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Cross-Sectional Study on Cycling Position and Non-Specific Low Back Pain: Ergonomic and Pain Analysis

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ABSTRACT

Introduction: Cycling is a physical activity that enhances physical fitness and involves moving various body parts, such as muscles and bones. This activity can lead to musculoskeletal complaints, including Non-Specific Low Back Pain (NSLBP), often caused by improper cycling posture. This study investigates whether non-ergonomic cycling positions contribute to the onset of NSLBP in cyclists.
Methods: This study utilized a cross-sectional design and purposive sampling technique to select subjects according to inclusion and exclusion criteria. The total sample comprised 44 cyclists. Data were collected through interviews to determine the duration, distance, and frequency of cycling, followed by pain examinations, palpation, and neurodynamic tests such as the Slump and Bragard tests. Cycling positions were assessed using the Rapid Entire Body Assessment (REBA).
Results: Chi-square analysis showed a p-value of 0.001, indicating a significant relationship between cycling position and NSLBP complaints.
Conclusion: This study concludes that there is a relationship between cycling position and Non-Specific Low Back Pain. Educating cyclists on ergonomics, as well as incorporating warm-up, cool-down, and stretching during breaks, can be steps to reduce NSLBP complaints.

Keywords: non-specific low back pain, cycling position, cyclists, ergonomics, back pain

INTRODUCTION

Cycling has recently become a new trend among the public. This is because cycling is an efficient exercise that can be done anytime and fits into various schedules. Notably, during the COVID-19 pandemic, people engaged in this activity to alleviate boredom caused by job losses and to maintain physical fitness, which can boost the immune system.[1] Bicycles are an environmentally friendly mode of transportation since they do not use fuel and therefore do not cause air pollution. As such, bicycles can be considered both eco-friendly and economical forms of transportation.[2]

Currently, cycling has become a new trend among the public. It is an efficient sport that can be done anytime and is environmentally friendly because it does not produce air pollution. During the COVID-19 pandemic, cycling became a popular way to alleviate boredom caused by layoffs and to enhance physical fitness, which helps boost the immune system. As an economical mode of transportation, bicycles come in various types, such as fixies, road bikes, electric bikes, and mountain bikes. The comfort of cycling depends not only on the bike's design but also on the bicycle fit, which involves adjusting the frame size to the cyclist's body measurements, such as the distance between the handlebars and the seat and the seat height.[3]

However, many cyclists need to pay more attention to the importance of ergonomic posture and rely solely on their intuition when determining the size and adjustment of their bicycles. Improper ergonomic posture can lead to musculoskeletal injuries, mainly Non-Specific Low Back Pain (NSLBP), characterized by pain and discomfort in the lower back without specific symptoms.[4] Several factors, including gender, occupation, duration of employment, working position, and body mass index, influence Low Back Pain (LBP). The incidence of LBP in Indonesia is estimated to be between 7.6% and 37%. The prevalence of lower back pain among cyclists is as high as 45% in professional cyclists. Cyclists often need to pay more attention to the importance of ergonomic posture, using only their intuition for bike sizing and adjustments. However, ergonomic posture significantly impacts the risk of musculoskeletal injuries, with low back pain being a common injury among cyclists.[3] Low back pain is characterized by pain and discomfort in the lower back, often resulting from prolonged sitting. Sitting for extended periods in high-risk positions can significantly contribute to the development of lower back pain. Additionally, non-specific lower back pain refers to pain and discomfort without specific symptoms or identifiable underlying causes. Several factors, including gender, occupation, duration of employment, working position, and body mass index, can influence low back pain.[5] The incidence of Low Back Pain in Indonesia is estimated to be between 7.6% and 37%. The prevalence of back pain caused by awkward body positions

among workers with high frequency, long duration of work, and heavyweight ranges from 10% to 15%. Among cyclists, lower back pain is as high as 45% in professional cyclists.[6]

