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The Relationship Between Body Mass Index (BMI) & Physical Activity with Cyphosis in Physiotherapy Students at the Faculty of Medicine, Udayana University

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Abstract---Introduction: *Kyphosis is generally defined as a disease that occurs in the area of the vertebrae or the human spine which causes a hunched posture. As for some musculoskeletal complaints caused by kyphosis, including changes in body posture that bends forward so that it affects appearance, pain is felt in the spinal area, muscles get tired easily, and tightness in the back area, which in the most severe conditions kyphosis can cause problems in the respiratory tract and other organs. The cause of kyphosis is caused by several factors, namely body mass index, workload, disease scheurman, and birth defects. This study aims to determine whether there is a relationship between Body Mass Index and Physical Activity with the Incidence of Kyphosis in Physiotherapy Students at the Faculty of Medicine, Udayana University. Method: This research is a type of descriptive-analytic research approach cross-sectional, using the total sampling technique, the number of subjects was 64 physiotherapy students who met the exclusion and inclusion criteria. Data was taken by measuring body mass index using the BMI formula, using the global physical activity questionnaire (GPAQ) to measure physical activity and flexicurve as a measure of the degree of kyphosis. Results: Nonparametric analysis test results in spearman rho the body mass index with kyphosis shows a value of $p=0.101$ ($p>0.005$) and $r=0.207$. While the results of bivariate analysis of the relationship between physical activity and kyphosis showed a significance value of $p=0.117$ ($p>0.005$) and $r=0.198$. Conclusion: Based on the results of the study, it can be concluded that there is no relationship between Body Mass Index and Physical Activity with the Incidence of Kyphosis in Physiotherapy Students at the Faculty of Medicine, Udayana University.*

Keywords---*body mass index, kyphosis, physical activity, physiotherapy.*

Introduction

With the development of an increasingly sophisticated era, it currently has a lot of impact on the community when carrying out their daily activities, whether it is a positive impact that helps the community or a negative impact that has an adverse effect on public health. An example of a positive impact is that it makes it easy to carry out all activities, from this it has several negative impacts which make people increasingly avoid physical activity caused by the easier it is to carry out activities with the help of increasingly advanced facilities and infrastructure. For example, many prefer to use escalators/ elevators compared to using the stairs, you don't have to go to the store to buy the

