Lower leg	2.68	1.33
Total	**3.73**	**1.17**

Discussion

Farmers in the inThanamaoy Sub-district lived at a high risk of ergonomic problems, including musculoskeletal discomfort from their framing practices. Farmers worked improperly in their daily lives, leading to ergonomic-related health problems.

Ergonomic problems are frequently reported among farmers who have difficulty in a proper position while working on their farms. Several steps of farming were detected as an improper position for farming, including sowing rice seeds and fertilizing; farmers were working with backpacks of gasoline seeds and fertilizer spreaders. They needed to carry hard equipment of more than 10 kg [5] and walk in the field. This was strongly related to body discomfort with hard pain (3.31, ±1.17) level. Pengseesang [6] reported that 99.7% of farmers suffered from physical pain due to their position in their work in farming, particularly in the harvest processes. Characteristics of farming that require muscles and bones are lifting, reaching, pulling, dragging, bending, and standing. A working posture unsuitable for a long time could lead to injury. Lower back pain is the main physical problem of farmers in Thailand [11] due to these muscles acting to control the balance of the whole body while standing. The lumbar is a muscle that keeps stability for the body in efficient movement [12]. Then, several muscles collaborate to maintain the position while framers work on their farms. If working in an improper position and cannot maintain balance [13], muscles could have injury that causes pain and discomfort [14].

In addition, this study found that continued movement and the imbalanced standing position affected thigh discomfort (4.78, ±.92), which is an extremely hard level. Plowing, sowing, and fertilizing steps of farming and walking through muddy ways, the muscles control body balance for a long time, leading to pain and discomfort [15].

Conclusion

Farmers in Thailand are suffering from working at high ergonomic risk. More investigation is needed, and behavior change is required. The farmers also face a high level of musculoskeletal discomfort. Most farmers have lower back, thigh, and neck discomfort at hard to most hard levels. Implementing proper ergonomic positions among Thai farmers urgently requires measures to reduce the suffering and well-being of the core Thailand national economic drivers.

Acknowledgments

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References

[1] Khayal OMES. Human factors and ergonomics. Atbara, Sudan: Nile Valley University; 2019. DOI:10.13140/RG.2.2.11156.86404.

[2] IEA. International Ergonomics Association: Triennial Report. Santa Monica, CA: IEA Press; 2000.

[3] The Royal Institute. The Royal Institute Dictionary. Bangkok: Nanmeebooks; 2011.

[4]Prempree P. Overcoming the pesticide crisis: situation and management guidelines throughout the supply chain. Academic conference for warning about pesticides. 2015.

[5] Phanwong W, Pintakham K. Occupational health hazards of Thai rice farmers: the case study of rice farmers in Ban Du Sub-district, Muang District, Chiang Rai Province. Kasalongkham Research Journal Chiang Rai University. 2017; 11 (3: Special Issue): 125-33.

[6] Pengseesang S. Ergonomic problems and risk factors of farmers in Sriwichai Subdistrict Wanon Niwat District of Sakon Nakhon Province. [Independent study Master of Public Health]. Chiang Mai: Chiang Mai University; 2009.

[7] Yaruang N, Sukonthasarn P. Occupational safety behaviors and health status among rice farmers in Chiang Rai Province. Journal of The Royal Thai Army Nurses. 2016; 17(2): 163-74.

[8] Nakhonsawan provincial agricultural extension office, strategy and information group. Strategic plan for sustainable rice development Nakhon Sawan Province 2023 – 2027. 2022

[9] Houngmitr C, Niyamosatha K, Siriputthipong P. Behavior and practice with insecticide usage of informal sector farmer's groups at inspector bureau area no.18. The office of disease prevention and control 8 Nakhon Sawan province, Department of disease control, Ministry of public health. 2552.

[10] Setha C. Factors effecting the decision-making to purchase chemicals as pesticide of farmers in Payuhakiri district, Nakhon Sawan Province. [Independent study Master of Business Admintration]. Chiangmai: Maejo University; 2016.

[11] Teerachitkul J, Naka K, Boonphadh P. Management of muscular aches and pains in old-age rubber tappers. Thai Journal of Nursing Council. 2012; 27(2): 134-47.

[12]Akuthota V, Nadler SF. Core strengthening. Archives of Physical Medicine and Rehabilitation. 2004; 85(3 Suppl 1): S86-92. DOI: 10.1053/j.apmr.2003.12.005.

[13] Wassinger CA, McKinney H, Roane S, Davenport MJ, Owens B, Breese U, Sokell GA. The influence of upper body fatigue on dynamic standing balance. The International Journal of Sports Physical Therapy. 2014; 9(1): 40–6.

[14] Kibler WB, Press J, Sciascia A. The role of core stability in athletic function. Sport Medicine. 2006; 36(3): 189-98.

[15] Cleak MJ, Eston RG. Muscle soreness, swelling, stiffness and strength loss after intense eccentric exercise. British Journal of Sports Medicine. 1992; 26(4): 267–72.

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Original Article Open Access

Prevalence of and Associated Factors with Uncontrolled Hypertension Among Middle-Aged Adults' Hypertensive Patients in Northeast Thailand

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ABSTRACT

Introduction: Numerous connected factors influence uncontrollable hypertension. Identifying elements influencing blood pressure regulation can provide valuable insights for addressing this issue. This study aimed to explore the prevalence of and identify the factors associated with uncontrolled hypertension among middle-aged adults living in northeast Thailand.

Methods: A cross-sectional study was conducted for data collection between January and March 2023. The study population was HT patients. Descriptive statistics and multiple logistic regression were used for data analyses with a significance level 0.05.

Results: The majority were females (67.84%), and the overall prevalence of uncontrolled hypertension was 37.76% (95% CI = 30.11-46.07). In the multivariable logistic regression, five (5) variables were found to be associated with uncontrolled hypertension: inadequate/problematic applied health information (Adjusted odds ratio (AOR) = 6.09; 95%CI=1.51-8.45), knowledge on herbs for hypertension treatment (AOR=5.33; 95%CI=2.04-13.91), education (AOR=5.06; 95%CI=1.87-13.79), household income (AOR=4.98; 95%CI=2.01-12.33), and drinking use (AOR=2.13; 95%CI=1.01-4.40). Conclusion: It is crucial to promote awareness of self-care practices among individuals with uncontrolled hypertension, especially those who engage in alcohol use, individuals with high income, and those with higher educational attainment.

Keywords: Uncontrolled, Hypertension, Prevalence, Associated factors, Middle-aged adults

Introduction

Hypertension emerged as a prominent health concern within the context of Thailand. The data reported the prevalence of hypertension among those aged 15 years and older. The numerical value experienced an upward trend, rising from 10 million in 2009 to 13 million in 2014. A significant proportion, specifically 50%, of individuals who were diagnosed with hypertension had poor awareness of their condition [1]. According to the findings of the Thai National Health Examination Survey 6th (NHES) in 2021, the prevalence of hypertension was observed to be 25.4%, with a higher prevalence among males (26.7%) than females (24.2%). The finding was slightly higher than the previous survey, the 5th survey conducted in 2014, which reported a prevalence rate of 24.7% (25.6% among males and 23.9% among females). Diagnosed, treated, and managed blood pressure prevalence was lower among males than females [2]. One significant challenge encountered in the management of hypertension in Thailand pertained to patients' lack of awareness regarding the need to achieve and maintain normal blood pressure. According to the Thai Hypertension Society (2019) [3], patients suffering from uncontrolled hypertension are a significant contributing factor to the development of cardiovascular, renal, and cerebrovascular morbidity and mortality [4].

Middle-aged adults were found to have poor awareness of their blood pressure control and maintaining their healthy stage, particularly by taking medicine regularly. Several factors [5] related to uncontrolled HT in middle-aged adults include job situation, dietary behavior, exercise, etc. Grossman et 2008 [6] reported that financial status was one of the important factors that contributed to uncontrolled hypertension. An unhealthy lifestyle described, including heavy alcohol consumption, tobacco consumption, sleep duration, non-adherence to dietary recommendations, and being overweight, was associated with uncontrolled HT at the individual and combined level, particularly in men. Improvement of these health behaviors could offer effective HT management [7]. The prevalence of uncontrolled HT was detected at a higher rate among the middle-aged population, particularly those living in poverty and having a family history of hypertension [8].

Health literacy has been found to significantly impact several health outcomes, including the reduction of severe hypertension stage and hospitalizations among uncontrolled HT[9]. Health literacy is the individuals' ability to apply knowledge for themselves or for their family members to improve and maintain individual health, including utilizing health-related information to make informed decisions regarding healthcare, illness prevention, and health promotion, ultimately contributing to the enhancement and preservation of their overall quality of life over the lifespan [7]. Sorensen et al. [8] reported that individuals with higher levels of health literacy had a better health status than those with poor health literacy. Those who had limited health literacy tended to engage in risky behaviors related to disease development [9] and delayed healthcare-seeking [10, 11].

Evidence from the nationwide survey in Thailand showed a 24.6% overall prevalence of uncontrolled hypertension [16], and several factors were related to uncontrolled blood pressure among middle-aged adults. We aimed to estimate the prevalence and determine factors associated with uncontrolled HT among middle-aged adults in northeast Thailand.

Methodology

Study Area and Sample Size

A cross-sectional study was utilized. The study focused on a total of 195,692 middle-aged people with uncontrolled hypertension. The data was collected at Regional Health Centers 7, 8, 9, and 10, located in the Northeast of Thailand, between January and March 2023. The study population comprised individuals diagnosed with hypertension who had inadequate control over their blood pressure levels. The criteria for participant selection encompassed individuals aged 35 to 59 years.

A total of 143 samples were required for the analysis from the sample size calculation based on the information in a previous study [21], which achieves 80% power at a 0.05 significance level using a sample size calculation formula (Hsieh et al., 1998) [17], details as following.

$$n = \frac{P(1-P)(Z_{1-\alpha} + Z_{1-\beta})^2}{\left[B(1-B)(P_0 - P_1)^2\right]}$$

Where;

P =0.23, P0=0.62, P1=0.37, Z1-α =1.96, Z1-β =0.84, B=0.72

$$n = \frac{0.23(1-0.23)(1.96+0.84)^2}{0.72(1-0.72)(0.62-0.37)^2}$$

Then, n = 115.75, rounding to 116, which meant that at least 116 samples were required. Adding up 20% for any errors, thus, 143 samples were required for the study.