Cycling is closely related to low back pain due to the biomechanics of the back while cycling, mainly when cyclists are hunched over or bent forward too much. [7] Furthermore, the bicycle's size, dimensions, and details can also contribute to back pain among cyclists. Cyclists need to have a wider field of vision to increase or achieve dynamic speed and ensure smooth travel without significant hindrances. To achieve this, cyclists often assume a flexed spinal position, commonly referred to as being hunched over, to optimize their posture.[3] Cycling with incorrect postures, such as excessive bending, can increase the risk of NSLBP due to biomechanical loads on the back. Factors such as bike size and dimensions also contribute to back pain. Cyclists often have to be in a flexed spinal position or hunched over to achieve dynamic speed and smooth travel.[8]

Based on the explanations above, it's evident that cycling position plays a crucial role in determining the occurrence of NSLBP. Therefore, this study investigates whether non-ergonomic cycling positions contribute to the onset of NSLBP in participants. This research hypothesises that non-ergonomic cycling positions significantly increase the risk of NSLBP among cyclists.

METHOD

This study employed a cross-sectional study design conducted on Renon Highway in Denpasar from November to December 2023. Sampling was carried out eight times at this location, a standard cyclist route. Samples were selected by approaching cyclists who were taking a break and were willing to participate in the study. The sample's involvement lasted one day during data collection. Data were collected through informed consent forms, screening for inclusion and exclusion criteria, measurement of NSLBP, and documentation of cycling positions measured using the Rapid Entire Body Assessment (REBA).

Purposive sampling was chosen to obtain subjects with specific characteristics to meet the inclusion and exclusion criteria. Inclusion criteria included cyclists who were willing to participate, provided informed consent, and aged 19-59. Exclusion criteria included cyclists with a history of falls, spinal surgery, or complaints of Hernia Nucleus Pulposus. The study sample comprised 44 individuals, calculated using the Lemeshow formula with a maximum estimated value of 0.001 based on previous references, with an additional 10% for dropout criteria.

The independent variable in this study was the cyclist's position while cycling, while the dependent variable was NSLBP complaints. Measurement of cycling positions using REBA included assessment of body posture (neck, spine, upper arms to wrists, and legs), exertions, types of movements or actions, repetitions, and coupling. REBA measurements were documented by recording cycling positions using a slow-motion smartphone and then analyzed using the Kinovea application. To reduce bias, the distance between the researcher and the subject during video recording was 1.5 meters, and subjects were instructed to pedal straight ahead.

NSLBP examination was conducted through palpation, neurodynamic tests (Bragard and Slump Test), and Visual Analog Scale (VAS). Univariate analysis provided an overview of age, body mass index, duration, distance travelled, cycling frequency, and position. Bivariate analysis with a Chi-Square test was used to test the research hypothesis. The Measurement data results were either NSLBP (yes or no) or REBA (low, medium, high, very high). This study was approved by the Ethics Commission of the Faculty of Medicine, Udayana University, with ethical clearance number 1591/UN14.2.2.VII.14/LT/2023.

RESULTS

This study utilized a cross-sectional method on cyclists. The research began with the licensing process, followed by sorting the target population according to inclusion criteria to be included as study subjects, data collection according to research variables, data analysis, and reporting of results as outlined in Diagram 1.

