

ASSOCIATION BETWEEN ERGONOMIC RISK FACTORS AND
MUSCULOSKELETAL PAIN AMONG FIXIE BIKE CYCLISTS

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ABSTRACT

Ergonomics is a field that seeks to design tools, equipment, and tasks to optimize human capabilities and accommodate human limitations. This study applied the ergonomic approach for analysis of human body pains while using the *Fixie* bike in cycling activities. The main objective of this study is to obtain the correlation between the ergonomic risk factors and corresponding level of musculoskeletal disorder (MSD) within the *Fixie* bike cycling activity and to provide control measures for ergonomic related problems. This research study has been done in three main areas of *Fixie* bike activity around Johor Bharu, namely at Universiti Teknologi Malaysia (UTM) Skudai, Danga Bay and Hutan Bandar Johor Bharu. A survey was carried out to identify the *Fixie* bike cyclist's background and, ergonomic risk factors that lead to uncomfortable pain and the level of MSD among the *Fixie* bike cyclists. Statistical analysis was carried out on 130 respondents by focusing on the general opinion on ergonomic risk factors and MSD among *Fixie* bike cyclists. A detailed analysis was done on the correlation between ergonomic risk factors and the level of MSD of *Fixie* bike cyclists. As a result, most cyclists reported that the *Fixie* bike pedals need high skill and energy. Also *Fixie* bike pedal design, *Fixie* bike saddle design/ uncomfortable saddle and the height of *Fixie* bike are significant by associated with hip, ankle/foot and knee pain among cyclists based on correlation analysis using SPSS software. The recommended personal protective knowledge and its implementation based on the cyclist riding technique help to reduce MSD problems when cycling.

ABSTRAK

Ergonomik ialah suatu bidang untuk mereka bentuk alat, peralatan, dan tugas untuk mengoptimumkan keupayaan manusia dan menampung batasan manusia. Kajian ini menggunakan pendekatan ergonomik untuk menganalisis sakit badan manusia semasa menggunakan basikal *Fixie* dalam aktiviti berbasikal. Objektif utama kajian ini adalah untuk mendapatkan korelasi antara faktor risiko ergonomik dan tahap gangguan muskuloskeletal (MSD) dalam aktiviti mengayuh basikal *Fixie* dan untuk menyediakan langkah kawalan bagi masalah berkaitan dengan ergonomik. Kajian ini telah dilakukan dalam tiga kawasan utama aktiviti berbasikal *Fixie* di Johor, iaitu di Universiti Teknologi Malaysia (UTM) Skudai, Danga Bay dan Hutan Bandar Johor Bharu. Satu kaji selidik telah dijalankan untuk mengenal pasti latar belakang pengayuh basikal *Fixie*, faktor risiko ergonomik yang membawa kepada kesakitan dan tahap MSD di kalangan pengayuh basikal *Fixie*. Analisis statistik telah dijalankan terhadap 130 responden bagi pengumpulan maklumat mengenai pendapat umum tentang faktor risiko ergonomik dan MSD di kalangan pengayuh basikal *Fixie*. Analisis terperinci telah diberikan bagi memperolehi korelasi antara faktor risiko ergonomik dan tahap MSD pengayuh basikal *Fixie*. Hasil daripada analisis statistik itu, kebanyakan pengguna basikal *Fixie* menyatakan pedal basikal *Fixie* memerlukan kemahiran dan tenaga yang tinggi. Reka bentuk pedal basikal *Fixie*, reka bentuk pelana basikal *Fixie* serta pelana yang tidak selesa dan ketinggian basikal *Fixie* adalah berhubungkait dengan kesakitan pada pinggul, pergelangan kaki/ kaki dan lutut di kalangan penunggang basikal berdasarkan keputusan analisis korelasi menggunakan perisian SPSS. Syor pengetahuan perlindungan peribadi dan pelaksanaannya dengan berlandaskan teknik pengayuh untuk mengayuh basikal dapat membantu mengurangkan masalah MSD ketika berbasikal.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Ergonomics is a field that seeks to design tools, equipment, and task to optimize human capabilities, (Dan MacLeod 2009). It seeks to harmonize the functionality of tasks with the human requirements of those performing them. Ergonomic design focuses on the compatibility of objects and environments with the humans using them.

