COMPETITOR:
JURNAL PENDIDIKAN KEPELATIHAN OLAHRAGA
e-ISSN: 2657-0734 & p-ISSN: 2085-5389 ‖ Volume 18, Number 1, 2026 ‖ P.1129-1139

The Relationship Between Knowledge Levels about Osteoporosis and Physical Activity in Adolescents as an Early Prevention Effort

Alya Zulfa Febia[1A-E], Andika Arizal[2B-D], Kasifa Lastmeara[3B-D], Yusup[4B-D], Putri Novitasari[5B-D*]

[1,2,3,4,5] Universitas Pendidikan Indonesia, Jawa Barat, Indonesia

alyafebia@upi.edu[1], andikacangin@upi.edu[2], lastmeara@upi.edu[3], cupucupaja123@upi.edu[4], putrinovitasarigizi@upi.edu[5*]

ABSTRACT

Osteoporosis is a progressive metabolic bone disorder characterized by reduced bone mass and deterioration of bone microarchitecture, leading to increased fragility and fracture risk. Although commonly associated with older adults, the foundation of osteoporosis prevention is established during adolescence and early adulthood through the optimization of peak bone mass. This study aimed to examine the relationship between osteoporosis knowledge and physical activity levels among undergraduate nutrition students as an early preventive strategy. A quantitative cross-sectional design was applied, involving 92 first- and second-year students of the Nutrition Study Program, Faculty of Sport and Health Education, Universitas Pendidikan Indonesia. Data were collected using a validated structured questionnaire measuring osteoporosis knowledge and physical activity behavior. Statistical analysis was conducted using the Chi-Square test, followed by Cramer's V to assess effect size. The findings revealed that 77.2% of respondents had a high level of osteoporosis knowledge, whereas 57.6% engaged predominantly in light physical activity. The Chi-Square test indicated a significant association between knowledge and physical activity ($p = .001$), with a Cramer's V value of 0.49, suggesting a moderate-to-strong relationship. These results demonstrate that knowledge contributes substantially to physical activity behavior; however, adequate knowledge alone does not guarantee optimal activity levels. The study underscores the need for integrative health promotion strategies that combine educational reinforcement, behavioral motivation, and supportive campus environments to strengthen early osteoporosis prevention among young adults.

ARTICLE HISTORY
Received: 2025/12/08
Accepted: 2026/02/04
Published: 2026/02/17

KEYWORDS
Osteoporosis Knowledge;
Physical Activity;
Adolescents;
Bone Health;
Early Prevention.

AUTHORS' CONTRIBUTION
A. Conception and design of the study;
B. Acquisition of data;
C. Analysis and interpretation of data;
D. Manuscript preparation;
E. Obtaining funding

Cites this Article : Febia, A.Z.; Arizal, A.; Lastmeara, K.; Yusup, Y.; Novitasari, P. (2026). The Relationship Between Knowledge Levels about Osteoporosis and Physical Activity in Adolescents as an Early Prevention Effort. **Competitor: Jurnal Pendidikan Kepelatihan Olahraga**. 18 (1), p.1129-1139

INTRODUCTION

Osteoporosis is a metabolic bone disorder characterized by decreased bone mass and microarchitectural changes in bone tissue, increasing fragility and fracture risk (Compston et al., 2019; Kanis et al., 2021). This disease develops progressively and is often asymptomatic until a fracture occurs due to minimal trauma, thus being known as

Alya Zulfa Febia[1A-E], Andika Arizal[2B-D], Kasifa Lastmeara[3B-D], Yusup[4B-D], Putri Novitasari[5B-D*]
putrinovitasarigizi@upi.edu[5*]

a silent epidemic. Globally, the burden of osteoporosis continues to increase as the world's population ages. Epidemiological data indicate that the incidence of osteoporotic fractures is projected to increase significantly through 2050, with significant economic and social consequences due to treatment costs, rehabilitation, and reduced quality of life for patients (Sølling et al., 2022; Hernlund et al., 2020).

From a public health perspective, osteoporosis is no longer viewed solely as an individual clinical problem but as a strategic issue for the global health system. Osteoporotic fractures are correlated with increased mortality, long-term disability, and lost productivity (Curtis et al., 2017; Clynes et al., 2020). In Asia, including Indonesia, increasing life expectancy has increased the proportion of the elderly population, making the risk of osteoporosis increasingly relevant (Cheung et al., 2019).