The stratified sampling method was used to select the participants for the study. In the northeastern region, four (4) distinct regional health systems are classified: Regional Health 7, Regional Health 8, Regional Health 9, and Regional Health 10. The inclusion criteria were those HT patients with uncontrolled blood pressure (³140/90 mmHg). Those who did not provide a consent form were excluded from the study.

Instruments

The questionnaires utilized in the study were designed as closed-ended and self-administered instruments which were divided into six sections: (i) information about the characteristics of a population, such as age, gender, income, and education level; (ii) the influence of environmental factors; (iii) Understanding the utilization of natural remedies for the management of hypertension; (iv) The concept of health literacy, as derived from a self-administered questionnaire known as HLS-EU-Q47; (v) Health Promoting Lifestyle Profile II (HPLP II), and (vi) PHQ-9 to assess depression.

The questionnaire was validated using the item objective congruence (IOC) method by five experts in the field. Following that, the questionnaire was modified and subsequently passed reliability testing. A pilot was used to improve the questionnaire quality: 17 questions were used to collect demographic data, environmental factors, and proficiency in applied herbal treatments for hypertension. In addition, ten questions were used to detect knowledge of herbal use for blood pressure control. Each question is provided two options; "Yes" and "No". The correct answer was scored "1", while the incorrect answer was scored "0". The total score of each participant was classified into three levels: poor (0-59% corrected answer), fair(60-79% corrected answer), and good (80-100% correct answer).

The measure of health literacy was detected by four components with 45 items: access/obtain, understand, appraise/judge/evaluate, and apply/use health information. Each question was rated using an ordinal scale that spanned from 1 to 4 (1 = very difficult, 2 = difficult, 3 = easy, 4 = very easy). The health literacy scores were classified into four distinct groups: inadequate (0-50%), problematic (51-66%), sufficient (67-84%), and excellent (85-100%). Health promotion behavior was classified into three groups using 27 question components, and each question has 4 response options. Finally, here behavior was categorized into three levels: poor (mean=1.00-2.00), moderate (mean=2.01-3.00), and good (mean=3.01-4.00).

The Patient Health Questionnaire-9 (PHQ-9) was used to evaluate the occurrence and intensity of depressive symptoms over two weeks which was employed in a 4-point Likert scale ranging from 0 (indicating no occurrence) to 3 (representing near-daily occurrence), so generating a comprehensive score that ranges from 0 to 27.

Data Analyses

Data analyses were conducted using STATA statistical version 14. Descriptive statistics of the demographic data, the environment factor, knowledge of herbal use to treat hypertension, health literacy, health promotion behavior, and depression were described using frequency and percentage for categorical data and mean, median, minimum, maximum, and standard deviation (SD) for continuous data. The estimated prevalence of uncontrolled hypertension (Uncontrolled-HT) was reported with frequency, percentage, and 95%CI. Bivariate analysis using simple logistic regression was conducted to identify crude odds and p-value for entry (Pe)<0.25 and p-value for remove (Pr)>Pe, which were used to select independent variables for the analytical model. Associated factors were determined with multiple logistic regression. The final model was obtained using the backward elimination method, and the research results were presented with the adjusted odds ratio and 95% CI at a significance level of 0.05 [18].

Ethical Considerations

The study was approved by the Ethics Committee of Khon Kean University's Institutional Assessment Board (HE652233). Written informed consent was obtained from each participant, ensuring their voluntary participation in the study. To preserve the privacy of the individuals, code names were assigned. Additionally, measures were taken to maintain the confidentiality of the collected data.

Results

The overall prevalence of uncontrolled hypertension was 37.76% (95% CI=30.11-46.07) (Table 1).

Table 1 Prevalence of uncontrolled HT patients (n=143)

Outcome	n (%)	95% CI
Controlled	89 (62.24)	53.93-69.89
Uncontrolled	54 (37.76)	30.11-46.07

The majority were female (67.84%), aged 55-59 years (32.87%), 81.12% were married and co-inhabiting, 55.24% were in primary school, 64.34% were farmers, and 51.75% had inadequate income. A large proportion (74.83%) had no family history of HT, 76.22% received a treatment by universal coverage, 13.29% smoked, 30.07% used alcohol, and 29.39% had diabetes mellitus as a comorbid disease. The majority had an average BMI of 24.07 kg/m2 (± 3.68), and the mean waist circumference was 88.03(±11.60).

The mean systolic blood pressure (SBP) was 136.03 ± 16.32 mmHg, with a standard deviation of 16.32, and the mean diastolic blood pressure (DBP) was 83.88 mmHg (±11.87). 44.06% ever used herbal, and 40.55% reported that the major source of herbal knowledge is from healthcare providers. More than half of participants (54.55%) reported that (54.55%) had 6-7 sleeping hours. Sticky rice was the main food (67.83%), 36.22% consumed soft drinks 1-3 times per week, and consumed sugar-sweet drinks 2-4 times per week (32.17%) (Table 2).

Table 2 Demographic characteristics of middle-aged adults with HT

Characteristics	n	%
Gender		
Male	46	32.16
Female	97	67.84
Age (years)		
35-39	7	4.90
40-44	20	13.98
45-49	38	26.57
50-54	31	21.68
55-59	47	32.87
Mean (± SD) = 50.36±6.45, Median (min:max) = 51(35:59)		
Marital status		
Single	15	10.49
Married/co-inhabiting	116	81.12
Separated/divorced/widowed	12	8.39
Education		
Illiterate	4	2.80
Primary school	79	55.24
High school	32	22.37
Diploma	7	4.90
College	6	4.20
Master's degree or higher	15	10.49
Occupation		
Unemployed	5	3.50
Agriculturist	92	64.34
Private business	9	6.29
Officer	20	13.99
Housewife	5	3.50
Employed	12	8.38
Household income (baht)		
none	8	5.59
≤5,000	55	38.45
5,001 – 10,000	34	23.78
10,001 – 15,000	18	12.59
> 15,000	28	19.59
Adequacy of income		
No	74	51.75
Yes	69	48.25
Health insurance		
Private health insurance	4	2.80
Social security scheme	23	16.08
Universal coverage scheme	109	76.22
Government officer	7	4.90

Characteristics	n	%
Family history of hypertension		
No	107	74.83
Yes	36	25.17
Smoking		
Never	113	79.02
Ever	11	7.69
Current smoker	19	13.29
Alcohol use		
Nondrinker	83	58.04
Ever	17	11.89
Current drinker	43	30.07
Comorbidity		
None	71	49.66
Diabetes mellitus	42	29.39
Hyperlipidemia	21	14.69
Ischemic heart disease (IHD)	2	1.39
Gout	1	0.69
Kidney disease	1	0.69
Other	5	3.49
Physical activity		
Yes	102	71.33
No	41	28.67
BMI (kg/m^2)		
<18.5	1	0.70
18.5-22.99	27	18.88
23-24.99	29	20.28
>25	86	60.14
Waist circumference (cm) (mean ± SD)	88.03± 11.60	
Blood pressure (mmHg)		
SBP (mean ± SD)	136.03 ±16.32	
DBP (mean ± SD)	83.88± 11.87	
Herbal use		
No	63	44.06
Few	20	13.98
Sometime	53	37.06
Frequently	2	1.40
Regular	5	3.50
Patterns of herbal use		
Tea	19	23.75
Powder	2	2.50
Extract	4	5.00
Capsule	26	32.50
Bolus	7	8.75
Decoction	22	27.50
Herbal knowledge source		
Healthcare providers	58	40.55
Friend	30	20.99
Relative	55	38.46
Sleep duration (hrs)		
< 4	9	6.29
4-5	26	18.18
6-7	78	54.55
>7	30	20.98

Characteristics	n	%
Type of rice consumption		
Sticky rice	97	67.83
Cooked rice	35	24.47
Brown rice	7	4.90
Rice Berry	4	2.80
Vegetable consumption		
Not daily	98	68.53
Daily	45	31.47
Soft drink		
No	45	35.71
< 1 time/month	29	22.83
1-3 time/week	46	36.22
4-6 time/week	1	0.65
> 6time/month	5	3.94
>1 time/day	1	0.65
Sugar sweet drink		
No	31	21.68
1 time/week	42	29.37
2-4 time/week	46	32.17
≥1 time/day	24	16.78
Duration of work (hrs/day)		
< 8	74	51.75
8-10	53	37.06
> 10	16	11.19
Communities		
Semi-urban	23	16.08
Rural	98	68.53
Urban	22	15.38
Housing		
Private house	127	88.81
Living with relatives	2	1.40
Rental	12	8.39
Welfare house	2	1.40
Place of work		
Outdoor	22	15.38
Indoor	47	32.87
Outdoor switch indoor	74	51.75
Environment pollution		
Low level	14	9.79
Moderate level	129	90.21

Table 3 Predisposing factors of HT

Factors	n	%
Knowledge of herbs for hypertension care		
Low (<60%)	26	18.18
Moderate (60-79.99)	48	33.57
High (≥80%)	69	48.25
Health literacy (total)		
Inadequate (0-50%)	30	20.98
Problematic (51-66%)	100	69.93
Sufficient (67-84%)	11	7.69
Excellent (≥85%)	2	1.40
HL finding health information (FHI)		
Inadequate (0-50%)	10	6.99
Problematic (51-66%)	32	22.38
Sufficient (67-84%)	79	55.24
Excellent (≥85%)	22	15.39

Factors	n	%
HL understanding health information (UHI)		
Inadequate (0-50%)	4	2.80
Problematic (51-66%)	4	2.80
Sufficient (67-84%)	92	64.34
Excellent (≥85%)	43	30.06
HL judging health information (JHI)		
Inadequate (0-50%)	2	1.40
Problematic (51-66%)	22	15.38
Sufficient (67-84%)	89	62.24
Excellent (≥85%)	30	20.98
HL applying health information (AHI)		
Inadequate (0-50%)	2	1.40
Problematic (51-66%)	10	6.99
Sufficient (67-84%)	94	65.73
Excellent (≥85%)	37	25.88
Health-promoting behavior		
Good (3.01-4.00)	36	25.17
Fair (2.01-3.00)	85	59.44
Poor (1.00-2.00)	22	15.39
Depression		
None (<7)	122	85.31
Mild (7-12)	18	12.59
Moderate (13-18)	3	2.10

48.25% had a high knowledge of hypertension, 55.24% had sufficient HL finding health information, 64.34% had sufficient HL understanding health information, 62.24% had sufficient HL judging health information, and 65.73% had sufficient HL applying health information.