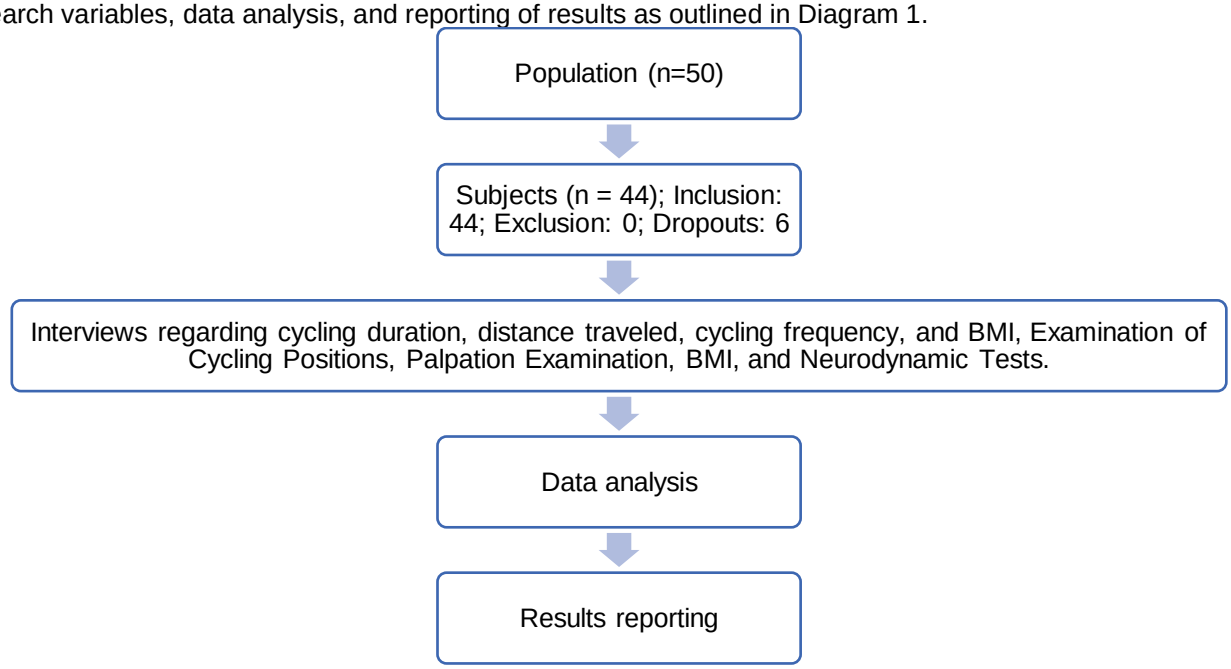

Diagram 1. Research Flowchart

The characteristics of the research subjects include age, duration of cycling, frequency of cycling, distance travelled, body mass index (BMI), cycling position, and NSLBP, as shown in Table 1.

Table 1. Sample Characteristics

Variable	Number	Percentage (%)
Age		
21-25	15	34.3
26-30	7	15.9
31-35	10	22.6
36-40	3	6.8
41-45	9	20.4
BMI		
Underweight	2	4.5
Normal	44	95.5
Duration		
Light	5	11.4
Moderate	39	88.6
Frequency		
1-3 times	31	36.0
4-7 times	33	38.4
Distance		
Medium	44	100.0
Body Position		
Medium Risk	13	29.5
High Risk	10	22.7
Very High Risk	21	47.7
NSLBP		
Yes	33	75.0
No	11	25.0

Based on Table 1, the research subjects are aged 21-45 years, with the majority being aged 21-25 years, totalling 15 individuals (34.3%). Most subjects have a normal BMI (95.5%), moderate cycling duration (88.6%), and cycle 4-7 times per week (64.0%). All subjects cover a medium distance (100.0%). Cycling positions with very high-risk levels were found in 21 individuals (47.7%), and 33 (75.0%) reported NSLBP. The analysis of Cycling Positions with Non-Specific Low Back Pain complaints can be seen in Table 2.

Table 2. Analysis of Cycling Positions with Non-Specific Low Back Pain Complaints

Cycling Position	NSLBP		
	Yes	No	Total
Medium Risk	5	8	13
High Risk	9	1	10
Very High Risk	19	2	21
Total	33	11	44

Based on Table 2, out of 13 medium-risk cyclists, five individuals (11.4%) experienced NSLBP complaints. Among the ten cyclists (22.7%) with high-risk positions, nine individuals (20.5%) reported NSLBP complaints. Additionally, 19 individuals (43.2%) of 21 cyclists with very high-risk positions experienced NSLBP complaints. The Chi-Square Test results regarding the Relationship between Cycling Position During Cycling and NSLBP Complaints can be seen in Table 3.

Table 3. Chi-Square Test Results Regarding the Relationship between Cycling Position During Cycling and NSLBP Complaints

The Relationship between Cycling Position and NSLBP Complaints	
p value	0,001

Based on the p-value indicated in Table 3, which is 0.001 ($p < 0.05$), there is a significant relationship between cycling position during cycling and NSLBP complaints among cyclists.