necessary items, because they can be easily purchased using the application online, for both food and manganese needs. Another example is consuming fast food instead of having to cook your own food. This habit of course has a bad effect on body health, one of the effects is related to body mass index, especially BMI overweight and obesity (Turege et al., 2019). Students are a group of people who have a habit of living with dependence on sophisticated technology and information, with busy lecture activities making students tend to have the habit of consuming unhealthy foods, as well as foods that have the potential to have high levels of fat, iodine, and cholesterol. Nearly 50% of students choose not to be involved in physical activity in any type of physical activity, which causes health problems, one of which is related to body mass index such as being overweight or obese (Andini, 2019). Body mass index is an indicator that is often used as a benchmark in measuring a person's level of being underweight or overweight. Body mass index is classified into underweight (23.0) and obesity I (25.0 – 29.9), obesity II (>30.0) (Sugiritama et al., 2015). Now, innovative policy and intervention efforts are still needed, to be able to prevent and control the prevalence rate of overweight and obesity (Lee et al., 2017) Based on the evidence obtained from Basic Health Research in 2018, it shows that 13.6% of people in the Republic of Indonesia are overweight, and as many as 21.8% are obese. In 2016, the results of the National Health Indication Survey showed that the obesity rate rose to 20.7% while the obesity rate rose to 33.5%. Factors that cause obesity are multifactorial, one of which is related to a person's lifestyle. Increasing the amount of fast food consumed, low physical activity, genetic factors, psychological factors, age, and gender are factors that have contributed to changes in energy balance and lead to being overweight (Lailani, 2013). Being overweight can increase a person's risk of experiencing back pain, this is due to increased pressure on the spine, especially on the discs which are then prone to developing herniations in the lumbar discs (Negara et al., 2015). Body weight is one indicator that determines a person's bone mass index. Osteoporosis is an example of a disease related to bone density, this disease is characterized by decreased bone mass and microstructural changes that can cause bone fragility and increase the risk of fracture. Apart from osteoporosis, body weight is also a factor that triggers several musculoskeletal complaints (Liu et al., 2019). Physical activity is associated with all types of body movement carried out by skeletal muscles which will cause the energy expenditure process that is needed, physical activity is categorized into 3 groups, namely light physical activity, moderate physical activity, and heavy physical activity. Each activity requires different energy depending on the intensity and work of the muscles. World Health Organization(WHO) said that physical activity and body weight have a relationship with various types of chronic diseases and it is generally known that they are one of the leading causes of death globally (Habut et al., 2016). As many as 48.2% of people in Indonesia who are at the age of 10 do not do physical activity. It is known that the female sex group is more likely to do no or less physical activity, as evidenced by the percentage reaching 54.5%, while the male group is slightly lower, as seen from the percentage of 41.4%. In addition, low levels of physical activity can occur and be experienced by all groups in society, regardless of their middle to low-economic income figures. Physical activity has a function, namely to channel excess energy intake which is stored and eventually becomes fat deposits in the body. The total amount of energy that can be excreted by physical activity is known to range from 20% to 50% which can be accommodated to reduce excess energy in fat tissue (Nurhadiono et al., 2016). Body mass index and physical activity are two indicators that have an important role in relation to the human body and every movement it makes. These two indicators are also an easy way that can be used to see a person's nutritional status, especially with regard to being overweight, underweight, and personal physical fitness. At the age of adolescents, many physical activities are carried out related to daily sports, for example lifting weights which are usually done at the school gym. Adolescents who often carry out physical activities by lifting weights directly or indirectly tend to experience changes in posture. This is caused by the weight of the load being lifted and the long duration of exercising lifting weights gives an effect that will become more visible the more often you do physical activity lifting weights (Akhmad, 2015). According to the OECD, which stands for Organization for Cooperation and Development said that Indonesia will be the country with the fifth largest number of bachelor's in the future, and will even increase by 6% in 2020⁹. Therefore, students who usually have limited physical activity and tend to choose things that are instantaneous because of their busy lives can change their lifestyle for the better. When performing movements, the quality of functional movements depends on the effectiveness and efficiency of individual movements. This is influenced by several factors and one of them, is a person's balance, flexibility, coordination, strength, and endurance (Habut et al., 2016). At the age of adolescents, many physical activities are carried out related to daily sports, for example lifting weights which are usually done at the school gym. Adolescents who often carry out physical activities by lifting weights directly or indirectly tend to experience changes in posture. This is caused by the weight of the load being lifted and the long duration of exercising lifting weights gives an effect that will become more visible the more often you do physical activity lifting weights (Akhmad, 2015). Kyphosis is a disorder in which the human spine bends forward. Based on previous research, kyphosis is defined as a disease in the spinal area where the bones in the thoracic spinal area are curved to

form an angle like a parabola. The human body is known to consist of bones that are arranged in such a way and orderly and have their respective functions, whose main task is to help support the human body in when doing activities. Therefore, changes in the position of bone structures that are wrong or out of place can greatly affect the shape of a person's posture, and it will be more obvious when you are at an advanced age. In general, the shape of everyone's spine is slightly curved, this curvature functions to help the body move when entering old age (Novianti, 2015). Musculoskeletal complaints that can arise due to kyphosis include, body posture that changes to become more hunched compared to normal people, muscles that get tired easily because the limitations of movement experienced cause the spine to become cramped, tightness, and in some of the most severe cases of kyphosis, which can cause interference with breathing and also other organs (Yaman & Dalbayrak, 2014). On examination for kyphosis, it is usually found that there is flattening of the front disc and widening of the disc at the back, which causes the nucleus to be pushed and squeezed on the front side and causes locked extension movement causing contractures, and the posterior longitudinal ligament is irritated. In addition, elongation of the ligament capsule and shortening on the other side of the ligament result in its occurrence of tightness. Changes in posture caused by kyphosis can affect the quality of a person's health, research says these changes in posture will cause pain in the spinal area, due to mechanical stress that occurs in the spine, imbalance in the vertebral muscles, stress on the ligaments, limitation of motion in the thoracic area, myofascial syndrome and respiratory distress. In general, kyphosis posture can also interfere with physical appearance due to poor posture (Fauzie et al., 2023). Based on Juliana's research, 2015, a study of changes in posture in adolescence, the prevalence of kyphosis in adolescents was 79.7% (n = 47), of which 47.5% (n = 28) showed changes on the frontal side and 61% (n = 36) there is a change on the sagittal side (Jacinto et al., 2022). Kyphosis is a spinal deformity that occurs in adolescents. The deformity rate is estimated to be around 15% in children aged 11 years and as many as 38% in adults aged 20 years (Seidi et al., 2014). Being overweight, either way, overweight or obesity, contributes additional burden to the thoracic area and the abdomen which results in stretching that exceeds normal limits on the thoracic wall, this makes someone who is overweight tend to have a more stooped posture than people with normal weight¹⁷. Other clinical manifestations related to kyphosis are lower back pain, shoulders, compression fractures of the vertebrae that occur in old age, changes in posture when walking, uncomfortable mobility, and decreased quality of life and life expectancy of a person¹⁸. Based on the background described above, the researcher's hypothesis is to believe that there is a relationship between body mass index and the incidence of kyphosis, physical activity and the incidence of kyphosis in physiotherapy students at the Faculty of Medicine, Udayana University, Denpasar, Bali. Researchers also feel that it is important to find out the relationship between body mass index and physical activity on the occurrence of kyphosis spinal abnormalities. Research conducted by Malepe, in 2015 previously discussed a similar research title, but this study only examined the relationship between body mass index and kyphosis and did not examine the relationship between physical activity and kyphosis. Physiotherapy students at Udayana Faculty of Medicine as a research sample are considered more cooperative because they are easier to reach, and can receive information related to this research. In addition, in the Physiotherapy Study Program, Faculty of Medicine, Udayana University, no research has been conducted on the relationship between body mass index and physical activity with kyphosis (Barton et al., 2021; Lowe, 2007; Kanca et al., 2017; Sandi et al., 2017). Therefore the researchers raised this topic in a study entitled "Relationship between body mass index (BMI) and physical activity with the incidence of kyphosis in physiotherapy students at the Faculty of Medicine, Udayana University".