In the univariable analysis, eight variables were found to be associated with uncontrolled hypertension among middle-aged adults with HT: Marital status, education, household income, health insurance, family history of hypertension, type of rice consumption, knowledge of herb for hypertension, HL applying health information (AHI) (Table 4).

Table 4 Univariable analysis for factors associated with uncontrolled hypertension among middle-aged adults with HT.

Factors	n	Uncontrolled HT (%)	OR	95%CI
Gender				
Female	97	32.99	1.00	
Male	46	47.83	1.86	0.90-3.81
Age (years)				
35-44	27	37.04	1.00	
45-54	69	39.13	1.09	0.43-2.73
≥55	47	36.17	0.96	0.36-2.57
Marital status				
Single	12	25.00	1.00	
Married/cohabiting	116	34.48	1.57	0.40-6.16
Separated/divorced/widowed	15	37.76	8.22	1.45-16.85*
Education				
Lower diploma	115	30.43	1.00	
Diploma or higher	28	67.86	4.82	1.98-11.71*
Occupation				
Unemployed /housewife	10	40.00	1.00	
Agriculturist	92	32.61	0.72	0.19-2.76
Private business /employed	21	23.81	0.47	0.09-2.35
Officer	20	75.00	4.5	0.89-12.74
Household income (baht)				
≤ 15,000	115	30.43	1.00	
>15,000	28	67.86	4.82	1.98-11.71*
Adequacy of income				
No	74	30.43	1.00	
Yes	69	67.86	1.42	0.72-2.80
Healthcare insurance				
Universal coverage scheme/ private health insurance	113	31.86	1.00	
Government officer /Social security scheme	30	60.00	3.20	1.39-7.36*
Family history of hypertension				
No	107	42.99	1.00	
Yes	36	22.22	0.37	0.15-0.90*

Factors	n	Uncontrolled HT (%)	OR	95%CI
Smoking				
Never	113	34.51	1.00	
Ever	11	63.64	3.32	0.91-12.04
Current smoker	19	42.11	1.38	0.51-3.71
Alcohol use				
None	83	36.14	1.00	
Ever	17	11.76	0.23	0.05-1.10
Current drinker	43	51.16	1.85	0.87-3.90
Comorbidity				
No	10	60.00	1.00	
Yes	133	36.09	0.37	0.10-1.40
Physical activity				
Yes	102	34.31	1.00	
No	41	46.34	1.65	0.79-3.45
BMI (kg/m^2)				
Low/normal (<23)	28	35.71	1.00	
Over weight(23-24.99)	29	37.93	1.10	0.37-3.22
Obesity (>25)	86	38.37	1.12	0.46-2.72
Waist circumference (cm)				
Normal(<80 cm.for women, <90 cm. for men)	42	35.71	1.00	
Abnormal (≥80 cm. for women, ≥90 cm. for men)	101	38.61	1.13	0.53-2.39
Herbal use				
No	80	38.75	1.00	
Yes	63	36.51	0.90	0.45-1.79
Sleep duration per night (hrs)				
< 4	9	44.44	1.00	
4-5	26	57.69	1.70	0.36-7.85
6-7	78	35.90	0.70	0.17-2.82
>7	30	23.33	0.38	0.07-1.81
Type of rice consumption				
Sticky rice	97	29.90	1.00	
Cooked rice	35	57.14	3.12	1.40-6.94*
Brown rice/ Rice Berry	11	45.45	1.95	0.55-6.91
Vegetable consumption				
Not daily	113	38.05	1.00	
Daily	30	36.67	0.94	0.40-2.17
Soft drink				
Not drink	45	42.22	1.00	
< 1 time/month	29	34.48	0.72	0.27-1.89
1-3 time/ month	45	35.56	0.75	0.32-1.76
1-3 time/ week	17	29.41	0.57	0.17-1.89
≥4-6 time/week	7	57.14	1.82	0.36-9.12
Sugar sweet drink				
Not drink	31	48.39	1.00	
1 time/week	42	26.19	0.37	0.14-1.01
2-4 time/week	46	36.96	0.62	0.24-1.57
≥1 time/day	24	45.83	0.90	0.31-2.62
Duration of work per day (hrs)				
≥8	69	36.23	1.00	
<8	74	39.19	1.13	0.57-2.23
Communities				
Semi-urban	23	52.17	1.00	
Rural	98	32.65	0.44	0.17-1.11
Urban	22	45.45	0.76	0.23-2.46

Factors	n	Uncontrolled HT (%)	OR	95%CI
Housing				
Private house	129	35.66	1.00	
Rental	14	38.39	1.55	0.88-2.71
Place of work				
Indoor	47	38.30	1.00	
Outdoor	22	40.91	1.11	0.39-3.13
Outdoor switch indoor	74	36.49	0.92	0.43-1.96
Environment pollution				
Low level	129	36.43	1.00	
Moderate level	14	50.00	1.74	0.57-5.27
Knowledge of herbs for hypertension				
Moderate and high	117	32.48	1.00	
Low	26	61.54	3.32	1.38-8.01*
HL applying health information (AHI)				
Sufficient /Excellent	131	34.35	1.00	
Inadequate/ Problematic	12	75.00	5.73	1.47-6.23*
Health-promoting behavior				
Good / Fair	107	38.32	1.00	
Poor	36	36.11	0.90	0.41-1.92
Depression				
None (<7)	122	37.70	1.00	
Mild (7-12)	18	33.33	0.82	0.29-2.35
Moderate (13-18)	3	66.67	3.30	0.29-7.46

*Significant level at α=0.05

After backward elimination in the final multivariable model, four variables were found to be associated with uncontrolled HT: HL applying health information (AOR = 6.09; 95% CI = 1.51-8.45), knowledge of herbs for hypertension (AOR = 5.33; 95% CI = 2.04-13.91), education (AOR = 5.06; 95% CI =1.87-13.79), household income (AOR = 4.98; 95% CI = 2.01-12.33), and drinking use (AOR = 2.13; 95% CI =1.01-4.40) (Table 5).

Table 5 Identifying factors associated with uncontrolled HT by multivariable logistic regression.

Factors	n	% of Uncontrolled HT	AOR (95%CI)	p-value
HL applying health information (AHI)				
Sufficient /Excellent	131	34.35	1.00	0.011*
Inadequate/ Problematic	12	75.00	6.09 (1.51-8.45)	
Knowledge of herbs for hypertension				
Moderate and High	117	32.48	1.00	0.001*
Low	26	61.54	5.33 (2.04-13.91)	
Educational Levels				
Lower diploma	115	30.43	1.00	0.001*
Diploma or higher	28	67.86	5.06 (1.87-13.79)	
Household income (baht)				
≤15,000	115	30.43	1.00	0.001*
>15,000	28	67.86	4.98 (2.01-12.33)	
Alcohol consumption				
Nondrinker/ Ex-drinker	100	32.00	1.00	0.041*
Current drinker	43	51.16	2.13 (1.01-4.40)	

*Significant level at α=0.05

Discussion

The findings of this study have significant implications for the public health system in Thailand, as hypertension has been identified as the primary cause of death of Thais. The findings of this study indicate that there is a considerable incidence of uncontrolled hypertension among late Thai adults who already have hypertension, with a rate of 37.76% (95% CI: 30.11-46.07). The current study observed a lower prevalence of uncontrolled hypertension than in India [19]. A study conducted in Thailand in 2019 reported that the prevalence of uncontrolled hypertension was 24.6% [20], which was lower than our findings.

In the domain of health literacy about the utilization of information about hypertension, it has been shown that individuals possessing inadequate/problematic information have difficulties in effectively managing hypertension. The p-value of 0.011 obtained in this study is deemed statistically significant. These findings align with the results reported by Kevser et al. (2018) [21] in their investigation on the health conditions of individuals with uncontrolled blood pressure, reported that those individuals with low health literacy had a 2.06-fold increased risk of developing uncontrolled hypertension. Aloufi et al. [22] reported that uncontrolled HT was associated with poor knowledge of herbs. Knowledge of herbs could be one of the options for caring for HT patients.

HT patients with postgraduate diploma education who had uncontrolled hypertension were at risk of experiencing uncontrolled blood pressure levels, which coincides with a study conducted by Meesub [23], who reported that HT patients with high education were associated with uncontrolled blood pressure. This might be because those with high education tend to work office jobs with poor movement. People's occupation characteristics were related to blood pressure [24].

Household income was an associated factor with uncontrolled blood pressure among HT patients. Specifically, individuals with an average monthly household income exceeding 15,000 baht were found to have a higher risk of developing uncontrolled hypertension compared to those with an average family income below 15,000 baht. This might be because those with high incomes could buy several kinds of food for daily consumption. Eating patterns, including the quantity, could contribute to uncontrolled blood pressure [25].

The consumption of alcohol was found to be a factor that indicated an association with the presence of unmanageable high blood pressure. Abdisa et al. [26] also reported that those who consumed alcohol had a higher rate of uncontrolled HT than those who did not. It is clearly known that alcohol is one of the sources that leads to poor quality blood vessel function and uncontrolled blood pressure. However, for those aged 60 years and lower, alcohol use had little impact on their blood pressure control [27].

Conclusion

A large proportion of middle-aged adults' population living in northeastern Thailand who are diagnosed with HT are suffering from uncontrolled blood pressure. One of the critical health promotions approaches that could support these patients in controlling their blood pressure is improving health literacy related to HT and encouraging them to use herbs for HT care in daily life. However, the interventions should focus on high-income and alcohol-use patients.

References

[1] Aekplakorn W. Thai national health examination survey 5th (NHES) in 2014. Nontaburi. Health Systems Research Institute (HSRI). 2014.

[2] Aekplakorn W. Thai national health examination survey 6th (NHES) in 2021.Nontaburi. Health Systems Research Institute (HSRI). 2021.

[3] Thai Hypertension Society. Guidelines in the treatment of hypertension 2019. 2019; Bankkok.

[4] Van de VS, Akinyi H, Oti S, Olajide A, Agyemang C, Aboderin I, et al. Status report on hypertension in Africa-consultative review for the 6th Session of the African Union Conference of Ministers of Health on NCD’s. Pan African Medical Journal. 2014; 16(1).

[5] Lee GKY, Wang HHX, Liu KQL, Cheung Y, Morisky Ds, Wong MCS. Determinants of medication adherence to antihypertensive medications among Chinese population using morisky medication adherence scale. PLoSOne. 2013; , 8(4), 62-75.