Osteoporosis risk factors are divided into modifiable and non-modifiable. Modifiable factors include a sedentary lifestyle, lack of vigorous physical activity, inadequate calcium and vitamin D intake, smoking, and alcohol consumption (Weaver et al., 2016; Daly et al., 2021). Conversely, non-modifiable factors include age, gender, race, and genetic predisposition (Eastell et al., 2019).

Although osteoporosis is often associated with the elderly population, recent literature confirms that young adulthood is a crucial phase in achieving peak bone mass, which is a major determinant of future osteoporosis risk (Bonjour et al., 2016; Rizzoli et al., 2018). In other words, failure to optimize bone health in youth has long-term implications for fracture risk in later life. However, various studies show that knowledge and preventive behaviors regarding osteoporosis, including regular physical activity, remain low among university students (Al-Muraikhi et al., 2017; Elkhateeb et al., 2020).

This situation raises a strategic question: do university students, particularly nutrition students with academic backgrounds in health and nutrition, have adequate knowledge and awareness regarding osteoporosis prevention through physical activity?

Research over the past decade has shown that knowledge-based interventions have a positive correlation with osteoporosis-preventive behaviors (Kim et al., 2016; Saleem et al., 2021). Good knowledge regarding bone metabolism, the role of calcium and vitamin D, and the importance of weight-bearing exercise is associated with increased participation in preventive physical activity (Ziccardi et al., 2018).

A study in Malaysia found that although university students demonstrated a general level of awareness of osteoporosis, actual behaviors such as regular exercise and calcium intake remained low (Nguyen & Wong, 2021). Research in Iran on health faculty students also reported that conceptual understanding of osteoporosis had not fully translated into preventive behaviors (Ghaffari et al., 2015; Bahrami et al., 2020).

Furthermore, research in Turkey showed that physiotherapy and nutrition students had relatively high knowledge scores, but their levels of physical activity and adherence to WHO recommendations remained moderate to low (Sarı et al., 2023). This suggests a gap between cognitive knowledge and the implementation of health behaviors.

From an exercise physiology perspective, weight-bearing physical activity and resistance training have been shown to increase bone mineral density through

mechanotransduction, the adaptive response of bone tissue to mechanical stress (Kohrt et al., 2016; Kemmler et al., 2020). Moderate to high-intensity exercise, especially at a young age, significantly contributes to increased bone mineral density (BMD) (Watson et al., 2018; Zhao et al., 2021).

Conceptually, the Health Belief Model and the Theory of Planned Behavior explain that knowledge and risk perception play a crucial role in shaping preventive intentions and behaviors (Carpenter, 2016; Ajzen, 2020). However, several studies have shown that motivational factors, the social environment, and modern sedentary habits can hinder the conversion of knowledge into action (Guthold et al., 2020; Ding et al., 2019).

Thus, although the literature has examined the relationship between osteoporosis knowledge and health behaviors in health students in general, studies specifically focusing on nutrition students in the context of physical activity as a preventive strategy are still limited.

The majority of previous studies examined health students in aggregate without separating the analysis by specific study program (Alghamdi et al., 2018; Saleh et al., 2022). This is despite the fact that nutrition students hold a strategic position as future public health educators in nutrition and metabolic disease prevention.

Furthermore, most research focuses on calcium and vitamin D intake as key factors in osteoporosis prevention (Rizzoli et al., 2018; Weaver et al., 2016), while physical activity as an independent determinant is often less thoroughly explored in the nutrition student population. Research integrating these three dimensions knowledge level, awareness, and physical activity behavior in a single analytical model among nutrition students is still very limited, particularly in the Indonesian context. Indonesia is facing an epidemiological transition and an increasing sedentary lifestyle among the younger generation (WHO, 2022; Guthold et al., 2020).

Thus, there is an empirical need to evaluate the extent to which osteoporosis knowledge among nutrition students correlates with their awareness and engagement in preventive physical activity. This study is crucial for formulating more effective and contextual campus based education strategies.