Method

The type of research used is a descriptive-analytic approach cross-sectional. This research was conducted from November to December 2022, and the process of obtaining a research permit takes approximately 2 months. This research was conducted after obtaining permission and was carried out at the Faculty of Medicine, Udayana University. Preliminary observations on the population and variable measurements for each study subject were only carried out once. The variables in this study are the independent variables, which include body mass index and physical activity, and the dependent variable, namely the degree of kyphosis. The sample selection technique in this study uses the technique total sampling which is a technique where the number of samples used is the same as the number of population, this technique is used because the number of reachable populations is below 100, so that the entire population is taken as a research sample. To reduce bias in this study, sample selection was carried out according to inclusion and exclusion criteria. The inclusion criteria in this study were physiotherapy students with active status at the Faculty of Medicine, Udayana University, aged 17 to 21 years, and willing to become research subjects and fill informed consent as evidence consent to be the research sample. While the exclusion criteria in this study were students who had a history of spinal cord injury, had kyphosis and spinal disorders since birth, and

students who were unable to carry out a series of research procedures to completion. After entering the inclusion and exclusion criteria, a total sample of 64 people was obtained who were physiotherapy students in the 2020 and 2021 batches at the Faculty of Medicine, Udayana University. The research began by contacting the physiotherapy study program at the Faculty of Medicine, Udayana University to ask for research permission, after obtaining research permission, the researchers then contacted physiotherapists as professionals, in this study experts were needed to measure the degree of kyphosis using flexicurve it is intended that the measurement results obtained are more valid, then provide information from researchers to the research population regarding filling in self-identity and matters related to inclusion and exclusion criteria through google forms to get a research sample. Next, the selected subject will be awarded informed consent to be signed as proof of agreement that the subject is willing to be a sample and follow all research procedures to completion. The process of collecting data and measuring the sample was carried out for 2 days, namely on 10 December 2022 which was attended by a sample of 40 people, and on 11 December which was attended by a sample of 24 people, this was done to reduce the number of people in 1 room and avoid the spread of COVID-19. The research location is located in the Physiotherapy Undergraduate Program and Physiotherapy Profession Building, Faculty of Medicine, Udayana University, while still implementing health protocols. Next, the researcher explained in detail to the sample the mechanisms and procedures of the research to be carried out. The process of measuring body weight is done first using a weight scale, then measuring height using a stadiometer. Then measure physical activity Global Physical Activity Questionnaire (GPAQ). The results of the GPAQ calculation will then be categorized into low, moderate and heavy physical activity categories. The final procedure of this study is measuring the degree of kyphosis using a flexicurve. The measurements are carried out by professionals. All data that has been collected is then analyzed using the help of the software Statistical Product and Service Solutions (SPSS). The analysis begins with analyzing univariate data and the results of the analysis will then be used to describe the characteristics of the sample, the data analyzed include age, sex, body mass index, physical activity, and the degree of kyphosis. From the univariate data obtained, it will then be used for bivariate analysis using spearman rho to determine the relationship between body mass index and kyphosis, and the relationship between physical activity and kyphosis. This research was approved by the Research Ethics Commission of the Faculty of Medicine, Udayana University. Ethical Clearance/ Description of ethical eligibility with number 2878/UN14.2.2.VII.14/LT/2022.