[6] Nguyen TN, Chow CK. Global and national high blood pressure burden and control. Lancet. 2021; 398(10304):932-3.

[7] David JH, Valory NP . Characteristics of patients with uncontrolled hypertension in the United States. N Engl J Med. 2001; 345:479-85.

[8] Cherfan, M., Vallée, A., Kab, S. et. at. Unhealthy behaviors and risk of uncontrolled hypertension among treated individuals-the constances population-based study. Sci Rep. 2020; 10, 1925. https://doi.org/10.1038/s41598-020-58685-1

[9] Hu L, Huang X, Zhou W, You C, Li J, Li P, et al. Effect of hypertension status on the association between sleep duration and stroke among middle-aged and elderly population. J Clin Hypertens. 2020; 22(1):65-73.

[10] Nielsen-Bohlman L, Panzer AM, Kindig DA. Health literacy: a prescription to end confusion: what is health literacy? 2004. Available from: https://www.ncbi.nlm.nih.gov/books/NBK216035/

[11] Cho YD, Lee SY, Arozullah A, Crittenden K. Effects of health literacy on health status and health service utilization amongst the elderly. Social Science& Medicine. 2008; 66, 1809-16.

[12] Sorensen K, Pelikan JM, Rothlin F, Ganahl K, Slonska Z, Doyle G, et al. Health literacy in Europe: comparative results of the European health literacy survey (HLS-EU). Eur J Public Health. 2015; 25(6), 1053-8.

[13] Ghaddar SF, Valerio MA, Garcia CM, Hansen L. Adolescent health literacy: the importance of credible sources for online health information. J Sch Health. 2012; 82(1), 28-36.

[14] Nutbeam D. The evolving concept of health literacy. Soc Sci Med. 2008; 67(12), 2072-8.

[15] McNaughton CD, Self WH, Zhu Y, Janke AT, Storrow AB, Levy P. Incidence of Hypertension-related emergency department visits in the United States, 2006 to 2012. Am J Cardiol. 2015; 116(11):1717-23.

[16] Sakboonyarat et al. Prevalence and associated factors of uncontrolled hypertension among hypertensive patients: a nation-wide survey in Thailand. BMC Res Notes. 2019; 12(380): 1-8.

[17] Hsieh FY, Block DA, Larsen MD. A simple method of sample size calculation for linear and logistic regression, statistics in medicine. 1998; 17:1623-1634.

[18] Hosmer DW. Lemeshow S, Sturdivant RX .Applied logistic regression: John Wiley &Sons. 2013.

[19] Kapoor M, Dhar M, Mirza A, Saxena V, Pathania M. Factors responsible for uncontrolled hypertension in the adults over 50 years of age: a pilot study from Northern India. Indian Heart J. 2021; 73(5):644-646.

[20] Sakboonyarat B, Rangsin R, Kantiwong A, Mungthin M. Prevalence and associated factors of uncontrolled hypertension among hypertensive patients: a nation-wide survey in Thailand. BMC Res Notes. 2019 4;12(1):380.

[21] Kevser TS, Yeliz M, Tuba A. Uncontrolled blood pressure in patients with hypertension and associated factors: the role of low health literacy. J Clin Pract Res. 2018; 40(4), 222-227.

[22] Aloufi BH, Atwan MA, Alshammari AM. Treatment of hypertension by using natural herbs and their mechanism of action. J Biochem Technol. 2022; 13(2): 19-28.

[23] Meesub P. Prevalence and factors affecting uncontrolled bood pressure in elderly hypertensive patients in Chiang Khong Hospital, Chiang Rai Province. PCMC. 2021; 4(2), 61-69

[24] Sakboonyarat B, Rangsin R, Kantiwong A, Mungthin M. Prevalence and associated factors of uncontrolled hypertension among hypertensive patients: a nation-wide survey in Thailand. BMC Res Notes. 2019; 12(1), 380.

[25] Hnuploy K, Sakrangkul K, Naepimay N, Changkaew S. Prevalence and factors associated with pre-diabetes mellitus among myanmar migrant workers in Suratthani Province. Health Sci J Thai. 2022; 4(1): 1-9.

[26] Abdisa L, Girma S, Lami M, Hiko A, Yadeta E, Geneti Y, et al. Uncontrolled hypertension and associated factors among adult hypertensive patients on follow-up at public hospitals, Eastern Ethiopia: a multicenter study. SAGE Open Med. 2022; 10, 1-12.

[27] Visanuyothin S. Health literacy and self-management behaviors among poorly controlled hypertension patients at the primary care level in an urban community of Nakhon Ratchasima Province, Thailand. Journal of Public Health and Development. 2019; 17(1)

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Factors Affecting the Effectiveness of Auditory and Speech Development in Pre-Lingual Deaf Children After Cochlear Implantation

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ABSTRACT

Introduction: A cochlear implant (CI) is an electronic device provided for deaf patients. Congenitally deaf children generally have delayed speech and language development due to hearing impairment. The aim after implantation is for patients to have speech development the same as normal-hearing children and to be able to communicate with other people by verbal language. However, some children provided with a CI at Siriraj Hospital were still unable to use spoken language and had delayed speech and language development. This study aimed to examine factors that affected the outcomes after cochlear implantation at Siriraj Hospital.

Methods: Sixty pre-lingual deaf children with CI were included in the research, which was a retrospective study. Three main related factors, consisting of age at implantation, duration of hearing deprivation, and multiple disabilities, were reviewed that affected the development in CI patients. The data were collected from Siriraj's outpatient department (OPD) documents between 1 January 2014 and 31 October 2022. The auditory and speech developments of participants in this study were compared with developmental milestones.

Results: The findings showed that 14 patients had auditory and speech developments similar to children with normal hearing (23.3%), and 46 samples experienced delayed developments (76.7%). The duration of auditory deprivation showed significant differences between successful and unsuccessful patients (p-value<0.05), while ages at implantation and multi-disabilities were not statistically different.

Conclusion: The significant factor affecting the auditory and speech development of CI patients from Siriraj Hospital was the duration of auditory deprivation. Samples who had periods of auditory deprivation more than or equal to 1.5 years tended to be more unsuccessful than those ages less than 1.5 years by 5.5 times.

Keywords: Cochlear implant, Auditory deprivation, Hearing loss, Pre-lingual Deafness, Speech development

Introduction

Hearing loss is the inability to hear sounds appropriately, leading to difficulty in understanding speech sounds. It can occur in one ear (unilateral) or both ears (bilateral). The capability to comprehend a conversation depends on the severity of hearing impairment, which can be categorized by hearing levels. People with mild to moderate hearing loss may have difficulty understanding words, especially in a noisy environment. In contrast, people with severe to profound deafness cannot hear anything, even in quiet situations [1]. ASHA (2011) states a profound hearing loss is hearing thresholds over 90 decibels [2]. In the past, Thai speech-language, and hearing association (THAISHA) followed ASHA's criteria. However, in 2022, the criteria changed to WHO's criteria. WHO (2008) classified a profound hearing impairment at hearing thresholds of more than 80 decibels [3].

Children with severe to profound hearing loss principally have delayed speech and language development. This is because they cannot perceive sounds to develop their auditory skill, which is the principle of speech and language development [4]. When children are diagnosed with hearing impairment, children will be required to fit a hearing aid to motivate inner ear function. If children do not have any benefit from traditional amplification devices, cochlear implantation (CI) will be considered [5]. The limitation of traditional hearing devices for deaf patients is they can hear sounds but do not understand meaning, especially speech sounds. Unfortunately, some cases who have total deafness are incapable of hearing any sound, even when hearing aids are set at full-on gain. These limitations may result in delayed speech and language development. Therefore, cochlear implantation is an alternative opportunity to improve children's development. The main purpose of cochlear implantation is so children can communicate with other people by using verbal language [6]. However, the perception of speech sounds between CI and normal-hearing children is incompatible. Sounds that children with CI hear are dissimilar to natural sounds.

For this reason, auditory training is exceptionally recommended for children after implantation to develop their speech and language skills to be equal to children with normal hearing [7]. At Siriraj Hospital, the number of children with CI has increased over the years. Some patients can use spoken language to communicate with other people and have speech and language development similar to normal-hearing children, while others cannot and have delayed speech and language development.

According to Patni et al [8] and Niparko et al [9] factors affecting the outcome of children with CI were the age at implantation and the duration of auditory deprivation. According to the study by Gaurav et al [10] patients wearing CI under five years had better speech and language development than patients over five years. Additionally, the research of Karltorp et al [11] revealed that children with the age at implantation under 5 to 11 months had speech and language development similar to children with normal hearing. Furthermore, other factors affecting the CI results were patients who had multiple disabilities such as autistic spectrum, learning disorder, or cerebral palsy. These factors can cause delayed speech and language development after implantation [12-13]. This study aimed to retrospectively explore factors that affect the outcome of pre-lingual children after cochlear implantation (CI) at Siriraj Hospital.

Methods

This research was a retrospective study. It was approved by the International Review Board (IRB) under the Faculty of Medicine, Siriraj Hospital, Ethics Framework 717/2022 (IRB4). The data were collected using information from out-patient-department (OPD) documents of Siriraj Hospital between 1 January 2014 and 31 October 2022. The inclusion criteria were children with pre-lingual deafness, having congenital profound hearing loss in both ears, and experiencing CI for at least two years.

The sample size was calculated by using the Rule of Thumb. From previous studies, there were three main factors related to the development of CI recipients: age at implantation, duration of hearing deprivation, and multiple disabilities. For this study, the researcher required five patients per one factor, so the number of successful and unsuccessful samples was 3 x 10 = 30. The percentage of successful patients at Siriraj Hospital was roughly 20. Therefore, the appropriate number of samples was 100 x 30/20 = 150. However, 60 CI children were recruited from all 110 patients for this study. Patients with post-lingual deafness, having progressive hearing loss, having operated CI for less than two years, and receiving some benefits from hearing aids before implantation were excluded from this study. The duration of data collection was around six months.

Statistical analysis

An unpaired t-test was used to analyze factors affecting speech and language development of CI children compared with Developmental Milestones for each independent variable. The Mann-Whitney U test was used for continuous data, and Chi-square or Fisher's exact tests were used for grouped data. Multiple logistic regression was used to analyze the relationship between dependent and independent variables. Moreover, an odds ratio (OR) was used to report the association between two events with a 95% odd ratio.