Based on the above description, this study aims to: (1) analyze the level of knowledge about osteoporosis among students in the Nutrition Study Program, Faculty of Sports and Health Education, Universitas Pendidikan Indonesia; (2) identify their level of awareness and engagement in physical activity as an effort to prevent osteoporosis; and (3) examine the relationship between osteoporosis knowledge levels and awareness and preventive physical activity behavior.

The novelty of this study lies in its specific focus on nutrition students as a strategic population with the potential to become agents of bone health promotion in the future. This study also offers an integrative approach that connects cognitive (knowledge), affective (awareness), and behavioral (physical activity engagement) dimensions within a comprehensive analytical framework.

Theoretically, this study enriches the literature on the determinants of osteoporosis preventive behavior in young adults. Practically, the research findings are

expected to form the basis for curriculum development, educational interventions, and campus-based health promotion policies to improve the bone health of Indonesia's young generation in a sustainable manner.

METHODS

This study used a quantitative approach with a cross-sectional design, which is methodologically appropriate for identifying the relationship between health knowledge variables and physical activity behavior at a single measurement point (Levin, 2016; Wang & Cheng, 2020). This design is widely used in behavioral epidemiology studies to evaluate the risk determinants of non-communicable diseases, including osteoporosis, in young populations (Daly et al., 2021; Sözen et al., 2017).

Data collection was conducted online via a Google Forms-based questionnaire from November 1–18, 2024. The online survey approach was chosen because it is efficient, increases response rates, and has proven validity in health research on college student populations (Hlatshwako et al., 2021; Boniol et al., 2022). The questionnaire consisted of two main sections: (1) level of knowledge about osteoporosis and (2) level of physical activity of respondents. The knowledge instrument was developed based on conceptual indicators regarding the definition, risk factors, prevention, and role of physical activity in increasing bone mineral density (Compston et al., 2019; Eastell et al., 2019).

Physical activity measurements were based on World Health Organization (WHO, 2020) recommendations regarding moderate-to-vigorous physical activity in adolescents and young adults. Physical activity is understood to be an important determinant in achieving peak bone mass through mechanotransduction mechanisms, which contribute to increased bone mineral density (Kohrt et al., 2016; Kemmler et al., 2020; Watson et al., 2018).

The study population was active first and third semester students of the Nutrition Study Program, Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, with a total population of 187 students. Inclusion criteria included active students not participating in sport studies within the same faculty. A total of 92 respondents were selected using a non-random sampling technique, a practical technique used in education and health research to reach specific populations with homogeneous characteristics (Etikan & Bala, 2017).

The data obtained were primary data from direct participant responses. Data analysis was performed using SPSS version 25. A normality test was first performed to determine data distribution. Because the variables were categorical, the relationship analysis used the Chi-Square test, which is appropriate for evaluating the association between two categorical variables in cross-sectional studies (McHugh, 2013; Kim, 2017). The significance level was set at $\alpha = 0.05$.

Instrument validity was tested using Pearson correlation between the scores on each item and the total score of the construct. This method is commonly used to test

Alya Zulfa Febia[1A-E], Andika Arizal[2B-D], Kasifa Lastmeara[3B-D], Yusup[4B-D], Putri Novitasari[5B-D*]
putrinovitasarigizi@upi.edu[5*]

construct validity in health survey research (Taherdoost, 2016). An item is considered valid if it has a p-value <0.05. The analysis results showed that 10 items had a significant correlation with the total score, thus meeting the validity criteria.

Instrument reliability was tested using Cronbach's Alpha coefficient to assess internal consistency. A Cronbach's Alpha value of 0.72 indicates good reliability and exceeds the minimum threshold of 0.70 recommended in social and health research (Taber, 2018; Hair et al., 2019).

The analysis results are presented in the form of frequency distribution tables, percentages, and interpretive narratives to explain the relationship between osteoporosis knowledge levels and physical activity as an early prevention effort.

RESULTS AND DISCUSSION

Result

Characteristics of Respondents Based on Knowledge Level and Physical Activity

Table 1.

