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Generalized Joint Hypermobility Associated with Shoulder Pain and Disability in Competitive Swimmers in Denpasar City

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ABSTRACT

Introduction: Generalized joint hypermobility conditions in competitive swimmers can be advantageous as they may enhance athletes' movement speed in the water but can also be a risk factor for shoulder pain. Hypermobility, coupled with repetitive movements, leads to an increased workload on supporting structures, such as muscles, ligaments, and tendons, without sufficient recovery time, thus damaging tissues. The accumulation of loading and tissue damage leads to shoulder pain and disability. This study aims to determine the relationship between Generalized Joint Hypermobility and shoulder pain and disability in competitive swimmers in Denpasar City.
Method: This study is an observational analytical study with a cross-sectional approach. The sampling technique used purposive sampling. The sample size obtained from this study was 54 individuals. The joint hypermobility condition was measured using the Beighton score. The Shoulder Pain and Disability Index (SPADI) questionnaire assessed shoulder pain and disability complaints.
Results: Based on non-parametric Spearman's rho analysis, the correlation coefficient between Generalized Joint Hypermobility and shoulder pain and disability was obtained at r = 0.686 and r = 0.657, respectively, with a p-value of 0.000 ($p < 0.05$).
Conclusion: This study concludes a significant correlation between generalized joint hypermobility, shoulder pain, and disability in competitive swimmers in Denpasar City.

Keywords: generalized joint hypermobility, shoulder pain, shoulder disability, competitive swimmers

PENDAHULUAN

Swimming involves the body's movement using the hands and feet to float and move freely in water. Apart from being a recreational sport, swimming is also practised as a competitive sport that focuses more on competition and breaking personal or world records. In swimming, forward movement is not generated by the lower extremities, but nearly 90% of the propulsion in swimming comes from the upper extremities.[1]

Based on research conducted by Hustlyn, on average, a swimmer, exceptionally competitive swimmers perform shoulder movements approximately 16,000 times per week.[2] According to Henlein & Cosgarea, competitive swimmers typically swim around 60,000 to 80,000 meters per week, with a typical count of 8 to 10 strokes per lap of 25 meters, resulting in each shoulder undergoing approximately 30,000 rotations per week.[3] This indicates that the shoulders will undergo a significant workload and must maintain the correct joint positions to provide maximum speed and strength against resistance. This may lead to joint hypermobility, where the joints exceed their normal range of motion, caused by efforts to counter water resistance through constant repetitive movements over long training periods. This condition is known as Generalized Joint Hypermobility (GJH).[4]

Generalized Joint Hypermobility (GJH) is characterized by increased mobility in connective tissues, typically manifesting as loose joints.[5] The prevalence of GJH is higher in athletic populations compared to the general population. In swimmers, the prevalence of GJH can vary between 62.9% and 86.6%, depending on characteristics such as age, gender, and athletes' race. In the age group of 13 to 20 years, a high prevalence of up to 60.6% has been found.[6] Meanwhile, based on athletes' race, a higher incidence rate is found in Asian (21.4%) and African (22.7%) races when compared to Caucasian/white races (11.5%).[7,8]

Shoulder pain incidence among swimmers ranges from 40% to 91%. During their careers, swimmers reportedly experience shoulder pain complaints at a rate of 80%. Compared to other age groups, adolescent swimmers have the highest pain rate, reaching 91.3%. Previous research has found that the percentage of shoulder pain increases and varies at each level of competition, including 47% at the national level, 66% at the elite senior level, and 73% on US swim teams.[9] Shoulder pain can lead to increased disability and functional impairment in athletes' shoulders. This affects athletes' performance due to inefficient movement patterns and motions while swimming.[10]

Denpasar City is one of the areas with numerous achievements in swimming. Denpasar swimmers won 13 gold medals at the XIV Bali Provincial Sports Week/2019, fielded hundreds of swimmers at the Mayor's Cup X in 2019, and won two bronze medals at the XX Papua National Games in 2021.[11] With the abundance of swimmers and a history of swimming achievements in Denpasar City; it is essential to provide special attention to the management of training and athlete health to support and maintain their performance. Therefore, the author feels it is necessary to investigate the relationship between GJH and shoulder pain and disability in competitive swimmers in Denpasar City.