Results

The average patient age in this study was approximately 8.58 ± 2.32 years. The impairment was diagnosed at the age of around 1.44 ± 0.64 years. The implantation and duration of CI ages were about 2.88 ± 1.13 and 5.83 ± 2.37 years, respectively (Table 1).

Table 1 General information of samples

	Mean	SD	Median	Min	Max
Patient age	8.58	2.32	8.67	4.5	16.08
Diagnostic age	1.44	0.64	1.58	0.25	2.5
CI implantation age	2.88	1.13	2.87	0.92	5.17
Duration of CI age	5.83	2.37	5.25	2.33	14.58

Speech development was used to classify patients into two groups. From the total number of 60 CI patients in this study, 14 CI patients (23.3%) had speech and language development similar to children with normal hearing, which were categorized into successful groups, while 46 patients with CI (76.6%) had delayed speech and language development, classified into unsuccessful groups (Table 2).

Table 2 Percentage of successful and unsuccessful patients

Outcome	n	%
Successful patients	14	23.3
Unsuccessful patients	46	76.7
Total	**60**	**100**

The successful group's average CI implantation age was roughly 2.17 ± 0.94 years. The duration of auditory deprivation was about 0.98 ± 0.62 years (the period before fitting a hearing aid). Three children had other disabilities regarding visual problems, which was 21.43% of the total group. One sample had an auditory nerve problem (7.14%) (Table 3).

The total number of unsuccessful patients was 46. They were operated on for CI implantation at around 3.10 ± 1.10 years. The duration of auditory deprivation was higher than the successful group, which was approximately 1.59 ± 0.98 years. There were five patients with other disabilities and ten auditory nerve problems (10.87% and 21.74% of this group), respectively. In this group, seven children attended a mainstream school, and 13 participants lost follow-up from the hospital (Table 3).

Table 3 Comparison between successful and unsuccessful groups

Factors	Successful (n = 14)	Unsuccessful (n = 46)	p-value
CI implantation age	2.17 ± 0.94	3.10 ± 1.10	0.319
Duration of auditory deprivation	0.98 ± 0.62	1.59 ± 0.98	0.016*
Duration of auditory deprivation (years)			
< 1.5	12 (85.7%)	24 (52.2%)	0.025*
≥ 1.5#	2 (14.3%)	22 (47.8%)	
Multiple disabilities	3 (37.5%)	5 (62.5%)	0.374
Auditory nerve problems	1 (9.1%)	10 (90.9%)	0.430

#Odds ratio (95% CI) = 5.50 (1.11, 27.37); *Significant level at α=0.05

The duration of auditory deprivation was statistically significant when comparing the results of successful and unsuccessful patients (p-value < 0.05). The average auditory deprivation for the successful group was about 0.98 years, while for the unsuccessful group, it was roughly 1.59 years. Children who had auditory deprivation more than or equal to 1.5 years had an opportunity to be unsuccessful patients by 5.5 times of ages under 1.5 years. On the other hand, other factors, including CI implantation age, multiple disabilities, and auditory nerve problems, had no statistical significance (p-value > 0.05). Moreover, no factors affected speech and language development after implantation when analyzing data with multiple logistic regression (Table 3).

Figure 1 Auditory and speech development of participants comparing CI ages.

Discussion

CI is an optional surgery for deaf patients who do not derive any benefits from hearing aids. The outcomes after implantation rely on several factors. The objective of this study was to explore factors that affect the effectiveness of auditory and speech development after cochlear implantation at Siriraj Hospital to recommend appropriate advice before implantation and to design a proper intervention after implantation for each patient. Figure 1 illustrates the development of each participant in terms of auditory and speech skills. A total of 60 patients were included in this study. The green line represents the ages of using CI. Squares and triangles mean hearing and speech development of each participant, respectively. There were 14 patients with auditory and speech development equal to CI ages (23.3%, square and triangle overlap green line) and 46 samples with delayed speech and language development (76.7%, square and triangle under green line). Developmental milestones in this study are at a maximum of 4 years. Participants with auditory and speech development over four years were grouped as successful. This is because they can understand speech and communicate with other people.

In addition, understanding the language of some participants in Figure 1 was better than speech because receptive language is generally developed faster than expressive language [14]. Receptive language is the capacity to comprehend language from hearing or reading. It is the elementary step before expressing language through verbal or nonverbal communication [15]. Therefore, some children are better able to develop receptively than expressively. The researcher used speech development in this study to categorize successful and unsuccessful groups. Overall, the CI ages of the successful group were approximately under five and over seven years.

According to other related studies, three main factors affected speech and language development after cochlear implantation. The most relevant factor was the duration of auditory deprivation, followed by ages receiving CI and multiple disabilities, respectively. The significant difference between successful and unsuccessful patients from this study was the duration of auditory deprivation. The result of this study demonstrated that the average of the successful group had a lower period of auditory deprivation than that of the unsuccessful group. Furthermore, the average CI implantation ages in the successful group were likely lower than in the unsuccessful group, but there was no statistical difference. In addition, other disabilities and auditory nerve problems in the successful group tended to be lower than in the unsuccessful group, but there was no statistical difference. This is because the sample size in this study was too small to analyze the data. If there are more samples in the research, some results might differ significantly.

Additionally, this study was a retrospective study, so some aspects may not have been able to be recruited into this study. This is the restriction of this research. For example, the consistency of intervention after implantation and family support may affect the outcome after implantation, but these factors were not included in this study. Some children attended auditory training at other hospitals, so the OPD document would not record this information. Therefore, further studies may include more factors related to auditory and speech development effectiveness after cochlear implantation.

Conclusion

For this study, the duration of auditory deprivation affected children's development in terms of auditory and language skills in pre-lingual deafness children after cochlear implantation, which was significantly lower than that of unsuccessful patients. Children with auditory deprivation over or equal to 1.5 years would experience delayed speech and language development rather than those under 1.5 years. Other factors, including ages with CI and multiple disabilities, were not statistically different between successful and unsuccessful groups. In the future, if the number of CI patients at Siriraj Hospital increases, more factors might be included in further studies.

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References

[1] Adam F. What's to know about deafness and hearing loss? 2023. Available from: https://www.medicalnewstoday.com/articles/249285 [Accessed 2023, July 18]

[2] American Speech-Language-Hearing Association. Type, degree, and configuration of hearing Loss. Audiology Information Series. 2011.

[3] Grades of Hearing Impairment. Geneva: World Health Organization. 2008. Available from: https://ec.europa.eu/health/scientific_committees/opinions_layman/en/hearing-loss-personal-music-player-mp3/figtableboxes/table-4.htm [Accessed 2023, January 31]

[4] Lertsukprasert K. Hearing Abnormalities. 2nd edition. Khon Kaen: Khon Kaenthuraphan Ltd. 2007. (In Thai)

[5] Luangpitakchumpon P. Hearing and speech abilities of deaf children using cochlear implants aged 1-5 years. 1st edition. Bangkok: Eakkarnpim Ltd. 2010. (In Thai)

[6] Tammasaeng M, Mitranun C. The quality of life of children with cochlear implantation: parental perspectives and experiences. Journal of Graduate Studies Valaya Alongkorn Rajabhat University. 2018; 12(2): 35-48. (In Thai)

[7] Boonmee S, Tammasaeng M. The auditory ability of the hearing impaired children with cochlear implantation at Rajavithi Hospital. Journal of Research and Development in Special Education. 2018; 7(1): 42-55. (In Thai)

[8] Patni P, Dalmia D, Udayanila T, Katakdhond H, Bhagavan K. Factors affecting outcome of cochlear implant: an observational Ssudy. International Journal of Otorhinolaryngology and Head and Neck Surgery. 2020; 6(10): 1811-1817.

[9] Niparko JK, Tobey EA, Thal DJ, Eisenberg LS, Wang N, Quittner AL, et al. Spoken language development in children following cochlear implantation. JAMA. 2010; 303(15): 1498-1506.

[10] Gaurav V, Sharma S, Singh S. Effects of age at cochlear implantation on auditory outcomes in cochlear implant recipient children. Indian J Otolaryngol Head Neck Surg. 2020; 72(1): 79-85.

[11] Karltorp ., Eklof M, Ostlund E, Asp F, Tideholm B, Lofkvist U. Cochlear implants before 9 months of age led to more natural spoken language development without increased surgical risks. Acta Paediatrica. 2019; 109(2): 332-341.

[12] Cejas I, Hoffman M, Quittner A. Outcomes and benefits of pediatric cochlear implantation in children with additional disabilities: a review and report of family influences on outcomes. Pediatric Health, Medicine and Therapeutics. 2015; 45-63.

[13] Glennon E, Svirsky M, Froemke R. Auditory cortical plasticity in cochlear implant users. Curr Opin Neurobiol. 2020; 108-114.

[14] Wallace A. Receptive language vs. expressive language: talking and listening. 2023. Available from: https://napacenter.org/receptive-vs-expressive-language/ [Accessed 2023, July 31)

[15] Vollmer E. Expressive vs. receptive language. 2020. Available from: https://therapyworks.com/blog/language-development/home-tips/expressive-vs-receptive-language/ [Accessed 2023, July 31)

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Yoga as a Complimentary and Alternative Therapy for Premenstrual Syndrome

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ABSTRACT

Introduction: Premenstrual syndrome (PMS) refers to the emotional and physical symptoms that occur one to two weeks before the start of each menstrual period. Yoga has been proven as an alternative treatment for symptomatic relief in menstruation conditions. The objective of this study is to assess the effect of yoga on urban women with premenstrual syndrome.

Methods: An online two-group pre-post experimental study design was conducted on (N=60) women suffering PMS symptoms from major Indian cities. Females having a history of normal menstrual cycle were included in this study. Women with menstrual disorders, physical and mental illness and female already practicing yoga have been excluded from the study. Informed consent and pre-post PMS scores were procured from all the participants. Yoga interventions were practiced for one hour daily, five days a week for 30 days and the control group followed their routine activities.

Result: The present study reported (21.04%) reduction in total premenstrual syndrome symptoms in the yoga group which was highly significant with (p-value=0.001), whereas in the control group only (1.63%) reduction in premenstrual syndrome symptoms, which was not statistically significant with (p-value=0.335) using Wilcoxon test.

Conclusion: Yoga is an effective practice in reducing premenstrual syndrome.