DISCUSSION

This study was conducted from November to December 2023 on Jalan Raya in Denpasar, with 44 subjects. A purposive sampling technique was employed for subject selection. The subjects of this study were adult cyclists aged 19-59 years. NSLBP complaints were found among cyclists aged 21-25 (34.3%). However, in 2022, Yelva Febriani also conducted a similar study, and the results showed no correlation between age and NSLBP complaints, based on the research hypothesis and interviews with respondents from Bike's Od Paliko. It was found that there was no correlation between age and lower back pain among cyclists. Hence, the researcher's results must be consistent with Yelva's findings. This inconsistency may be attributed to some respondents in this study being inactive in cycling activities, and upon resuming activity, they immediately embarked on long-distance rides, leading to lower back pain complaints.[6] Indeed, according to the assumptions made in this study, the high incidence of NSLBP complaints among individuals

aged 21-25 years is likely due to their active engagement in cycling activities for extended durations and covering considerable distances.

This study found NSLBP complaints among cyclists with a normal BMI, totalling 33 individuals (75.0%), while those with underweight BMI did not report NSLBP complaints. These findings are different from those of Tintin Sukartini's research. According to Tintin Sukartini's study, 68% of obese or overweight individuals experienced lower back pain, while the group with normal BMI experienced lower back pain less frequently. This discrepancy may be attributed to the load borne by the spine of cyclists with normal BMI and the average weight load, which reduces the burden on the spine, allowing some of the body weight to be borne by the bicycle saddle.[9,10]

This study found that 30 cyclists experienced NSLBP moderately, while only three cyclists with light duration experienced NSLBP. This study's moderate cycling duration ranged from 1-2 hours per day. According to the researcher's assumption based on interviews with respondents, it was explained that the 30 respondents who experienced NSLBP due to moderate duration may be attributed to the lack of warm-up before cycling. This could also be due to an uncomfortable saddle position during long-distance cycling or prolonged durations. However, this study does not align with the research conducted by Yelva Febriani in 2022, which stated that there was no relationship between back pain and duration. This is because respondents often have uncomfortable saddle positions during long-distance cycling, and cyclists tend to skip warm-ups.[6]

This study found NSLBP complaints among cyclists with a frequency of 1-3 times, totalling 26 individuals, while those with a frequency of 4-7 times experiencing NSLBP numbered seven. However, this study aligns differently from the research by Schultz, which stated that there was no significant difference between cycling frequency, cycling speed, and the number of gears on the bicycle. This may be due to poor road conditions, infrastructure, and other operator-related issues contributing to NSLBP.[11]

This study found NSLBP complaints among cyclists covering a medium distance, totalling 33 individuals. This study's medium distance ranged from 2.5km to 4.4km. However, this study does not align with the research conducted by Marsden dan Schwellnus, which stated that distance does not affect NSLBP complaints. This discrepancy could be due to the potential influence of excessive low gears during cycling.[12]

The cyclists' body position during cycling was measured using REBA. To reduce the potential for bias in this measurement, the researcher established a standard measurement procedure where the distance between the researcher and the subject being examined was set at 1.5 meters, with instructions for the cyclist to maintain a straight posture while cycling. It was found that poor cycling positions led to NSLBP complaints. This study identified NSLBP complaints among cyclists with high-risk positions in 19 individuals, high-risk positions in 9 individuals, and medium-risk positions in 5 individuals.

The Relationship between Cycling Position and Non-Specific Low Back Pain Complaints

The analysis of cycling position regarding NSLBP complaints, as stated in Table 3, shows a p-value of 0.001 ($p < 0.05$), proving the hypothesis that non-ergonomic cycling positions lead to NSLBP complaints among cyclists. NSLBP complaints can occur due to a posture too hunched over while cycling. This hunched position is adopted during pedalling to maintain balance. This aligns with the research by Clarsen et al., which demonstrated that injuries due to excessive use occur among professional cyclists. They studied 109 cyclists with perceived injuries in the 12 months prior. It was stated that non-ergonomic seating positions lead to many cyclists experiencing NSLBP complaints, primarily because of the mismatch between ergonomic design and cyclists' adjustments based solely on feel. This needs attention from cyclists as it contributes to the emergence of NSLBP complaints.[13]

This study is supported by research conducted by Febriani Yelva on cyclists, which suggests a correlation between saddle height and NSLBP complaints. This may be due to respondents' need for warm-up exercises before starting cycling activities and non-ergonomic saddle positions, leading to NSLBP complaints. According to the researcher's assumption in this study, based on the results of angle projection measurements, most of the very high-risk positions had a back flexion of ≥ 20°. This is because of the mismatch between saddle height and handlebar height, resulting in NSLBP complaints in this study. [3,7]

