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ASSOCIATION BETWEEN MOUNTAIN BIKE AND FOLDING BICYCLE USAGE WITH LOWER EXTREMITY PAIN

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ABSTRACT

Background: Lower extremity pain from cycling with wrong technique or without adequate preparation could cause bodily injury and pain. Pain might cause reduced patient's mobility and quality of life in physical and psychological aspects which results in disruption of sufferers when did their daily activities. **Objective:** Knowing relationship between uses of mountain bikes and folding bicycles with lower extremity pain. **Methods:** 65 respondents were involved in research conducted in Semarang online at the respective respondent's and researcher's premises. The study used cross-sectional method to assess relationship between certain types of bicycles uses with lower extremity pain presence and quality. Statistical test used in this study was the Mann-Whitney and Fischer's exact test. **Results:** There were significant differences in handlebar height, saddle height, and wheel diameter between two groups of respondents ($p = 0.032$, $p = 0.001$, $p < 0.001$). There was insignificant difference between mountain bikes and folding bicycles uses with lower extremity pain presence and quality ($p = 0.481$, $p = 0.599$). There was also non-significant correlation and very weak correlation mountain bikes and folding bicycles uses with lower extremity pain presence and quality ($p = 0.613$, $p = 0.603$), negative correlation to presence of pain ($r = -0.088$), and positive correlation to quality of pain ($r = 0.066$). Location of lower extremity which felt most painful by respondents was knee in both groups. **Conclusion:** There was insignificant relationship between certain types of bicycles uses with lower extremity pain.
Keywords: *Cycling, lower extremity pain, mountain bike, folding bicycle*

INTRODUCTION

Lower extremity pain can cause a decrease in mobility and life quality of patients in physical and psychological aspects that could disrupt patients in going through daily activities.[1,2] This pain could be induced by daily activities or sports. Doing sports with the wrong technique or without adequate preparations could cause injury and induce pain. Data from Basic Health Research (*Riskesdas*) 2018[3] showed that the highest proportion of body parts that suffered from injury in Indonesia was lower extremity with 67.9%. Pain could be felt as a result of pain stimuli transmission from peripheral nerve towards central nerve, starting with stimulation, transduction, transmission, and modulation until the stimuli slowly disappeared.[4] Extremity pain could be caused by injury in muscles, tendons, ligaments, or joints. Lower extremity pain caused by sports could be categorized into two, acute pain and pain due to overuse.[5] Acute pain is generally caused by injury during sports.[5,6] Pain due to overuse is a pain caused by micro-trauma that previously was not felt by the body and happened repeatedly until noticeable pain occur.[7]

Cycling is one of the sports that become a global trend, including Indonesia, in 2020 until now. This trend could be seen through sales increase in online shops.[8] Bicycle sales trend in Tokopedia during May 2020 increased 40% when compared to previous month.[8] According to the newest survey by SYSTRA in England, it was reported that 61% of English people were worried in using public transportation.[9] Two types of bicycles that are most searched in March 2020-June 2021 were folding bicycles and mountain bikes.[10]

A research that evaluated lower extremity and back pain concluded that the most occurrence of pain in the lower extremity was in the knee region, with a result of 40% out of all research subjects, and another research showed that 43.4% out of all research subjects that suffered from gradual-onset lower extremity pain due to cycling occurred in knee region.[5,11]

The aim of this research is to know the relationship between uses of mountain bikes and folding bicycles with lower extremity pain.

METHOD

This research was conducted in Semarang through online means in the places of each respondents and researchers. This was an observational analytic research with cross-sectional method.

Research subjects that was used were mountain bike and folding bicycle users who were in the range of youths to adults, had normal body mass index, used mountain bikes or folding bicycles in the past one month with a frequency of once every two weeks, and warmed up before cycling. Research subjects did not have any history of heavy injury nor stimulants use prior to cycling. Subjects were chosen using consecutive sampling. 34 mountain bike users and 31 folding bicycle users agreed to be included in this research.

This research was conducted using online questionnaire through Google Form. The questionnaire contained a confirmation of informed consent after explanation of the research, questions regarding exclusion criteria, cycling profile, and the existence of pain, such as its location and quality on the lower extremity.