According to Dan MacLeod (2009), there are other terms of ergonomic that have been used for the field, for example man-machine system, human-system interface and human factor engineering. Ergonomic design is believed to be human-centered design that focusing on the usage where it seeks to connect human restrictions and capabilities plus it is supported by design options. Equipment and tasks will be associated in an ergonomic environment. This study is concerning on applying ergonomic approach obtain the correlation between ergonomic risk factors and the corresponding level of musculoskeletal disorder (MSD) in *Fixie* bike cycling activity.

Bicycle riding is one of the less popular modes of transportation, recreation, fitness and sport in Malaysia. Physical activities as mode of transportation was low in Malaysia including only 2.9% of cycling and 17.7% walking for traveling to and from work according to socio-demographic groups compared to car 40.8% , motorcycle 33.6%, public transportation including bus, LRT or commuter 9.2% (Poh BK, Safiah MY, Tahir A et al., 2010).

Cycling is an accessible, economical and resourceful form of non-impact exercise aerobic with cardiovascular beneficial effects. In the other hand, bicycles are the common source of major injuries. The bicycle related injuries are the neck (48.8%), knee (41.7%), groin/buttock area (36.1%), hands (31.1%) and lower back (30.3%) based on one survey among 294 male and 224 female recreational cyclist (Schwellnus and Derman 2005). Weiss et al. (1985) also mentions that the neck aches and back aches are the usual complaints resulting from the cyclist's upper body position with hyperextension of the neck and flexion of the lower back.

In Malaysia, ergonomics among cyclist are not documented widely compared to other issues such as motorize accidents and other hazards in roadway. Ergonomics bicycle means that the design of the bicycle needs to be fit and suitable for cyclist. Ergonomics helps to improve the output and the comfort of bike riding. When improving the comfort, we can use our power more for bike riding and not for struggling against pain. When we improve our output, we will get extra comfort because our muscles become stronger and we do not sit on the bike like a sack of potatoes (Juliane 2007). There are several factors that may contribute to musculoskeletal pain among cyclist and need to identify detailed.

1.2 Background study

The health status among Malaysians is not satisfied because of the obese people are growing Malaysia. Most of the obese people would be a victim to health problems. In a survey of the Third National Health and Mobility in year 2006 showed that 29.1% of the adult population surveyed 33.055 of BMI that experiencing heavyweight. Being overweight is when your BMI is between 25.0 to 29.90. Prevalence of obesity (BMI > 30) was reported to 14.0%. One of the easiest ways to deal with health issues is to foster cycling habits among the people. As well as to strengthen the muscles and burn calories, cycling activities also contribute to the health rate in Malaysia effectively and collectively.

The case study was carried out on road cyclist activities in Johor Bharu, Johor. The popularity of cycling has increased by leaps and bound over recent years. Bicycle is the best example of the most popular vehicles for cycling. Bicycle has always been a favorite form of recreation for children, but recently, more adults especially teenagers have migrated to cycling for its benefits as aerobic exercise whether exercising on a stationary bike or taking in the sights during an outdoor bike ride. Recently, teenagers in Malaysia especially in Johor use a bicycle as their recreation medium for their activity. Cycling is an ideal way to support our aerobic fitness.

Article review from Sheldon Brown (2013) shown that the normal suffer pain or injure to cyclists when using existing product are lower back pain, knees pain, ankles pain, feet paint, wrist pain, thighs pain ,shoulders pain, hands pain, neck pain , finger pain, and Achilles tendons. In these cases, a cyclist needs vehicle that he or he can get and increase healthy exercise without get any suffer in cycling. Based on several researches to support this study, Wilber et al. (1995) found that 44.2 % of male and 54.9% of female recreational cyclists presented for medical treatment of neck pain, while approximately 30% presented with back pain. Weiss (1985) also reported that 66.4 % of recreational cyclists reported neck and shoulder symptoms following an 8-day of 500 mile bicycle tour.