Results

The subjects in this study were students in the 2020 and 2021 physiotherapy study programs aged 17 to 21 years. The total population of physiotherapy students in the 2020 and 2021 batches is 111 people, and from this total population, 64 research samples were obtained that match the inclusion and exclusion criteria. After data collection and univariate analysis and bivariate analysis were carried out using spearman rho data found in the table below.

Table 1
Frequency distribution of demographic characteristics of respondents (n=64)

Age	Frequent (n)	Percentage %
18	2	3,1
19	28	43,8
20	32	50,0
21	2	3,1
Sex		
Female	54	84,4
Male	10	15,6
Body Mass Index		
<i>Underweight</i>	10	15,6
Normal	39	60,9
<i>Overweight</i>	9	14,1
Obesity	6	9,4
Physical Activity		
Light	8	12,5

Medium	27	42,2
Heavy	29	45,3
Kyphosis		
Normal	56	87,5
Hyperkyphosis	8	12,5

Based on the data in Table 1 above, it can be seen that the majority of the sample in this study were 20-year-old students, namely 32 people (50.0%). For samples aged 19 years, there were 28 people (43.8%), while samples aged 18 and 21 years each amounted to 2 people (3.1%). In the research characteristic variable based on gender, it can be seen that the sample in this study was dominated by female samples, namely 54 people (84.4%), while the male sample totaled 10 people (15.6%). The characteristics of the research sample can be seen based on the classification of body mass index, the results obtained show that this study was dominated by samples that fall into the normal body mass index category, namely as many as 39 people (60.9%), while samples with body mass index category underweight as many as 10 people (15.6%), overweight as many as 9 people (14.1%) and the sample with an obese body mass index totaled 6 people (9.4%). In the variable table for the degree of kyphosis, the results showed that of the 64 samples in this study, there were 8 people (12.5%) who had kyphosis, while the other 56 people (87.5%) had a normal degree of kyphosis.

Table 2
Correlation test results in spearman's rho relationship between body mass index and degrees of kyphosis

Variable Correlation	Correlation	<i>p Value</i>
BMI		
Kyphosis	0,207	0,101

Table 2 shows that the value Sig. (2-tailed) of 0.101, where the value Sig. (2-tailed) greater than 0.05. These results indicate that H_a is rejected and H_o is accepted, which means there is no relationship between the degree of kyphosis and body mass index in the sample. Mark correlation coefficient he obtained value is 0.207, which means that the strength of the relationship between the variable degree of kyphosis and body mass index is 0.207 or a very weak correlation. The correlation coefficient is positive, so the relationship between the two variables is unidirectional, thus meaning that it can be interpreted that the higher the body mass index in the subject, the degree of kyphosis in the subject will also increase (Miranda et al., 2022; Hannink et al., 2022; Setchell et al., 2014).

Table 3
Correlation test results spearman's rho relationship between physical activity and degrees of kyphosis

Variabel Correlaion	Correlation	<i>p Value</i>
Physical Activity		
Kyphosis	0,198	0,117

Table 3 shows that the value Sig. (2-tailed) of 0.117, where the value Sig. (2-tailed) greater than 0.05. These results indicate that H_a is rejected and H_o is accepted, which means there is no relationship between physical activity and the subject. Mark correlation coefficient 0.198, which means that the strength of the relationship between the degree of kyphosis and physical activity is 0.198 or a very weak correlation. The correlation coefficient is positive, so the relationship between the two variables is unidirectional, this meaning that it can be interpreted that the more strenuous the physical activity is, the degree of kyphosis in the subject will increase.