Keywords: Premenstrual Syndrome; Women health; Psycho-physiological health; Yoga practice; Therapy

Introduction

Millions of women undergo premenstrual syndrome (PMS) during the reproductive phase of life. Premenstrual syndrome, a common cyclic disorder found in young and middle-aged women, is characterized by emotional and physical symptoms that consistently occur during the luteal phase of the menstrual cycle. Precisely PMS is depiction of hormonal changes in body exhibited via behavioral, psychological, and physical symptoms. The disorders can manifest with a wide variety of symptoms, including depression, mood lability, abdominal pain, breast tenderness, headache, and fatigue [1].

College-going students experiencing premenstrual syndrome account for (67%) of the reproductive age female population and the numbers are large as compared to the working women and housewife. Thereafter, second most affect group would be the working women and a smaller percentage of population is housewives [2]. In India around (27.7%) of the females of age group 15-29 years encounter this condition. Numerous epidemiological studies concluded that around (80%) of the women experience some symptoms in their premenstrual phase [3]. The prevalence of premenstrual syndrome was (18.4%). Moderate to severe premenstrual syndrome was (14.7%) and PMDD was (3.7%) according to DSM IV-TR and (91%) according to International Classification of Diseases, 10th edition criteria. The symptoms commonly reported were fatigue and lack of energy, decreased interest in work, and anger or irritability. The most common functional impairment item was school productivity and work efficiency. premenstrual symptom screening tool (PSST) has (90.9%) sensitivity, (57.01%) specificity, and (97.01%) predictive value of negative test [3].

Women with premenstrual syndrome show majority of symptoms, particularly during luteal phase, regularly every month. These symptoms are classified into 3 emotional (EM), physical (PHY) and behavioral (BE) categories [4]. The common symptoms of premenstrual syndrome are bloating, breast tenderness, headache, frequent urination, loss of appetite, insomnia, irritability, depression, lack of energy and increased or decreased of libido [5]. premenstrual syndrome has lower work performance (27.5%), impaired working relationships (23.1%), disputation with their husbands (8.82%), and relationship problems with their children (6%) and social relationship problems (41%) [4]. premenstrual syndrome interferes with the life of patients directly by treatment expenditures and indirectly by inefficient working hours, absenteeism, and productivity [6] and requires cure and management [4].

Earlier few studies reported that Complementary and Alternative Therapy were used to manage the symptoms for premenstrual syndrome. Regular practice of the relaxation response is an effective treatment for physical and emotional premenstrual symptoms and is most effective in women with severe symptoms [7]. Massage therapy is an effective method for relieving symptoms of premenstrual syndrome [8, 9]. The pilates exercises decreases the premenstrual syndrome symptoms considerably and have an important role in healing the PMS symptoms [10]. Aromatherapy can be used for coping with premenstrual syndrome symptoms and sub-dimensions of anxiety, depressive affect, nervousness, pain, bloating, depressive thought scores [1]. MBCT intervention improved depression and anxiety symptoms and total PMS score and potentially beneficial in women with PMS symptoms [12].

Over 90% of women attending premenstrual syndrome (PMS) clinic had used at least one complementary therapy for the treatment of their condition [13]. The integrative approach seeks to combine the best of conventional medicine with the range of treatment options available through other, unconventional therapeutic modalities. In the case of premenstrual syndrome, particularly given its multifactorial etiology and its tendency to present in different ways in different women, this approach is well suited and will provide benefit for many patients [14]. A descriptive exploratory design was conducted on a sample of 1120 students with different types of CAM therapy, which shows that (87.0%) used complementary and alternative therapies to minimize PMS. Herbal therapy was the most commonly used as CAT followed by hydrotherapy, changing food types, massage, and exercise [15]. Aromatherapy is an effective tool for the relief of PMS symptoms [16]. herbal medicine can be regarded as an alternative treatment for women suffering from premenstrual syndrome [17]. Exercise reduces premenstrual syndrome symptoms [18]. Acupuncture may be beneficial to patients with premenstrual syndrome [13]. Herbal therapy was effective complementary and alternative therapy for PMS symptoms [19].

A randomized clinical trial of 46 women with premenstrual syndrome found that subjects assigned to the relaxation response group reported significantly greater reduction of mood symptoms compared with controls assigned either charting of symptoms or reading over a 5-month period [20]. Van Zak has reported a protocol using vaginal temperature biofeedback, in which the patient is taught to control vaginal temperature as a means of regulating PMS symptoms. In this study, the investigators did find a significant rise in temperature from vaginal temperature feedback that correlated with a reduction in PMS symptoms [21]. Fifteen subjects completed the entire study and had significant increases in menstrual cycle length during the 3 months of imagery as well as significant declines in total premenstrual syndrome scores [22].

Blake et al 83 compared a group of women randomized to receive immediate weekly cognitive therapy with a group of controls allocated to a waiting group list that kept a symptom diary over a 12-week period. Results indicated that cognitive-behavioral therapy (CBT) was significantly more effective at remitting psychological and somatic symptoms as well as impairment. of functioning compared with controls [23]. Morse et al found that women utilizing CBT with relaxation instructions had significantly reduced premenstrual syndrome symptoms compared with women randomized to a non-active control group during two menstrual cycles [24]. In a study by Kirkby, 37 women with severe premenstrual symptoms were nonrandomly assigned to cognitive-behavioral coping skills treatment, a nonspecific treatment, or a waiting-list group. The author found significant reductions in premenstrual symptoms in the coping skills group compared to control subjects both at post treatment and at a 9-month follow-up evaluation [25]. One large survey of over 1,800 women found that Aerobic exercise was used by over half of the women as a self-help measure for alleviating premenstrual syndrome symptoms [26]. Light therapy has been investigated as a possible therapeutic intervention in premenstrual syndrome [27]. Twenty-four women with premenstrual dysphoric disorder were with massage therapy or relaxation therapy reported the decreases in anxiety, depressed mood, and pain in subjects receiving massage (immediately following first and last massage) compared with the control group [9]. Women receiving true reflexology demonstrated a significantly greater decrease in PMS symptoms [28].

Yoga is a practical discipline incorporating a wide variety of practices with desired result of the development of a state of mental and physical health, well-being, inner harmony and ultimately union of the human individual with the universal and transcendent existence. It includes the practice of meditation, regulation of respiration with a variety of breathing exercises, and the practice of a number of physical exercises and postures, in which the focus is more on isometric exercise and stretching than on aerobic fitness [29, 30]. Yoga reduces negative effects of stress on the immune system by positively regulating the levels of immunoglobulin [31].

Yogic techniques (Asanas, Pranayama and Dhyana) help in reducing PMS symptoms and preventing suffering from premenstrual tension [32]. Practice of regular Asanas like Makarasana, Shavasana, Pranayama, and meditation along with simple healthy lifestyle changes including regular exercise and healthy diet are beneficial in preventing the premenstrual syndrome [33]. Short-term yoga exercise in the luteal phase in PMS women make feel better and showed a better attention level [34]. Regular practice of yoga for 45 minutes daily, five days a week, for three months in the medical schools can decrease the symptoms of premenstrual syndrome compared to taking daily calcium tablet [35]. Yoga exercise for 12 weeks on Sixty-four premenstrual symptoms may decrease premenstrual distress and improve female employee health [36]. Yoga performed for 10 weeks in three sessions with each session of 60 minutes' duration had showed significantly relieves the PMS symptoms and improved quality of life [4]. PMS subjects attend short-term 12 weeks of yoga classes showed the positive effect in premenstrual syndrome symptoms and edema [37]. Yoga with aerobic exercise were are effective in treating premenstrual syndrome symptoms [7]. Yoga over two months in three sessions with each 60 minutes' session was concluded that yoga has strong effects on depression symptoms and blood pressure [38]. Relaxation therapy is one of the most benefited methods to reduce the difficulties of PMS symptoms [39].

Yoga was found to be a more effective non-pharmacological method for coping with premenstrual symptoms. The relaxation, pranayama & yogic asanas response in the females suffering from PMS showed a reduction in an abnormally high basal sympathetic activity and a heightened Relaxation response [40]. Yoga is beneficial in improving general health and helps relieve nervous tension, anxiety blood circulation, maintaining muscle tone, weight control or reduction and flexibility and increasing the levels of mood-regulating chemicals in the brain, decrease in fluid retention and increase in self-esteem that helps the females in overcoming the distress of premenstrual symptoms. Yoga has potentials to be prescribed for managing anxiety in women with PMS during their menstrual cycle [38]. Yoga has strong effects on depression symptoms and blood pressure; therefore, it can be used as a complementary or alternative remedy for premenstrual syndrome patients [41]. Premenstrual symptoms were found to decrease symptoms and improve quality of life with yoga and acupressure [42]. Yoga significantly relieves the premenstrual syndrome symptoms and can be prescribed for treatment of PMS [4]. Recently a systematic review and meta-analysis evaluating the effectiveness of yoga on the total scores and sub-domains of PMS. Both quantitative and qualitative analysis of the accumulated data was performed and found that yoga was beneficial in the management of PMS. This benefit was also seen when all the sub-domains of premenstrual syndrome [43].

The above studies on premenstrual syndrome are along with other alternative therapies such as relaxation techniques [39], aerobic exercise [7], calcium intake [35] and has demonstrated the positive effects on women with PMS symptoms.

Few studies demonstrated the positive effects of yoga on premenstrual syndrome related depression [38], reduced premenstrual syndrome symptoms and edema [37], Improved Health related quality of life SF-36 and menstruation pain and distress [36], improved premenstrual tension [32], better attention level [34], improved sleep quality and quality of life [4].

The literature review indicates that no study has been done to assess the effect of yoga as a standalone practice on women with premenstrual syndrome symptoms. This present study aimed to see the effect of yoga intervention on women suffering from pre-menstrual syndromes.

Methodology

The present study is a two-group pre-post experimental design conducted on (N=60) women suffering PMS symptom, were recruited for the study. All the participants were recruited from major cities like Delhi, Bangalore, Mumbai and Bhopal. The participants attended online yoga intervention. Female below 50 years, having the history of regular menstrual cycle, working and non-working women were included in this study. Women with any menstrual disorders, menopause diagnosed, physically challenged and mental illness and female already practicing yoga have been excluded from the study. Informed consent was procured from all the participants.

Convenient sampling was followed based on the self-report given by prospective participants having PMS and the participants were allocated in the two groups in sequence (Odd numbers in Yoga and Even numbers in Control group respectively).

All subjects gave their informed consent in digital format before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Centre for Open and Distance Education (CODE), Swami Vivekananda Yoga Anusandhan Samsthana (SVYASA, deemed to be University).