METHODS

This research employed an observational analytical study with a cross-sectional approach conducted in December 2023 at the Praja Raksaka swimming pool, Pedungan Subdistrict, Denpasar. The sampling technique utilized in this study was purposive sampling, with 54 samples determined using the Lemeshow formula and selected according to the established inclusion and exclusion criteria. Inclusion criteria included active swimmers aged 13-18 years, participating in swimming competitions at least once through interviews, training frequency of at least three times a week as known through interviews, and willingness to fill out informed consent forms. Meanwhile, the exclusion criteria for this study were subjects with fractures and acute shoulder injuries during the research period, as known through interviews.

In its implementation, the researcher collaborated with the coaching team at the Praja Raksaka swimming pool to recruit respondents who were competitive swimmers aged 13-18 years. The research began by explaining the flow, including filling out informed consent forms, interviewing injury history, measuring the Beighton score, and completing the SPADI questionnaire. Through the interview process, the researcher paid attention to injury histories such as fractures, history of brutal impacts, and other acute injuries that served as exclusion criteria as they could affect the research results. The research team kept the interpretation of the Beighton score and SPADI measurement results confidential until the data collection period ended to avoid bias.

Beighton Score was used to measure GJH. This measurement tool has a sensitivity of 85% and a high specificity of 90%, with intra-rater reliability of 0.81 and inter-rater reliability of 0.75. The Beighton Score examination consists of nine assessments valued at one point each if successfully performed. If the total score obtained is ≥ 4, it can be interpreted that a person experiences joint hypermobility.

SPADI (Shoulder Pain and Disability Index) is the questionnaire used to measure shoulder pain and disability, with a validity of 0.93 and a reliability of 0.975. SPADI consists of two measurement scales, including a pain scale with five questions regarding the severity of someone's pain. Pain score ranges from 0 to 10, with 0 indicating no pain and 10 indicating unbearable pain. The second scale is the functional ability scale, consisting of eight questions. The functional ability scale measures the difficulty level a person experiences in performing daily activities using the upper extremities. This scale ranges from 0, indicating no difficulty, to 10, indicating very difficult and requiring assistance. The final SPADI score is interpreted as the more significant the percentage of the total score, the higher the decline in someone's functional ability. This final score is obtained by dividing the subject's total score by the total SPADI score and multiplying it by 100%.

All collected data were analyzed using SPSS software version 27.0. Univariate analysis was conducted to determine the characteristics of research subjects based on age, gender, and training frequency in the form of mean and standard deviation. Bivariate analysis in this study used non-parametric statistical tests, namely Spearman's rho correlation test method, to determine the significance and direction of the relationship between the variables under investigation. This research obtained approval and permission from the Ethics Commission of Udayana University with the number 2256/UNI4.2.2.VII.14/LT/2023.

RESULTS

Subjects in this study were competitive swimmers in Denpasar City who met the inclusion criteria. The identification stage of research subjects can be seen in Figure 1.

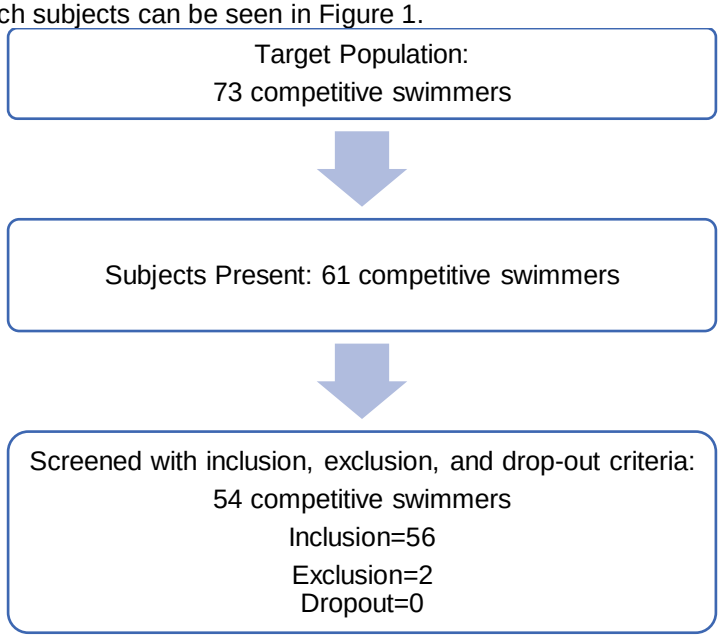

Figure 1. Research Subject Identification Stage

Based on Figure 1, the total number of research subjects is 54, which met the sample calculation results using the Lemeshow formula. The characteristics of the sample based on age, gender, and training frequency are outlined in Table 1.