Discussion

The characteristics of the sample in this study were that it had a sample of 64 people who were physiotherapy students at the Faculty of Medicine, Udayana University who met the inclusion and exclusion criteria. The

characteristics of this study were dominated by a sample aged 20 years, namely as many as 32 people. Students' daily lifestyle has a very big influence on their body mass index and physical activity. Lonner, et al, 2015 said that the relationship between body mass index and kyphosis is still not known with certainty even though there have been several studies related to this matter (Lonner et al., 2015). Fotiadis et al. (2008), concluded that people with kyphosis tend to have higher weight, height and body mass index compared to normal people. This shows that people with a body mass index are in the classification overweight and obese people have a higher probability of experiencing kyphosis than people who are in the body mass index classification underweight and normal. The characteristics of the research subjects based on gender showed that the sample was female, namely 54 respondents (84.4%), while the sample was male as many as 10 respondents (15.6%). This is because the subjects who filled in and met the inclusion criteria in the study were dominated by women. This is consistent with the higher percentage of female students in Indonesia, which is around 56.10%, while male students are known to be as much as 43.90%. Relationship between Body Mass Index and the Degree of Kyphosis Based on the results of the correlation test spearman's rho, Table 2 can be seen that the value of Sig. (2-tailed) of 0.101, where the value Sig. (2-tailed) greater than 0.05. These results indicate that H_0 is accepted and H_a is rejected which indicates that there is no relationship between body mass index and the incidence of kyphosis in the subject. Value of the correlation coefficient 0.207 which means that the strength of the relationship between the body mass index variable and the degree of kyphosis in the subject is 0.207 or it can be concluded that the correlation between variables is very weak. The correlation coefficient is positive, so that the relationship between the two variables is unidirectional, thus meaning that it can be interpreted that the higher the body mass index in the subject, the degree of kyphosis in the subject will also increase. The results of the correlation test in this study are in line with the results of research conducted by Malepe in 2015. Research conducted by Malepe, 2015 showed that there was no significant relationship between body mass index and kyphosis. This study was conducted on 100 students at the University of Venda, taken by sampling technique namely purposive sampling and shows that the results of statistical analysis by test chi square obtained $p = 0,196$ ($p < 0.05$), with a sample data distribution of 61 women and 39 men. From the results of this study, it was found that 34 people had kyphosis with a percentage of 13 female subjects (21.3%), while male subjects had kyphosis (53.8%), namely 21 subjects had kyphosis (Lonner et al., 2015).

The results of this study are in line with previous research conducted by Fotiadis in 2008, the sample in this study was taken randomly, which numbered 10,000 adolescents and a total of 175 children diagnosed with Scheurman's disease aged between 11 and 17 years. The results of this study said that there was no relationship between body weight ($r = -0.019$, $p = 0.804$), height ($r = 0.053$, $p = 0.0484$) and body mass index ($r = -0.177$, $p = 0.019$). Fotiadis also said that the cause of kyphosis can be influenced by many factors. This study, it shows that changes in body mass index also have no effect on increasing the kyphosis curve in children diagnosed with Scheurman's disease and have no relationship with the incidence of kyphosis in healthy samples (Fotiadis et al., 2008).

The long-term study conducted by Murray, et al evaluated the long-term effects of kyphosis patients in University of Iowa using radiographic data, physical examination, several lung function tests, and questionnaires. The results of this study indicate that kyphosis does not have a major impact on daily life. In the research conducted by Abdullah said that the Center of gravity has a great influence on human body posture, COG in every human being has different points. COG is the point of gravity that is present in all objects, both animate and inanimate, the midpoint of the object is the location of the center of gravity. In humans, COG when standing upright is located 1 inch in front of the second sacral vertebra. When the body is subjected to gravitational forces, the COG of the body coincides with the COG. Anatomically the human COM is located in front of the second sacral vertebra, but the exact position of the COM will change if a person changes their body position (Petcharaporn et al., 2007).

The function of the COG is to distribute the mass of objects evenly. In humans, the body's weight is always supported by this point so that the body is in a state of balance. The COG point always moves automatically according to direction or changes in weight. When the COG is located inside and right in the middle, the body will be balanced, if it is outside the body, an unbalanced condition will occur (Neumann, 2010). The Relationship between Physical Activity and the Degree of Kyphosis Based on the results of the correlation test spearman's rho, Table 3 shows that the value Sig. (2-tailed) of 0.117, where the value Sig. (2-tailed) greater than 0.05. These results indicate that H_0 is accepted and H_a is rejected, which means there is no relationship between physical activity and the subject. Mark correlation coefficient 0.198, which means that the strength of the relationship between the degree of kyphosis and physical activity in the subject is 0.198 or a very weak correlation. The correlation coefficient is positive, so that the relationship between the two variables is unidirectional, thus meaning that it can be interpreted that the more strenuous the physical activity is, the degree of kyphosis in the subject will increase. Physical activity has a crucial and useful role in everyday life. By doing enough physical activity, it can maintain and improve the degree of health.