Yoga interventions were practiced for one hour daily for thirty days through online. All the participants were sent the first questionnaire on PMS (Premenstrual Syndrome) via Google form on email id. The questionnaires were filled pre-intervention & post-intervention for (PMS) via Google form. There were no dropouts from the study.

Assessments tools

Premenstrual syndrome Information on premenstrual symptoms was collected through using the Premenstrual Syndrome Scale (PMSS), with an inter-rater reliability between 0.81 and 0.97. The PMSS consists of 40 items with 5-point Likert- type scale (Never, Rarely, Sometimes, Very often, Always). It consists of three subscales: physical symptoms, psychological symptoms and behavioral symptoms. PMSS has a scoring system from 1-5, as 1 for rarely and 5 for always, accordingly. The lowest scale score is 40 and the highest score is 200. A total score estimated as 80 points or above indicates PMS. The increase in the scores indicates PMS severity increase [44].

PMS (Premenstrual Syndrome) Questionnaire was sent via Google form on email. The PMS questionnaire was filled with the participants in both control and intervention groups. Then the questionnaire was filled after the 1-month yoga sessions. The intervention group was provided the 2nd set of questionnaire post completion of yoga sessions [44].

Intervention

The intervention group practiced specific yoga intervention modules from the list mentioned in the SVYASA book 'Yoga for Common Ailments' (Block 3, Section 1.5, Menstrual Disorders) for 1 hour 5 days a week for 4 weeks via Google meet. The yogic exercises to be administered were mentioned in Table -1. Yoga Module exercise intervention participants attended the session 60 minutes per day for 30 days [45].

The yoga program was implemented following a standardized yoga module developed for women with menstrual disorder (Robin et al. 1991). The intensity was mild to moderate so the practices could be easily followed and performed by novice practitioners. Control group has followed the routine activity.

Table 1 Details of yoga intervention (Robin et al. 1991)

Loosening Exercises (Shitilikarana vyayama)	Frequency
Forward –Backward Bending	5 rounds
Side Bending	5 rounds
Twisting	6 rounds
Rocking and rolling	6 rounds
Surya namaskar (12 counts)	4 rounds
Pavan muktasana	4 rounds
Lumbar stretch	4 rounds
Butterfly flappings	20 rounds
Straight leg raising	4 rounds
Side leg raising	6 rounds
Cycling	10 rounds
QRT (Quick Relaxation Technique)	2 mins
Loosening Exercises (Shitilikarana vyayama)	**Frequency**
Asanas	
Baddhakonasana	1 min
Padhasthasana	1 min
Ardhacakrasana	1 min
Viparitakarni Kriya	1 min
Naukasana	1 min
Pranayama	
Kapalbhati	20 rounds
Sectional Breathing	4 mins
Nadishuddhi	9 rounds
Bhramari	5 rounds
Meditation	
Nadanusandhana (once in a week)	4 rounds 4 times in 30 days
Dhayan (OM Meditation) (once in a week)	4 times in 30 days
Cyclic Meditation	1 times in 30 days
DRT	Once in every session

Statistical Analysis

Data was extracted from the participant's Google form in an excel file for analysis. Data was analyzed by using SPSS 20 software. For the final analysis, excel file was converted to SPSS format. As the data was not normally distributed and Mann-Whitney U-test was used for statistical analysis to test the significant differences between the two groups.

Results

Demographic details of participants:

The present study demographic distribution was shown in Table 2 with a mean age of 37.80±6.39-year-old in yoga intervention group and 36.90±9.08-year-old in control group which depicts a near similar age group of the study population.

Table 2 Demographic details of women with premenstrual syndrome

Characteristics	**Yoga** (n=30)	**Control** (n=30)
Age	Mean/SD: 37.80±6.39	Mean/SD: 36.90±9.08
Education		
School	0	1
Diploma	1	1
Bachelors	11	15
Masters	17	13
Phd	1	0
Occupation		
Student	0	1
Self employed	1	3
Employed	15	15
Homemaker	14	11
Marital status		
Married	28	25
Single	2	5

In the present study premenstrual syndrome (PMS) symptoms were categorized into physiological, psychological, and behavioral and combine symptoms of pre and post yoga intervention group as shown in Table.3

There were significant changes in physical symptoms (p-value<0.001: 18.25%), psychological symptoms (p-value<0.001:24.11%), behavioral symptoms (p-value<0.001: 21.33%), total symptoms of PMS (p-value<0.001:21.04%) in PMS symptoms occur in yoga intervention group compared to control group (Table 3).

Table 3 Changes in physical symptoms, psychological symptoms, behavioral symptoms, total premenstrual symptoms of (PMS) after one-month intervention in both groups

Measurement	**Groups**	**Pre** (n=30)	**Post** (n=30)	**% change**	**Within Groups Wilcoxon signed rank test**
		Mean ±SD	Mean ±SD		Pre/Post
PMS (Physical Symptoms)	Yoga	39.67 ± 10.42	32.43 ± 9.01	18.25	0.001*
	Control	36.47 ± 10.09	35.63 ± 9.60	2.30	0.235
PMS (Psychological Symptoms)	Yoga	33.43 ± 8.93	25.37 ± 8.51	24.11	0.001*
	Control	29.80 ± 7.78	29.43 ± 8.43	1.24	0.645
PMS (Behavioural Symptoms)	Yoga	29.20 ± 9.27	22.97 ± 8.39	21.33	0.001*
	Control	25.33 ± 8.42	25.03 ± 8.83	1.18	0.640
PMS (Total PMS Symptoms)	Yoga	102.30 ± 25.87	80.77 ±24.01	21.04	0.001*
	Control	91.60 ± 22.58	90.10 ±23.97	1.63	0.335

*Significant level at α=0.05

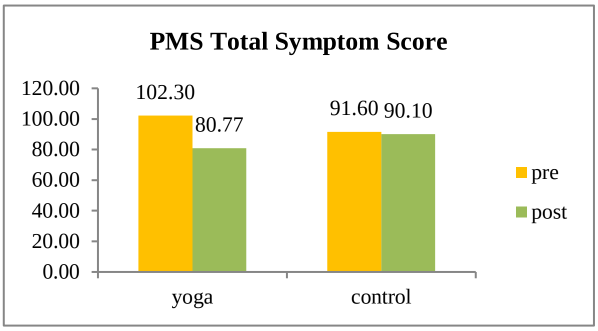

Figure 1 The PMS Total Symptom Score

Discussion

The present study showed that one-month yoga intervention showed significant changes in Premenstrual Symptoms of in yoga group compared to control group. There were significant changes in physical symptoms (18.25%), psychological symptoms (24.11%), and behavioral symptoms (21.33%), Total Symptoms of premenstrual syndrome (21.04%) in PMS symptoms occur in yoga intervention group compared to control group.

The previous studies were Yoga intervention on PMS, and the findings of present study were compared with previous studies. Most of research concluded 10-12 weeks' yoga intervention significantly relieved 57% PMS symptoms related behavior which were unlike present study which suggested 4 weeks' yoga intervention showed 24% psychological changes in premenstrual syndrome symptoms [46]. The present study showed beneficial effects of yoga even at a shorter duration of time which is not available in the literature.

The yoga intervention in the present study includes breathing exercise, Asanas, and meditation for 60 minutes per session, five days a week for one month. This was also advocated by Oates et al [47] in a systematic review that frequency ranges from 10 to 90 minutes for duration of 14 days to 16 weeks. This signifies that irrespective of the frequency and duration of yoga intervention a significant reduction in premenstrual syndrome was found in all the research [47].

Tsai concluded that the physical premenstrual syndrome symptoms relieved most followed by psychological which was shown as improvement in six scales of SF-36 [36]. It was unlike in our study where maximum reduction was seen in psychological (24%) followed by behavioral (21%) and then physical symptoms (18%). This can be attributed to study population where Tsai had evaluated on working females while present included all type of occupation of females thus removing the lifestyle bias.

A randomized controlled clinical trial with 62 subjects performed yoga for 10 weeks in 3 sessions with each session of 60 minutes' duration evaluated the effect of yoga exercise on emotional, behavioral, physical symptoms and quality of life of subjects with premenstrual syndrome demonstrated that, yoga significantly relieves the premenstrual syndrome symptoms [4]. Premenstrual syndrome symptoms with Sixty-two subjects practiced yoga over two months in three sessions with the duration of 60 minutes has strong effects on reduction of (51%) depression symptoms and blood pressure [38].

The possible mechanism explaining about the improvement due to yoga practice is hormonal fluctuations resulting in physical, psychological and behavioral symptoms of premenstrual syndrome as explained previously [48]. yoga can significantly reduce the effects of elevated stress responses and reduces both anxiety and depression through downregulating the hypothalamic–pituitary–adrenal axis which is activated in response to a physical or psychological stressor and is responsible for a chain of behavioral, physiological, and psychological responses in a human body. These changes are said to be due to the release of cortisol, epinephrine, and norepinephrine which can be regulated with a regular practice of yoga, ultimately leading to a healthy mind, body, and soul [48] As stress and anxiety are proportionately related to the symptoms of premenstrual syndrome and menstrual pain, reduction in stress and anxiety with yoga can significantly reduce menstrual pain and symptoms of premenstrual syndrome symptoms [48].

Strength of the study is a comparable control group, awareness about the premenstrual syndrome through questionnaire. With technological aid, tele-yoga and online mode yoga intervention showed the changes on the symptoms. Limitations of the study are short term intervention period, and small sample size. It was self-reported assessment based on PMS scale and the data was done based on the self-report provided by the prospective participants, so it is difficult to understand the actual magnitude reduction of the Symptoms. This study will be helpful to provide specific effect sizes or any other relevant statistics to further support the findings.

The Scope for the future studies are large sample size study, longer duration of intervention period, follow-up study and offline intervention can be studied. Yoga is a non-invasive treatment modality, which is being scientifically validated through numerous experiments across the globe. It is cost-effective and can be practiced under professional trainers and on own after following the practices thoroughly. The add-on benefits of yoga are positive physical and psychological health in the clinical population.

Conclusion

The present study concluded that a short duration yogic intervention significantly reduces premenstrual syndrome symptoms in females compared to control group.

References

[1] Dickerson LM, Mazyck PJ, Hunter MH. Premenstrual syndrome. Am Fam Physician. 2003 Apr 15;67(8):1743-52.

[2] Ashritha M, Rani SL, Brundha MP. Effects of premenstrual syndrome in day-to-day life of women. Drug Invention Today. 2020 Jul 15;14(7).