By using ergonomic method and approach on this research, the ergonomics risk factor and level of Musculoskeletal Disorders will be determined among cyclists. The correlation analysis will be conducted to obtain the correlation between each risk factor and the corresponding MSDs among them.

1.3 Problem statement

Recently, Malaysia's population especially teenager have choose a bicycle as transportation for recreation. Currently, we always see a number of teenagers especially in Johor cycling of colorful bike on the road. The type of the bike is a *Fixie* bike. The normal average age youth cyclists in Johor who are using *Fixie* bike are within 12-15 years old. It is supported by the DfT (2004) and Dot (1996) , shown in Table 1.0 that youth cyclist aged 12 to 15 (those most at risk) have a relative fatality rate similar to adults aged between 20 to 29, 30 to 39 and 50 to 59 and a lower relative fatality rate than adults aged 40 to 49. Cyclist aged 12 to 15 shown the highest distance travelled than adults aged.

Table 1.1: Population fatality rates, distance travelled and relative fatality rates
(Sources: DfT (2004) and DoT (1996))

Age	5-7	8-11	12- 15	16- 19	20- 29	30- 39	40- 49	50- 59	60-69
Pop'n fatality rate	0.0	0.1	0.4	0.1	0.2	0.2	0.3	0.2	0.1
Miles per year	14.5	31	81	76	55	43.5	43.5	43.5	17.5
Relative fatality rate	0.0	.003	.005	.001	.004	.005	.007	.005	.006

Fixie bikes or fixed-gear bicycle is a kind of bicycle that has no freewheels, that means it cannot coast because of the pedals are always moving when the bicycle is in motion. This type of bicycle has attracted young people in Malaysia today because it has such a design and color according to the current youth trends. Could this bicycle affect the health of riders, especially the parts of bicycle that are always associated with injury and pain to cyclist? The injury or pain may occur towards cyclist's leg and knees cause lot of energy and skill needs to use to control bicycle speed. It is because leg and knee may use for controlling pedals for speed and stability of *Fixie* bike.

Loss of control can happen when the beginner rider cycle at a high speed as the pedals hit the road. The cyclists may fall down or suffer pain in knee or ankle. Riding a brakeless *Fixie* bike creates a cult status in some areas where there are many urban *Fixie* riders who think that brakes are not necessary (Wisenthal 2007). Many of them love the experiences of riding brakeless bike that creates an "oneness with the road" where it forces them to be more aware of their surroundings particularly in urban environments because of the inability to bring the bicycle to a quick stop. They believe that brakes and the cables will add extra bulk to the simple appearance of a fixed gear bicycle.

Churchill (2005) state that based on image rather than practicality, some riders dismiss cycling on road without brakes as their way. Doing so can be risky where it is prohibited by law and may affect the chances of a successful claim if any accidents happen (Colegrove et al.,2007). To slow down or stop a fixed-gear bike, a rider can resist the turning cranks, lock the rear wheel and skid. These steps can be started by unweighting the rear wheel while in motion where the riders have to shift their weight slightly forward and pulling up on the pedals using or toe clips and straps. The rider then stops turning the cranks, thus stopping the drive train and rear wheel, while applying body weight in opposition to the rotation of the cranks. This causes the rear wheel to skid and slowing the bike. The skid can be held until the bicycle stops or until the rider desire to continue pedaling again at a lower speed. These techniques require practices and it is dangerous to perform it while cornering (Brown (2007); Sheldon (2013)). A wet surface also will reduce the effectiveness of

this method. By using a pedal as a medium to stop and slow the riding may cause pain and injuries in knees and foot to cyclist if they are riding for long distance.