Physical activity is all movements of any form of body movement produced by skeletal muscles and produces significant energy expenditure and is divided into light, moderate and heavy physical activity categories. Each activity requires different energy depending on the intensity and work of the muscles (Habut et al., 2016). According to the world health organization, values of body weight and physical activity are associated with a number of diseases and overall causes of death globally. Physical activity can prevent a decrease in bone mass and increase bone mass through a process of bone formation that is greater than the erosion of the bone surface caused by osteoclast cells (Tussakdiah, 2014). Useful physical activity is one that can withstand loads such as light exercise, aerobics, cycling and walking. Therefore, daily activities that are less productive can be changed to prevent a decrease in bone mass which can increase the risk of kyphosis (Seftivani, 2022).

Previous research said that the relationship between physical activity and kyphosis is still not specifically known (Eum et al., 2013). Any physical activity that uses a muscle or muscle group in a shortened position in a particular posture tends to have an effect that will exacerbate that posture (Johnson, 2016). For example, in people who have thoracic kyphosis, their condition will get worse if they do rowing activities or play golf excessively because the body position when playing golf uses more thoracic rotation and other sports that involve activities that use excessive muscles such as lifting iron. It can be concluded that types of physical activity that use one side of the body are more at risk of causing an imbalance in posture compared to physical activities that use the entire body's muscles. This research has several limitations and weaknesses. This research is limited by the search terms and the searched index. Therefore, it is very likely that other research results are not included. Because so little literacy is found, conclusions based on the findings are also limited. The weakness of this study is that it does not control the factors that can influence the results of the study, there are confounding variables that are not given enough attention. In addition, another weakness of this research is using the method cross-sectional, which is a research method that takes measurements only one time, and is a research method whose level of validation is very weak in determining the relationship between the variables studied (Stevens-Lapsley et al., 2010; Ferreira et al., 2022; Kunstler et al., 2018).

Conclusion

Based on the results of the research described above, it can be concluded that there is no relationship between body mass index and the incidence of kyphosis in physiotherapy students at the Faculty of Medicine, Udayana University. The results above also show that there is no significant relationship between physical activity and the incidence of kyphosis in physiotherapy students at the Faculty of Medicine, Udayana University, Bali. This study shows that there is no relationship between body mass index and physical activity with the incidence of kyphosis. Based on the research that has been done, there are some suggestions from researchers for more complete research in the future, namely considering and paying attention to every other factor that can influence the occurrence of kyphosis, so that it can be added to the variables that must be studied to obtain more accurate research results. Explain the process of measuring the degree of kyphosis using flexicurvein in detail and clearly to the sample so that the sample can understand and understand to avoid bias during the measurement, and the results obtained are valid, as well as adding several other variables such as gender, mass index category more specific bodies, and types of physical activity, to control variables in research so that later they can complement and strengthen research results.

References

- Akhmad, I. (2015). Efek latihan berbeban terhadap fungsi kerja otot. *Jurnal Pedagogik Olahraga*, 1(2), 80-102.
- Andini, R. (2019). Indeks Massa Tubuh Sebagai Faktor Risiko Pada Gangguan Muskuloskeletal. *Jurnal Ilmiah Kesehatan Sandi Husada*, 8(2), 316-320.
- Barton, C. J., King, M. G., Dascombe, B., Taylor, N. F., de Oliveira Silva, D., Holden, S., ... & Shields, N. (2021). Many physiotherapists lack preparedness to prescribe physical activity and exercise to people with musculoskeletal pain: a multi-national survey. *Physical Therapy in Sport*, 49, 98-105. <https://doi.org/10.1016/j.ptsp.2021.02.002>
- Eum, R., Leveille, S. G., Kiely, D. K., Kiel, D. P., Samelson, E. J., & Bean, J. F. (2013). Is Kyphosis Related to Mobility, Balance and Disability?. *American journal of physical medicine & rehabilitation/Association of Academic Physiatrists*, 92(11), 980.
- Fauzie, I. F., Norisa, N., & Usrina, N. (2023). Analisis Perubahan Body Mass Index (BMI) Selama Masa Studi Pada Mahasiswa Poltekkes Kemenkes Aceh Tahun 2022. *Jurnal Rekam Medis dan Informasi Kesehatan*, 1(2), 29-40.
- Ferreira, A. S., Lack, S., Taborda, B., Pazzinatto, M. F., de Azevedo, F. M., & Silva, D. D. O. (2022). Body fat and skeletal muscle mass, but not body mass index, are associated with pressure hyperalgesia in young adults with