[3] Raval CM, Panchal BN, Tiwari DS, Vala AU, Bhatt RB. Prevalence of premenstrual syndrome and premenstrual dysphoric disorder among college students of Bhavnagar, Gujarat. Indian Journal of psychiatry. 2016 Apr;58(2):164. http://doi: 10.4103/0019-5545.183796.

[4] Kamalifard M, Yavari A, Asghari-Jafarabadi M, Ghaffarilaleh G, Kasb-Khah A. The effect of yoga on women's premenstrual syndrome: a randomized controlled clinical trial. International Journal of Women's Health and Reproduction Sciences. 2017 Jul 1;5(3):205-11.

[5] Zaafrane F, Faleh R, Melki W, Sakouhi M, Gaha L. An overview of premenstrual syndrome. Journal de Gynecologie, Obstetrique et Biologie de la Reproduction. 2007 Feb 26;36(7):642-52.

[6] Ledger WL. The menstrual cycle. Dewhurst's textbook of obstetrics & gynaecology. 2012 Jan 10:485-94._DOI:10.1002/9781119979449.

[7] Vaghela N, Mishra D, Sheth M, Dani VB. To compare the effects of aerobic exercise and yoga on premenstrual syndrome. Journal of Education and Health Promotion. 2019;8. doi: 10.4103/jehp.jehp_ 50_19.

[8] Moradi M. Assessment of the effects of massage therapy on premenstrual syndrome. Zahedan Journal of Research in Medical Sciences. 2011 May 31;13(2). https://brieflands.com/articles/zjrms-94066.html.

[9] Hernandez-Reif M, Martinez A, Field T, Quintero O, Hart S, Burman I. Premenstrual symptoms are relieved by massage therapy. Journal of Psychosomatic Obstetrics & Gynecology. 2000 Jan 1;21(1):9-15.

[10] Çitil ET, Kaya N. Effect of pilates exercises on premenstrual syndrome symptoms: a quasi-experimental study. Complementary Therapies in Medicine. 2021 Mar 1;57:102623. doi.org/10.1016/ j.ctim.2020.102623.

[11] Uzunçakmak T, Alkaya SA. Effect of aromatherapy on coping with premenstrual syndrome: A randomized controlled trial. Complementary Therapies in Medicine. 2018 Feb 1; 36:63-7. doi.org/10.1016/j.ctim.2017.11.022

[12] Panahi F, Faramarzi M. The effects of mindfulness-based cognitive therapy on depression and anxiety in women with premenstrual syndrome. Depression Research and Treatment. 2016 Oct;2016. doi.org/ 10.1155/2016/9816481.

[13] Domoney CL, Vashisht A, Studd JW. Use of complementary therapies by women attending a specialist premenstrual syndrome clinic. Gynecological Endocrinology. 2003; 17(1), pp.13-18. doi.org/10.1080 /gye.17.1.13.18

[14] Girman A, Lee R, Kligler B. An integrative medicine approach to premenstrual syndrome. American Journal of Obstetrics and Gynecology. 2003 May 1;188(5):S56-65.

[15] Amasha HA, Mohamed RA, Nageeb H. Complementary and alternative therapies for premenstrual syndrome: an exploratory study. Khartoum Medical Journal. 2017;10(3).

[16] Es-Haghee S, Shabani F, Hawkins J, Zareian MA, Nejatbakhsh F, Qaraaty M, et al. The effects of aromatherapy on premenstrual syndrome symptoms: a systematic review and meta-analysis of randomized clinical trials. Evidence-Based Complementary and Alternative Medicine. 2020 Dec 21;2020. doi.org/ 10.1155/2020/6667078

[17] Maleki-Saghooni N, Karimi FZ, Moghadam ZB, Najmabadi KM. The effectiveness and safety of Iranian herbal medicines for treatment of premenstrual syndrome: a systematic review. Avicenna Journal of Phytomedicine. 2018 Mar;8(2):96. PMC5885324.

[18] Babazadeh R, Keramat A. Premenstrual syndrome and complementary medicine in Iran: a systematic review. KAUMS Journal (FEYZ). 2011 Jun 10;15(2) :174-87.

[19] Nageeb H, Mohamed RA, Amasha H. Prevalence of premenstrual syndrome: complementary and alternative therapy among nursing students. IOSR Journal of Nursing and Health Science. 2015;4(2):7-15.

[20] Goodale I, Domar A, Benson H. Alleviation of premenstrual syndrome symptoms with the relaxation response. Obstetrics & Gynecology. 1990 Apr 1;75(4) :649-55.

[21] Van Zak DB. Biofeedback treatments for premenstrual and premenstrual affective syndromes. International Journal of Psychosomatics. 1994 Jan 1;41(1-4):53-60.

[22] Groer M, Ohnesorge C. Menstrual-cycle lengthening and reduction in premenstrual distress through guided imagery. Journal of Holistic Nursing. 1993 Sep;11(3):286-94.

[23] Blake F, Salkovskis P, Gath D, Day A, Garrod A. Cognitive therapy for premenstrual syndrome: a controlled trial. Journal of Psychosomatic Research. 1998 Oct 1;45(4):307-18.

[24] Morse CA, Dennerstein L, Farrell E, Varnavides K. A comparison of hormone therapy, coping skills training, and relaxation for the relief of premenstrual syndrome. Journal of Behavioral Medicine. 1991 Oct;14:469-89.

[25] Kirkby RJ. Changes in premenstrual symptoms and irrational thinking following cognitive-behavioral coping skills training. Journal of Consulting and Clinical Psychology. 1994 Oct;62(5):1026. doi.org/ 10.1037/0022-006X.62.5.1026.

[26] Pullon SR, Reinken JA, Sparrow MJ. Treatment of premenstrual symptoms in Wellington women. The New Zealand Medical Journal. 1989 Feb 1;102(862):72-4.

[27] Parry BL, Haynes P. Mood disorders and the reproductive cycle. The Journal of Gender-specific Medicine. 2000 Jul 1;3(5):53-8. PMID: 11253256.

[28] Oleson T, Flocco W. Randomized controlled study of premenstrual symptoms treated with ear, hand, and foot reflexology. Obstetrics & Gynecology. 1993 Dec 1;82(6):906-11.

[29] B.K.S. Iyengar, Light on Yoga: The Classic Guide to Yoga, 2006.

[30] Khalsa SB. Yoga as a therapeutic intervention. Principles and practice of stress management. 2007 Aug 16;3:449-62.

[31] Brotto LA, Krychman M, Jacobson P. Eastern approaches for enhancing women's sexuality: mindfulness, acupuncture, and yoga (CME). The Journal of Sexual Medicine. 2008 Dec;5(12):2741-8.

[32] Choudhary A, Mishra J. Effect of 16 weeks yogic intervention in premenstrual syndrome. International J Pharma and Bio Sci. 2013 Jan;4(1): B207-b212. ISSN 0975-6299.

[33] Thejaswini HJ, Narayana BP, Suhas SK, Savitha HP. Yoga and healthy life style modification in prevention of premenstrual syndrome. http://indianyoga.org.

[34] Wu WL, Lin TY, Chu IH, Liang JM. The acute effects of yoga on cognitive measures for women with premenstrual syndrome. The Journal of Alternative and Complementary Medicine. 2015 Jun 1;21(6):364-9.

[35] Bharati M. Comparing the effects of yoga & oral calcium administration in alleviating symptoms of premenstrual syndrome in medical undergraduates. Journal of Caring Sciences. 2016 Sep;5(3):179. doi: 10.15171/jcs.2016.019

[36] Tsai SY. Effect of yoga exercise on premenstrual symptoms among female employees in Taiwan. International Journal of Environmental Research and Public Health. 2016; 13(7), p.721. doi.org/10.3390/ijerph13070721.

[37] Tsai FH, Chu IH, Lin TY, Liang JM, Hsu HT, Wu WL. Preliminary evidence on the effect of yoga on the reduction of edema in women with premenstrual syndrome. European Journal of Integrative Medicine. 2017 Jan 1;9:63-8.

[38] Ghaffarilaleh G, Ghaffarilaleh V, Sanamno Z, Kamalifard M. Yoga positively affected depression and blood pressure in women with premenstrual syndrome in a randomized controlled clinical trial. Complementary Therapies in Clinical Practice. 2019 Feb 1;34:87-92. doi.org/10.1016/j.ctcp.2018.11.007.

[39] Jose A, Nayak S, Kamath N, Nalini M. The mystery behind relaxation therapy: adieu to premenstrual syndrome. Journal of Health and Allied Sciences NU. 2021 Sep;11(03):119-25.

[40] Sharma B, Misra R, Singh K, Archana RS. Comparative study of effect of anuloma-viloma (pranayam) and yogic asanas in premenstrual syndrome. Indian J Physiol Pharmacol. 2013 Oct 1;57(4):384-9.

[41] Ghaffarilaleh G, Ghaffarilaeh V, Sanamno Z, Kamalifard M. Yoga positively affects depression and blood pressure of women with premenstrual syndrome. Complement Ther Clin Pract. 2018 Feb;34:87-92.

[42] Kucukkelepce DS, Unver H, Nacar G, Tashan ST. The effects of acupressure and yoga for coping with premenstrual syndromes on premenstrual symptoms and quality of life. Complementary Therapies in Clinical Practice. 2021 Feb 1;42:101282. doi.org/10.1016 /j.ctcp.2020.101282.

[43] Arghya P, Banashree N, Sayanti P, Snehlata M. Evaluation of the effectiveness of yoga in management of premenstrual syndrome: a systematic review and meta-analysis. Journal of Psychosomatic Obstetrics & Gynecolog. 2022; 43(4): 517-25.

[44] Padmavathi MP, Sankar R, Kokilavani N, Dhanapal K, Ashok B. Validity and reliability study of premenstrual syndrome scale (PMSS). International Journal of Advances in Nursing Management. 2014 Jan;2(1):04-5. ISSN-2347–8632.

[45] Robin Monro, Nagendra HR, Nagarantha R. (1991). Yoga for common ailments.

[46] Lata P, Lohan U. Effect of yoga on pre menstrual syndrome amongst college girl students. Int J Phy Edu. Spo.;3(01):23-6.

[47] Oates J. The effect of yoga on menstrual disorders: a systematic review. The Journal of Alternative and Complementary Medicine. 2017 Jun 1;23(6):407-17.

[48] Sengupta P. Health impacts of yoga and pranayama: a state-of-the-art review. International Journal of Preventive Medicine. 2012 Jul;3(7):444. PMC3415184.