Table 1. Characteristics of Research Sample

Variable	Frequency (n)	Mean ± SD	%
Gender			
Male	37		68.5%
Female	17		31.5%
Age, years old			
13	11		20.4%
14	12		22.2%
15	12	15.11 ± 1.7	22.2%
16	5		9.3%
17	7		13%
18	7		13%
Training Frequency, times per week			
4	5		9.3%
5	5		9.3%
6	7		13%
7	3	7.85 ± 2.13	5.6%
8	10		18.5%
9	5		9.3%
10	18		33.3%
11	1		1.9%

Based on Table 1 above, it is known that the sample consists of 54 individuals, comprising 37 males and 17 females. The mean age value for this study is 15.11 years, with a standard deviation of 1.7. The mean training frequency was also 7.85, with a standard deviation 2.13. Next, the frequency distribution of subject characteristics based on independent and dependent variables is outlined in Table 2.

Table 2. Frequency Distribution of Subject Characteristics Based on Generalized Joint Hypermobility and Shoulder Pain and Disability Levels

Variable	Frequency (n)	Mean ± SD	%
GJH			
With GJH	42		77.8%
Without GJH	12		22.2%
Shoulder Pain Level (%)			
0	1		1.9%
4	2		3.7%
6	5		9.3%
8	4		7.4%
12	4		7.4%
14	4		7.4%
16	4		7.4%
18	4		7.4%
20	4		7.4%
22	1	22.33 ± 15.03	1.9%
24	2		3.7%
28	2		3.7%
32	3		5.6%
34	3		5.6%
36	2		3.7%
38	1		1.9%
40	3		5.6%
42	3		5.6%
64	1		1.9%
72	1		1.9%

Continuation of Table 2. Frequency Distribution of Subject Characteristics Based on Generalized Joint Hypermobility and Shoulder Pain and Disability Levels

Variable	Frequency (n)	Mean ± SD	%
Shoulder Disability Level (%)			
0	2		3.7%
5	5		9.3%
7	3		5.6%
10	2		3.7%
12	6		11.1%
14	6		11.1%
15	4		7.4%
17	4		7.4%
19	4	16.06± 8.39	7.4%
20	6		11.1%
22	1		1.9%
23	5		9.3%
25	2		3.7%
27	1		1.9%
28	1		1.9%
29	1		1.9%
50	1		1.9%

Based on the information obtained from Table 2, more than half of the sample consisted of competitive swimmers with GJH (77.8%; n=42). Shoulder pain and disability levels were assessed using the SPADI questionnaire. In this study, the subjects' pain levels ranged from 0% to 72%, while the shoulder disability levels ranged from 0% to 50%. It was found that the subjects had a mean pain level of 22.33 with a standard deviation of 15.03. The mean shoulder disability level was 16.06, with a standard deviation 8.39. Spearman's rho correlation tests were conducted to test the study's hypotheses, with the results in Table 3.

Table 3. Results of Spearman's Rho Correlation Test between the Relationship of Generalized Joint Hypermobility with Shoulder Pain Level and the Relationship of Generalized Joint Hypermobility with Shoulder Disability Level

Variable	Correlation	p value
GJH and Shoulder Pain Level	0.686	0.000
GJH and Shoulder Disability Level	0.657	0.000

Table 3 indicates a significant relationship between GJH and Shoulder Pain Level in competitive swimmers aged 13-18 years in Denpasar City, as evidenced by a p-value of 0.000 ($p < 0.05$) and a correlation coefficient of 0.686. Similarly, a significant relationship was found between GJH and Shoulder Disability Level in competitive swimmers aged 13-18 years in Denpasar City, as evidenced by a p-value of 0.000 ($p < 0.05$) and a correlation coefficient of 0.657. Both correlations have positive values, indicating a direct relationship with a strong correlation level, as the values are between 0.61 – and 0.80.