- patellofemoral pain. *Brazilian Journal of Physical Therapy*, 26(4), 100430. <https://doi.org/10.1016/j.bjpt.2022.100430>
- Fotiadis, E., Kenanidis, E., Samoladas, E., Christodoulou, A., Akritopoulos, P., & Akritopoulou, K. (2008). Scheuermann's disease: focus on weight and height role. *European Spine Journal*, 17, 673-678.
- Habut, M. Y., Nurmawan, I. P. S., & Wiryanthini, I. A. D. (2016). Hubungan indeks massa tubuh dan aktivitas fisik terhadap keseimbangan dinamis pada mahasiswa fakultas kedokteran Universitas Udayana. *Majalah Ilmiah Fisioterapi Indonesia*, 2(1).
- Hannink, E., Newman, M., & Barker, K. L. (2022). Does thoracic kyphosis severity predict response to physiotherapy rehabilitation in patients with osteoporotic vertebral fracture? a secondary analysis of the prove RCT. *Physiotherapy*, 115, 85-92. <https://doi.org/10.1016/j.physio.2022.02.003>
- Jacinto, M., Matos, R., Alves, I., Lemos, C., Monteiro, D., Morouço, P., & Antunes, R. (2022). Physical Activity, Exercise, and Sports in Individuals with Skeletal Dysplasia: What Is Known about Their Benefits?. *Sustainability*, 14(8), 4487.
- Johnson, J. (2016). Postural Correction: An illustrated guide to 30 pathologies. *United States of America: Human Kinetics*.
- Kanca, I. N., Swadesi, I. K. I., Yoda, I. K., & Wijaya, I. M. A. (2017). The effect of aerobic and anaerobic physical training on the absorptive cells, absorption of carbohydrate and protein in small intestine. *International Research Journal of Engineering, IT and Scientific Research*, 3(6), 77-88.
- Kementerian Kesehatan RI. Laporan Riskesdas 2018 Kementerian Kesehatan Republik Indonesia [Internet]. Vol. 53, Laporan Nasional Riskesdas 2018. 2018. p. 154-65.
- Kunstler, B. E., Cook, J. L., Freene, N., Finch, C. F., Kemp, J. L., O'Halloran, P. D., & Gaida, J. E. (2018). Physiotherapists use a small number of behaviour change techniques when promoting physical activity: a systematic review comparing experimental and observational studies. *Journal of science and medicine in sport*, 21(6), 609-615. <https://doi.org/10.1016/j.jsams.2017.10.027>
- Lailani, T. M. (2013). Hubungan antara peningkatan indeks massa tubuh dengan kejadian nyeri punggung bawah pada pasien rawat jalan di poliklinik saraf RSUD Dokter Soedarso Pontianak. *Jurnal Mahasiswa PSPD FK Universitas Tanjungpura*, 3(1).
- Lee, B. Y., Bartsch, S. M., Mui, Y., Haidari, L. A., Spiker, M. L., & Gittelsohn, J. (2017). A systems approach to obesity. *Nutrition reviews*, 75(suppl_1), 94-106.
- Lewis, C. L., & Sahrman, S. A. (2015). Effect of posture on hip angles and moments during gait. *Manual therapy*, 20(1), 176-182. <https://doi.org/10.1016/j.math.2014.08.007>
- Liu, T. T., Li, X. D., Wang, W. Z., Zhang, J. G., & Yang, D. Z. (2019). Efficacy of weight adjusted bone mineral content in osteoporosis diagnosis in Chinese female population. *Chinese Medical Journal*, 132(07), 772-781.
- Lonner, B. S., Toombs, C. S., Husain, Q. M., Sponseller, P., Shufflebarger, H., Shah, S. A., ... & Newton, P. O. (2015). Body mass index in adolescent spinal deformity: comparison of Scheuermann's kyphosis, adolescent idiopathic scoliosis, and Normal controls. *Spine deformity*, 3(4), 318-326. <https://doi.org/10.1016/j.jspd.2015.02.004>
- Lowe, T. G. (2007). Scheuermann's kyphosis. *Neurosurgery Clinics of North America*, 18(2), 305-315. <https://doi.org/10.1016/j.nec.2007.02.011>
- Miranda, A. P., Penha, P. J., Pereira, L. G., Pessoa, W. C., & João, S. M. (2022). Influence of Sex and Body Mass Index on the Thoracic Kyphosis and Lumbar Lordosis. *Journal of Manipulative and Physiological Therapeutics*, 45(7), 508-514. <https://doi.org/10.1016/j.jmpt.2022.12.001>
- Negara, K. N. D. P., Wibawa, A., & Purnawati, S. (2015). Hubungan antara indeks massa tubuh (Imt) kategori overweight dan obesitas dengan keluhan low back pain (Lbp) pada mahasiswa Fakultas Kedokteran Universitas Udayana. *Majalah Ilmiah Fisioterapi Indonesia*, 3(1).
- Neumann, D. A. (2010). Kinesiology of the hip: a focus on muscular actions. *Journal of Orthopaedic & Sports Physical Therapy*, 40(2), 82-94.
- Novianti, H. (2015). Hubungan Antara Beban Kerja Dengan Kejadian Postural Kifosis (Postur Membungkuk) Pada Pekerja Buruh Gendong Wanita Di Los Tengah Pasar Johar Semarang. *Jurnal Kesehatan Masyarakat (Undip)*, 3(1), 375-384.
- Nurhadiyono, H. M., Wahyuni, S., & Kurniawati, D. (2016). *Hubungan Antara Sikap Kerja membungkuk dengan Perubahan kurva Vertebra Pada Kuli Bangunan* (Doctoral dissertation, Universitas Muhammadiyah Surakarta).
- Petcharaporn, M., Pawelek, J., Bastrom, T., Lonner, B., & Newton, P. O. (2007). The relationship between thoracic hyperkyphosis and the Scoliosis Research Society outcomes instrument. *Spine*, 32(20), 2226-2231.