The research was analysed through descriptive analysis, hypothesis test, and correlation test. Descriptive analysis were done to obtain mean data, standard deviation, minimum value, maximum value, and median. Hypothesis test was conducted with Mann-Whitney test and correlation test was conducted with Fischer's Exact test. All statistical analyses were performed using IBM SPSS Statistic 26 software

Ethical clearance was obtained through Health Research Ethics Committee of Faculty of Medicine of Diponegoro University.

RESULTS

Respondent data that had been obtained from research subjects that agreed to fill the questionnaire were then screened for exclusion criteria. Research subjects that fulfilled inclusion criteria were dominated by mountain bike users, males, and a frequency of once a week. Data obtained had mean mountain bike users' age of 28.5 years, mean folding bicycle users' age of 30.35 years, mean height of 164.79 cm in mountain bike users and 165.65 cm in folding bicycle users, and mean weight of 58.12 kg in mountain bike users and 59.71 kg in folding bicycle users.

Table 1. Cycling Profile

Profile	Mountain bike group (n = 34)		Folding bicycle group (n = 31)		*p-value*
	n (%)	Mean (SD)	n (%)	Mean (SD)	
Handlebar Height	34	24.12 (20.65)	31	32.97 (21.85)	p=0.032
Cycling Position					
- Straight	9 (26.5)		14 (45.2)		p=0.118
- Bent	25 (73.5)		17 (54.8)		
Saddle Height	34	86.41 (27.62)	31	64.94 (28.16)	p=0.001
Wheel diameter	34	24.71 (3.22)	31	19.29 (2.45)	p<0.001
Position of Hip Joint					
- Bent Upwards (<90^0)	1 (2.9)		2 (6.5)		
- Perpendicular to Bicycle Pedals (90^0)	20 (58.8)		23 (74.2)		p=0.087
- Bent Downwards (>90^0)	13 (38.2)		6 (19.4)		
Position of Knee Joint					
- Bent (<180^0)	20 (58.8)		21 (67.7)		p=0.460
- Straight (180^0)	14 (41.2)		10 (32.3)		
Position of Ankle					
- Bent Upwards (<90^0)	3 (8.8)		8 (25.8)		
- Perpendicular to Bicycle Pedals (90^0)	27 (79.4)		19 (61.3)		p=0.227
- Bent Downwards (>90^0)	4 (11.8)		4 (12.9)		

Research subjects mostly used a bent position, whether in mountain bike or folding bicycle users, positioned hip joint perpendicularly to bicycle pedals when the foot was at the highest pedal, positioned knee joint at a bent position when the foot was at the lowest pedal, and positioned ankle perpendicularly to bicycle pedals when the foot was at the lowest pedal. There was a significant difference in bicycle handlebar height, bicycle saddle height, and wheel diameter used between groups of research subjects.

Table 2. Relationship between Mountain Bike and Folding Bicycle Usage with Lower Extremity Pain

Variable	Mountain bike group n (%)	Folding bicycle group n (%)	*p-value*
Lower Extremity Pain			r = -0.088**, p = 0.613*
- Yes	19 (55.9)	20 (64.5)	p = 0.481***
- No	15 (44.1)	11 (35.5)	
Quality of Pain (Mean ± SD; Median Minimal – Maximal)	1.85 ± 1.94; 2 (0 – 6)	2.16 ± 2.12; 2 (0 – 7)	r = 0.066**, p = 0.603** p = 0.599***

*Fischer's exact test
**Spearman rho test
***Mann-Whitney test

Majority of both groups experienced lower extremity pain during cycling and showed that no significant relationships were found between types of bicycle with the existence and quality of lower extremity pain. P-value in the relationship between mountain bike group and folding bicycle group with the existence of lower extremity pain (p=0.613) and quality of pain (p=0.603) showed no significant correlations with very weak degrees of correlation. Correlation between mountain bikes and folding bicycles with the existence of lower extremity pain was opposite, while with quality of pain was unidirectional. Most of the pain occurred in both groups were in knee.