The maximum deceleration of bike equipped with a front brake is much higher than on a bike with only rear wheel braking (Stevenson (2007)). Weight is transferred towards the front wheel and away from the rear wheel causing the amount of grip the rear wheel to decrease as the vehicle brakes. The efficiency of a rear wheel braking will increase when transferring the rider's weight back, but a front wheel fitted with an ordinary brake might supply 70% or more of the braking power when braking hard.

A lot of researchers have found that bicycle is a major transport that leads to pain and injuries to the cyclist. J.Srinivasan and Balasubramaniam (2006) reported that the weak back muscles in the Low Back Pain group can happen due to cycling. The neck and back pain are the most common complaints as a survey has been conducted among the cyclists (Chad 2005).

1.4 Research Questions

There a few research questions of this research.

- i. How the correlation between ergonomic risk factors and corresponding level of musculoskeletal (MSD) lead to body pain in cycling?
- ii. What the most part of human body involve of pain in *Fixie* bike cycling?

1.5 Research objective

This master project will help and train teenagers in Malaysia to be more adventurous and healthy by cycling a *Fixie* bike. This is a brilliant way for a teenager to get benefits and healthy during their free time activity. The *Fixie* bike has to play its role in creating healthy lifestyles. The objectives of this research are as below:

- i. To establish the correlation between ergonomic risk factors and the corresponding level of musculoskeletal disorder (MSD) in cycling activity.
- ii. To establish the most body pain of the *Fixie* bike cyclists in cycling activity
- iii. To provide control measure for ergonomic problems on *Fixie* bike cycling activity.
- iv. To validate the control measure for ergonomic in *Fixie* bike cycling by protocol analysis.

1.6 Scope of Study.

The scopes of this master project are to identify the ergonomic risk factors in *Fixie* bike cycling and to evaluate the level of musculoskeletal disorder (MSD) among teenager *Fixie* bike cyclist. The focus of this research will be concentrate at knee, hip, foot and ankle of *Fixie* bike cyclist in analysis. The surveyed subject will be focusing on the teenager cyclists (12-21 years) who must use *Fixie* bike for long distance tour (10 km) with selected track in Johor area. Only the most significant correlation data will develop in personal protective knowledge stage as a recommendation.

1.7 Significant of Study

- i. This research can be applied in determining adequate ergonomic intervention to reduce the MSDs in cycling activity.
- ii. Identify ergonomic risk factors that lead to health hazards in using *Fixie* bike

1.8 Research Outline.

This chapter will contain six chapters namely introduction, literature review, methodology, data collection and analysis, proposed solutions and analysis and the final chapter is the conclusion and future works.

Chapter 1 contains the introduction to the project which consists of background of the study, problems statement, research objective, scope of study, research limitation and significant of this project.

Chapter 2 reviews the related concept of ergonomic including ergonomic risk factor. This chapter also describes the steps that can be taken to overcome problems related to ergonomics in cycling *Fixie* bike. Related theory on statistics is also discussed as well as Likert scale.

Chapter 3 provides description about the methodology used in collecting information and data. For this study, questionnaire is used to collect the data. To analyze the data, statistical method using Statistical Package for Social Sciences (SPSS) was used.

Chapter 4 describes data analysis. In this study, the data is analyzed to determine correlation between ergonomic risk factor and level of pain experienced by the *Fixie* cyclists.

Chapter 5 will discuss detail about the data analysis and result from Chapter 4. The discussion will cover about analysis result from correlation and MSD in *fixie* bike cycling. In this chapter also will validate the counter measure of ergonomic risk factor by protocol analysis.

Chapter 6 present the proposed control measures to reduces ergonomic risk factor in cycling *Fixie* bike. The control measures will propose by using personal protective knowledge.

Chapter 7 explains the conclusion of the report, summary of the study and recommendations for future works including area that can be expanded.

1.9 Conclusion

This chapter provided the introduction that comprised all the background, problem, objective and scope of this study. For the next chapter, there will be overall explanation for the subject that we want to study including the ergonomic factor in cycling a *Fixie* bike as the main focus of this research.

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