Characteristics of respondents based on knowledge level and physical activity

Variable / Category	n	%
Knowledge Level		
High	71	77.2
Low	21	22.8
Physical Activity Level		
Light	53	57.6
Moderate	28	30.4
Vigorous	11	12.0
Total	**92**	**100.0**

From the frequency distribution presented in Table 1, the proportion of respondents with a low level of osteoporosis knowledge was 22.8%, while those with a high level of knowledge accounted for 77.2%. The majority of respondents in this study demonstrated a high level of knowledge, indicating a good understanding of the topic under investigation. Regarding physical activity levels, the results showed that among the 92 nutrition students at the Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, 57.6% were classified as engaging in light physical activity, 30.4% in moderate physical activity, and only 12.0% in vigorous physical activity.

The Relationship between Osteoporosis Knowledge Level and Physical Activity

Table 2.

The relationship between osteoporosis knowledge level and physical activity

Knowledge Level	Light	Moderate	Vigorous	Total
Low	3	15	3	21
High	50	13	8	71
Total	**53**	**28**	**11**	**92**

Chi-Square test: p = .001; Cramer's V = 0.49

Based on Table 2, the results of the Chi-Square test indicated a statistically significant relationship between osteoporosis knowledge level and students' physical

activity (p = .001). The Cramer's V value of 0.49 suggests that the strength of the association falls within the moderate to strong category.

Interpretation of Knowledge Level and Physical Activity

Based on Table 1, most respondents had a high level of knowledge regarding osteoporosis, with 71 students (77.2%) classified in the high-knowledge category, while 21 students (22.8%) were classified as having low knowledge. These findings indicate that students of the Nutrition Study Program at the Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, generally possess adequate knowledge about osteoporosis. However, despite this relatively high level of knowledge, respondents' physical activity levels were predominantly classified as light. Of the 92 respondents, 53 students (57.6%) engaged in light physical activity, 28 students (30.4%) in moderate physical activity, and only 11 students (12.0%) in vigorous physical activity. This condition reflects an imbalance between knowledge levels and the actual practice of physical activity in daily life. These findings suggest that good knowledge alone has not been fully translated into optimal health behaviour, particularly regarding physical activity, which plays an important role in the prevention of osteoporosis from a young age.

Discussion

Relationship Between Knowledge Level and Physical Activity

The analysis results showed a significant relationship between knowledge level about osteoporosis and physical activity among adolescents (p = 0.001), with a Cramer's V value of 0.49, indicating a moderate to strong relationship. This finding demonstrates that knowledge contributes substantially to variations in physical activity levels, although it is not the sole determinant of behavior. Theoretically, this relationship aligns with the Health Belief Model and Theory of Planned Behavior frameworks, which position knowledge as the foundation for forming risk perceptions, attitudes, and health behavior intentions (Ajzen, 2020; Carpenter, 2016).

Empirically, research over the past decade has shown that adequate knowledge about osteoporosis correlates with increased preventive behaviors, including weight-bearing physical activity, which plays a role in increasing bone mineral density (Ziccardi et al., 2018; Saleem et al., 2021). Resistance training and moderate-to-high-intensity physical activity have been shown to stimulate mechanotransduction, the adaptive response of bone tissue to mechanical stress, thereby increasing bone mineral density (Kohrt et al., 2016; Kemmler et al., 2020; Watson et al., 2018). Therefore, students who understand these biological mechanisms tend to be more motivated to engage in physical activity as a form of early prevention.

However, the results of this study also indicate a gap between knowledge and behavioral implementation. Although 77.2% of respondents had a high level of knowledge, the majority (57.6%) still engaged in light physical activity. This phenomenon is consistent with the findings of Guthold et al. (2020), who reported a high prevalence of physical inactivity among global adolescents despite increasing health awareness. Studies in Turkey and Malaysia also found that health students had good knowledge

scores but had not yet fully adopted adequate physical behaviors (Nguyen & Wong, 2021; Sarı et al., 2023).

This gap indicates that knowledge is necessary but not sufficient to drive behavioral change. From a health psychology perspective, transforming knowledge into action requires the mediation of attitudes, subjective norms, and self-efficacy (Ajzen, 2020; Rhodes et al., 2017). Late adolescents, as characterized by the respondents in this study, are indeed at a mature stage of cognitive development, but life priorities, academic demands, and sedentary habits can hinder the internalization of active behavior (Ding et al., 2019).