Table 3. Incidence of Pain Location in Lower Extremity

		Mountain bike group			Folding bicycle group		
		Hip	Knee	Ankle	Hip	Knee	Ankle
Pain Presence	Yes	8	10	3	7	13	4
	No	29	24	31	24	18	27

DISCUSSION

Aspects that must be observed during cycling are the aspect of bicycle users and the aspect of bicycle profile. Both of these aspects create a cycling technique that is used by the cycler. This research evaluated cycling profile that is used by the cycler, both in mountain bikes and folding bicycles. Result of this research showed a significant difference in bicycle handlebar height, bicycle saddle height, and wheel diameter used between groups of research subjects (p=0.032, p=0.001, p<0.001), which meant that the settings of bicycle handlebar height, bicycle saddle height, and wheel diameter had been adjusted with the comfort of research subjects. These were important for comfort, the slowing of gradual-onset pain or overuse pain in lower extremity, and risk reduction of acute lower extremity pain.[12]

Low handlebar height and high saddle height could cause the body to bend while cycling, hence the increased risk of neck pain, intervertebral stress, vertebrae interdiscus pressure, or viscoelasticity deformity in soft tissues of the lumbar, and give load to the lower extremity while cycling and cause a greater lumbar flexion and anterior pelvic tilt.[5, 12-15] Bicycle handlebar that is too high could influence the backbone to be anatomically straight, yet cause all loads to focus on the hips and cause hip pain, which also cause the power that is channelled to the foot while cycling to be lower.[16] Saddle that is too high could cause the knee to flex more and burden tibiofemoral joint, anterior cruciatum ligament, posterior cruciatum ligament, and knee menisci due to high force from quadriceps femoris muscles towards distal and cause discomfort while cycling.[12, 17, 18]

There had not been any research that discussed the effect of wheel diameter towards lower extremity pain, but as long as both wheels are inflated equally, the bicycle only changes height according to the floor and does not influence movement during cycling. Mountain bikes have a wider wheel surface, which makes it usable in various terrain due to its adherence to contours and ability to dampen the impact received from the terrain in order to protect musculoskeletal system and bicycle structure.[19] Folding bicycles have a lighter and more flexible wheel in order to make it easier in storage, but require more energy in turning the wheels while cycling.[20]

The effects of mountain bikes and folding bicycles usage towards the existence and quality of lower extremity pain did not have any significant difference (respectively p=0.481 and p=0.599). This was caused by lower extremity pain that could occur in any bicycle types. Lower extremity pain is only

affected through bicycle settings that influenced repeated unhealthy body posture while cycling, which could cause pain due to overuse.[15, 17, 19]

Insignificant correlation in the usage of mountain bikes and folding bicycles with the existence and quality of lower extremity pain (respectively p=0.613 and p=0.603) with very low degree of correlation and had opposite nature in the existence of lower extremity pain (r=-0.088) and had unidirectional nature in the quality of lower extremity pain (r=0.066) were caused due to the existence and quality of lower extremity pain to not be directly influenced by the types of bicycle because the profiles of bicycle settings were different between each bicycles that were used. Mean height of the saddles in folding bicycles was lower than mountain bikes, as stated in Table 1. Low mean saddle height in folding bicycle caused a higher knee pain incidence in folding bicycle users than mountain bikes, as concluded by Bini, *et al.* [17] that showed higher saddle height to be inversely correlated with compressive force felt in the knees.

Lower extremity pain incidence during cycling was observed to be most frequent in the knees, which was in line with a research held by Piotrowska, *et al.*[15], that stated knee pain as the most frequent pain in cyclists. This incidence data was also supported by the fact that majority of the research subjects admitted to having a bent knee when the foot is at the lower pedal. Recommendations from various studies suggest that to avoid knee pain while cycling, the knee should be positioned at a flexion state 25^{o} – 30^{o} in static condition while the pedal is at the lowest position (bottom dead centre) and 30^{o} – 40^{o} in dynamic condition. [12, 17]

CONCLUSION

Cycling profile that was significantly different were bicycle handlebar height, bicycle saddle height, and wheel diameter. Mountain bike and folding bicycle usage with lower extremity pain had no significant correlation and very low degree of correlation, negatively correlated with the existence of lower extremity pain, and positively correlated with the quality of lower extremity pain. Most frequent lower extremity pain found in cyclers of both groups was knee pain.

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