- Saminan, S. (2019). Efek Kelebihan Berat Badan Terhadap Pernafasan. *Jurnal Kedokteran Nanggroe Medika*, 2(4), 27-33.
- Sandi, N., Ardana, A. G., Parwata, M. Y., & Teresna, W. (2017). Effect of relative humidity on expenditure of body fluids and blood pressure when exercise. *International research journal of engineering, IT & scientific research*, 3(2), 114-122.
- Seftivani, S. A. (2022). *Hubungan Antara Aktivitas Fisik Dengan Resiko Terjadinya Kifosis Pada Lansia Di Komunitas Lansia Joyo Grand Kota Malang* (Doctoral dissertation, Universitas Muhammadiyah Malang).
- Seidi, F., Rajabi, R., Ebrahimi, I., Alizadeh, M. H., & Minoonejad, H. (2014). The efficiency of corrective exercise interventions on thoracic hyper-kyphosis angle. *Journal of back and musculoskeletal rehabilitation*, 27(1), 7-16.
- Sekretariat Direktorat Jendral Perguruan Tinggi. Statistik Pendidikan Tinggi; 2022. Available from: <https://pddikti.kemdikbud.go.id>.
- Setchell, J., Watson, B., Jones, L., Gard, M., & Briffa, K. (2014). Physiotherapists demonstrate weight stigma: a cross-sectional survey of Australian physiotherapists. *Journal of Physiotherapy*, 60(3), 157-162. <https://doi.org/10.1016/j.jphys.2014.06.020>
- Stevens-Lapsley, J. E., Petterson, S. C., Mizner, R. L., & Snyder-Mackler, L. (2010). Impact of body mass index on functional performance after total knee arthroplasty. *The Journal of arthroplasty*, 25(7), 1104-1109. <https://doi.org/10.1016/j.arth.2009.08.009>
- Sugiritama, I. W., Wiyawan, I. G., Arijana, I. G. K., & Ratnayanti, I. G. A. (2015). Gambaran IMT (indeks massa tubuh) kategori berat badan lebih dan obesitas pada masyarakat banjar Demulih, kecamatan Susut, kabupaten Bangli. *Universitas Udayana*.
- Turege, J. N., Kinasih, A., & Kurniasari, M. D. (2019). Hubungan Antara Aktivitas Fisik Dengan Obesitas Di Puskesmas Tegalrejo, Kota Salatiga. *Jurnal Ilmu Keperawatan Dan Kebidanan*, 10(1), 256-263.
- Tussakdiah, H. A. L. I. M. A. H. (2014). Hubungan indeks massa tubuh dengan keseimbangan anak usia 10 sampai 12 tahun. *Repository Universitas Esa Unggul*.
- YAMAN, O., & DALBAYRAK, S. (2014). Kyphosis: Diagnosis, classification and treatment methods. *Turkish Neurosurgery*, 24(1).