DISCUSSION

The research was conducted at the Praja Raksaka swimming pool, Pedungan, with a sample of 54 competitive swimmers. Based on the results presented in Table 1, the sample consisted of 37 males (31.5%) and 17 females (68.5%). The subjects included in this study were 13-18 years old, with a mean age of 15.11. The distribution of the sample's age was highest at 14 and 15, with 12 individuals each (22.2%), and lowest at 16 with five individuals (9.3%). Other samples included 11 individuals aged 13 (20.4%) and seven aged 17 and 18 (13%). Joint hypermobility commonly occurs in children under ten, but a higher prevalence is found in the 13-20 age group.[7] Based on research conducted in 2018, it is known that competitive swimmers aged 13 and above have a more significant potential to experience shoulder pain accompanied by shoulder instability.[12]

During their membership in the swimming club, the average frequency of swimming training sessions for swimmers is eight times per week. The most common distribution among respondents is as follows: 18 individuals (33.3%) have a training frequency of 10 times per week, 10 individuals (18.5%) have a training frequency of 8 times per week, and there are seven individuals (13%) with a training frequency of 6 times per week.

Table 2 outlines the research results obtained from the sample data, with 42 individuals (77.8%) having GJH and 12 individuals (22.2%) not having GJH. Consistent with research conducted by Magdalena Gebska, it was found that the prevalence of GJH in competitive swimmers varies up to 86.6%.[13] Research conducted by Natalia Radlinska on the prevalence of GJH in competitive swimmers in Poland also found high-category results, with 62.9% of the sample having GJH. Swimming movements are complex and exert significant resistance against water. Swimming also requires strength, endurance, coordination, and especially flexibility in the shoulders, which are performed repetitively. One of the reasons for the high prevalence of GJH is the flexibility athletes achieve due to repetitive stretching exercises during training.[14]

The SPADI questionnaire obtained diverse results for pain and functional scale values, as shown in Table 2. The highest pain level received by the sample was 72%, with one individual, and the lowest was 0%, with one individual. The highest shoulder disability level obtained by the sample was 50%, with one individual, and the lowest was 0%, with two individuals. Data also revealed an average pain level of 22.33 with a standard deviation 15.03. The average shoulder disability level was 16.06, with a standard deviation 8.39.

Relationship between Generalized Joint Hypermobility and Incidence of Shoulder Pain and Disability in Competitive Swimmers

Based on the data testing results using Spearman's rho non-parametric analysis in Table 3, it was found that the p-value is 0.000 ($p < 0.05$) and the correlation coefficient is 0.686 for the relationship between GJH and shoulder pain level, and a correlation coefficient of 0.657 for the relationship between GJH and shoulder disability level. This indicates a significant relationship with a strong correlation level and a direct relationship between GJH and the incidence of shoulder pain and disability in competitive swimmers aged 13-18 years in Denpasar City.

This aligns with research conducted by William McMaster on the relationship between joint hypermobility and shoulder pain in competitive swimmers aged 13-24 in America. It was found that out of a total of 40 samples, 14 individuals (35%) with joint hypermobility experienced significant disruptive shoulder pain during assessment ($p < 0.05$). Additionally, nine individuals reported mild bilateral pain, while five reported mild unilateral pain. Statistical analysis indicated a significant and positive correlation with disruptive shoulder pain at a 95% confidence level.[15]

Another study conducted by Magdalena Gebska on the consequences of joint hypermobility among swimmers and rowers supports this theory. The study found that musculoskeletal pain and significant injuries occurred more frequently in swimmers with joint hypermobility ($p <0.0001$) compared to rowers with joint hypermobility, with 60% reporting shoulder pain complaints and 26% reporting elbow pain among respondents. Additionally, a higher percentage of swimmers experienced overload injuries (78% of athletes) and soft tissue tears (20% of athletes).[13]

Based on a study conducted by Behman Liaghat in 2018, fatigue conditions in shoulder movements, particularly internal rotation, are associated with the occurrence of GJHS (Generalized Joint Hypermobility and Shoulder Hypermobility) in competitive swimmers ($p=0.047$). Athletes with GJHS were found to have lower endurance compared to the control group. The reduced endurance in swimmers with GJHS can affect shoulder movement coordination and increase the risk of shoulder pain, weakness, or fatigue.[16]