Based on research conducted by Streisfeld regarding seated positions with the spine maintained in a flexed position for lower back pain, a systematic review found that imbalance in muscle activation is a risk factor for lower back pain. Cyclists with lower back pain experience asymmetric conditions in the lumbar multifidus muscles, decreased thickness of the transversus abdominis and lumbar multifidus muscles, and reduced endurance of the extensor muscles. This imbalance is caused by prolonged seated positions with flexion associated with cycling, leading to maladaptive spinal kinematics and increased spinal pressure, contributing to lower back pain.[8]

NSLBP complaints can be caused by handlebar height lower than the saddle position, improper bike size, and prolonged flexion when muscles experience overexertion and a deficit in back extensor endurance.[9] This study found that the higher the risk of the cycling position, the higher the occurrence of NSLBP complaints. Cyclists should adjust the handlebar height and bike size properly rather than relying solely on feeling, as this increases the potential for NSLBP complaints.

In 2023, Leticia conducted a study on lower back pain related to changes in joint positions among cyclists. The research indicated a correlation between upper extremity reach and lower back pain. Excessive stretching of the spinal muscles tends to produce less force, disrupting posture adjustment and resulting in fatigue and discomfort. Excessive seat retraction causes the upper thigh position to advance, leading to excessive trunk flexion and more significant muscle stretching.[14]

According to the research assumptions, there is a correlation between cycling position and NSLBP complaints. Based on interview and examination results, most respondents adopt a high-risk cycling position, which may influence NSLBP complaints, considering the varying frequencies, distances, and durations among respondents. However,

interviews with cyclists with light duration, weekly frequency, and moderate distance suggest that these issues are primarily due to incorrect cycling positions and insufficient warm-up and cool-down routines before cycling. Some respondents cycling for a long time also reported experiencing pain.

This study explores the relationship between cycling position and Non-Specific Low Back Pain (NSLBP) complaints among cyclists in Denpasar. The findings indicate a significant association between non-ergonomic cycling positions and NSLBP complaints. Research limitations include purposive sampling, which may result in a non-representative sample. Additionally, potential sources of bias, such as measurement errors and uncontrolled confounding variables, exist.

Although the study results are consistent with previous research showing a relationship between non-ergonomic cycling positions and NSLBP complaints, there is diversity in the analysis and similar studies. Therefore, the interpretation should consider this diversity and provide a broader context.

Despite the significant research findings, it is essential to consider their generalizability. These results may only partially apply to cyclist populations outside Denpasar or different road conditions. Factors such as population characteristics and research context should be considered when evaluating the generalizability of these results.

Ergonomic education for cyclists is crucial as a practical implication of this research. Regular seminars on the importance of ergonomic cycling positions and warm-up and cool-down practices before and after cycling can help reduce the risk of NSLBP among cyclists. Providing ergonomic education targeting cycling communities, especially those in Bali, is essential. Periodic seminars accompanied by evaluations or follow-ups will have a better and more controlled impact on improving cyclist ergonomics. Cyclists can also stretch during breaks after cycling, and warming up and cooling down are essential to reduce the risk of NSLBP.

CONCLUSION

This study has found a significant relationship between non-ergonomic cycling positions and Non-Specific Low Back Pain (NSLBP) complaints among cyclists in Denpasar. The analysis results indicate that cycling positions with a "very high risk" have a higher prevalence of NSLBP compared to "medium risk" and "high risk" positions. Although this study utilized purposive sampling, which may limit the generalization of the results, these findings are consistent with previous research indicating the importance of ergonomic cycling positions in preventing NSLBP complaints. The study also underscores the importance of ergonomic education for cyclists to reduce the risk of NSLBP. Implementing education programs focused on adjusting cycling positions and warming up and cooling down exercises can reduce the prevalence of NSLBP among cyclists.

The limitations of this study include the use of sampling methods that may not be fully representative, as well as the potential bias from variables that needed to be fully controlled. Future studies should consider more representative sampling methods and stricter variable controls to strengthen these findings. Therefore, the results of this study provide a strong foundation for ergonomic-based interventions among cyclists and highlight the need for a more holistic approach to managing cyclists' health.

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