The relationship between shoulder pain and disability and GJH can occur in swimmers due to the characteristics of the sport of swimming. Generalized Joint Hypermobility (GJH) in swimmers can occur due to the significant load on the shoulders to generate full force against the water and the body during repetitive and constant movements over extended periods of training, leading to the possibility of joint hypermobility.[4] The condition of GJH in swimmers can be an advantage as it can support the speed of athletes' movements in the water, but it can also be a risk factor for shoulder pain. Biomechanical aspects of swimming are related to increased complaints of pain and injuries, including shoulder disabilities in joint hypermobility conditions. Joint hypermobility followed by repetitive movements results in supporting structures such as muscles, ligaments, and tendons working harder and not getting enough recovery time, leading to tissue damage.[17]

Swimming movements tend to involve open-chain kinematics with characteristics of high speed, broad range of motion, and low stability. During these movements, proprioceptive stimulation is minimal, primarily activating agonist and synergistic muscles. This results in joint instability and increased shear force during swimming, leading to damage and overloading in the surrounding joint structures.[13] Local ischemia and accumulation of lactic acid also occur due to repetitive arm movements during prolonged swimming. Structures such as tendons can also experience damage due to repeated failure under loads exceeding their maximum tensile strength. The accumulation of loading and damage to supporting tissues leads to pain.[18] Increased disability to functional impairment can accompany the shoulder pain experienced by swimmers. Movement patterns during swimming will change as shoulder pain increases. This will result in inefficient movements, causing repeated shoulder injuries and decreasing athlete performance.[19]

Activities such as forced passive shoulder stretching resulting in discomfort, using paddles on hands, and weight training with heavy resistance above the head can transform physiological hypermobility into a pathophysiological condition.[20] Additionally, there is an increase in training volume with large quantities during swimmers' transition from childhood to adolescence.[21] Athletes may exhibit different adaptations and responses to the training provided. As these differences influence the occurrence of shoulder pain in swimmers, research also illustrates how routine screening is essential to ensure the overall readiness of athletes' bodies when entering the competition phase, not just competitive swimmers in Denpasar.[22]

Competitive swimmers typically undergo a 3-6 week overload training phase followed by a 1-2 week deload phase before competitions. Researchers suggest conducting athlete screening during the midpoint of the overload phase, including assessing Generalized Joint Hypermobility using the Beighton Score and examining shoulder pain and disability using the SPADI questionnaire. The purpose of screening for GJH and shoulder pain and disability is to observe how competitive swimmers respond to pre-competition training volume and provide insights into training method modifications that the athlete coaching team can make. The health of competitive swimmers is crucial when planning competition schedules and overall competition loads.

The researchers encountered several limitations in this study. Firstly, the analysis was based on generalized joint hypermobility, assessed through the Beighton Score, shoulder pain, and disability levels. The study did not conduct a more comprehensive and specific assessment of the shoulder's structural components, such as bones, muscles, tendons, and ligaments. A more detailed evaluation of these structures could provide a clearer understanding of the subjects' shoulder conditions and their relationship with reported complaints. Additionally, internal factors that may contribute to GJH, such as gender, proprioceptive function, and other health conditions, were not controlled for by the researchers. The study may only fully explain the more profound correlation between shoulder conditions and perceived pain with specific measurements of the shoulder's supporting structures.

Furthermore, the study did not control for several other confounding variables, posing a challenge to generalizing the results. Using a cross-sectional method, where data collection occurred only at a one-time point, limits the study's ability to determine relationships between variables effectively.

CONCLUSION

Based on the research findings, it is concluded that there is a significant relationship with a strong correlation between Generalized Joint Hypermobility (GJH) and shoulder pain and disability in competitive swimmers aged 13–24 years in Denpasar. The study has implications for swimmers and athletic coaching teams. Coaching teams may consider integrating GJH measurement into athletes' routine health assessments. This can aid in early identification of potential risks of shoulder pain and disability associated with GJH. The researchers also emphasize the importance of selecting training activities that do not exacerbate pathophysiological hypermobility and designing customized training programs to address and prevent potential health issues.

REFERENCES

1. Hilda P. Hubungan Daya Ledak Otot Tungkai, Kelenturan Sendi Bahu, Dan Kekuatan Otot Lengan Terhadap Kecepatan Renang Gaya Kupu-Kupu 50 Meter Pada Atlet Putri Klub Spectrum Semarang. 2018;
2. Hustlyn M. Shoulder Injuries in The Athlete. Primary Care of The Injured Athlete. 2017;2.
3. Heinlein, Scott; Cosgarea A. Biomechanical Considerations in the Competitive Swimmer's Shoulder. Sports Physical Therapy. 2019;2(6).
4. Hibberd E. Effect of a 6-Week Strengthening Program on Shoulder and Scapular-Stabilizer Strength and Scapular Kinematics in Division I Collegiate Swimmers. Journal Sport Rehabilitation. 2015;21(3).
5. Czaprowsk D. Generalized Joint Hypermobility, Diagnosis and Physiotherapy. J Nov Physiother. 2016;6(4).
6. Radlinska Natalia. Prevalence of Generalized Joint Hypermobility in Relation to Selected Medical and Training Indicators in Swimmers: Randomised Control Study. South African Journal for Research in Sport, Physical Education and Recreation. 2019;41(3):75–86.
7. Reuter P. Prevalence of Geeneralized Joint Hypermobility, Musculoskeletal Injuries, and Chronic Musculoskeletal Pain among American University Students. PeerJ. 2019;
8. Morris, Susan. O'Sulivan P. Hypermobility and Musculoskeletal Pain in Adolescents. The Journal of Pediatric. 2016;09(060).
9. Elizabeth M. Swimmer's Shoulder: Painful Shoulder In The Competitive Swimmer. American Academy Of Orthopedic Surgeon. 2016;24(8).
10. Ganu SS, Tadge AB. Generalized Joint Hypermobility: A Review. International Journal of Science and Healthcare Research. 2021;6(3):41–7.
11. Budiarti Ir A. 231 Atlet Renang Denpasar Ikuti Wali Kota Cup X Kota Denpasar. Tribun Bali. 2019;
12. Kuntjoro B. Analisis Biomekanika Pada Olahraga Renang "Gaya Bebas." Journal Phederal. 2015;11(1).
13. Gebska M, Weber-Nowakowska K, Oklejak M, Boćkowski R, Żyżniewski J, Żyżniewska-Banaszak E. Polyarticular hypermobility and its consequences in rowers and swimmers: a preliminary report. Trends Sport Sci [Internet]. 2016;23(3):141–5. Tersedia pada: http://proxy.lib.ohio-state.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=118580202&site=ehost-live
14. Decoster L. Generalized Joint Hypermobility and Its Relationship to Injury Patterns among NCCA Lacrosse Players. J Athl Train. 2014;34(2):99–105.
15. McMaster W. A Correlation Between Shoulder Laxity and Interfering Pain in Competitive Swimmers. Am J Sports Med. 2014;26(1).
16. Behnam L. Competitive Swimmers With Hypermobility Have Strength and Fatigue Deficits in Shoulder Medial Rotation. Journal of Electromyography and Kinesiology. 2018;39.
17. Gareth M. Doing Competitive Swimming: Exploring the Skilled Practices of the Competitive Swimming. Int Rev Sociol Sport. 2020;56(1).
18. O'Neil BA. Chronic Occupational Repetitive Strain Injury. Canadian Family Physician. 2015;47.
19. Ganu SS, Tadge AB. Generalized Joint Hypermobility: A Review. International Journal of Science and Healthcare Research. 2021;6(3):41–7.
20. Klaus Bak M. The Practical Management of Swimmer's Painful Shoulder: Etiology, Diagnosis, and Treatment. Clin J Sport Med. 2017;5.
21. Stef Feijen M. Swim-Training Volume and Shoulder Pain Across the Life Span of The Competitive Swimmer: A Systematic Review. J Athl Train. 2020;55:32–41.
22. Neufer PD. Effect of Reduced Training on Muscular Strength and Endurance in Competitive Swimmers. Med Sci Sports Exerc. 2016;19(5):486–490.