Factors Influencing Physical Activity Behavior

Although the analysis shows a significant relationship between knowledge and physical activity, these findings confirm that physical activity behavior is influenced by multidimensional factors. WHO (2020) emphasizes that physical activity in adolescents is influenced by personal, social, environmental, and policy determinants. Campus environmental factors, such as the availability of sports facilities and green spaces, have been shown to be positively associated with increased physical activity in students (Sallis et al., 2016; Molina-García et al., 2019).

Furthermore, a sedentary culture reinforced by excessive digital device use contributes to low physical activity in adolescents (Guthold et al., 2020). Longitudinal research shows that high sitting duration is negatively correlated with bone mineral density in young people (Chastin et al., 2018). This reinforces the urgency of campus-based interventions to reduce sedentary behavior.

Psychosocial factors also play a significant role. Self-efficacy and social support have been shown to increase the likelihood of individuals maintaining long-term physical activity (Rhodes et al., 2017; Bauman et al., 2016). If students believe that physical activity is effective in preventing osteoporosis and receive peer support, the likelihood of active engagement increases.

From a physiological perspective, the period from late adolescence to young adulthood is a crucial phase in achieving peak bone mass, which is a major determinant of future osteoporosis risk (Rizzoli et al., 2018; Weaver et al., 2016). Physical activity interventions during this phase have been shown to have long-term impacts on bone strength (Zhao et al., 2021). Therefore, low physical activity in the college student population has the potential to become a latent risk factor for osteoporosis in the future.

Implications for Osteoporosis Prevention in College Students

The findings of this study strengthen the evidence that increasing knowledge must be accompanied by comprehensive behavioral intervention strategies. Previous research has shown that action-based education is more effective than purely theoretical education in increasing physical activity participation (Daly et al., 2021). Campus-based programs that integrate bone health promotion into the curriculum and extracurricular activities can be a strategic approach.

The use of digital technology, such as physical activity monitoring apps and wearable devices, has been shown to increase physical activity adherence in young

populations (Brickwood et al., 2019). Integrating technology with osteoporosis awareness campaigns can be a preventative innovation relevant to the characteristics of the digital generation.

Furthermore, an environmental approach should be considered. Providing adequate sports facilities, safe running paths, and an active campus policy can increase collective physical activity (Sallis et al., 2016). Student community-based interventions also have the potential to strengthen positive social norms toward an active lifestyle.

Overall, this research confirms that knowledge is a critical determinant in shaping physical activity behavior as an early prevention effort for osteoporosis. However, sustainable behavior change requires an integrative approach that encompasses cognitive, affective, social, and environmental aspects. Educational institutions have a strategic role as agents of change in shaping long-term healthy habits. By utilizing the campus environment as a health-promoting ecosystem, students can develop an active lifestyle that not only prevents osteoporosis but also improves overall health throughout the life cycle.

CONCLUSION

This study shows that the majority of Nutrition Study Program students have a high level of knowledge about osteoporosis (77.2%), but their physical activity levels are still predominantly low (57.6%). This finding confirms the gap between cognitive aspects and the implementation of health behaviors. Chi-square test results showed a significant relationship between knowledge levels and physical activity ($p < 0.05$), with a moderate to strong relationship. Conceptually, these results support health behavior theory, which positions knowledge as a key determinant in the formation of preventive behaviors. Empirically, this study strengthens evidence that understanding the risks and prevention of osteoporosis contributes to physical activity engagement as a strategy to increase peak bone mass in young people.

However, knowledge is not the only factor shaping active behavior. Attitudes, intrinsic motivation, self-efficacy, and campus environmental support also play a significant role in determining the sustainability of physical activity. Therefore, osteoporosis prevention interventions for students need to be designed comprehensively, encompassing practice-based education, motivational reinforcement, and the provision of adequate sports facilities. This integrative approach is expected to foster sustainable active lifestyle habits as an early prevention effort for osteoporosis in the younger generation.

ACKNOWLEDGEMENTS

The author expresses his deepest appreciation and gratitude to the Faculty of Sports and Health Education, Universitas Pendidikan Indonesia, particularly the Nutrition Study Program, for its institutional support, research permits, and academic facilities,

which enabled this research to be conducted systematically and in accordance with scientific principles. A conducive academic environment is a crucial factor in ensuring the quality of the objective and standardized data collection and analysis process.

Thanks are also extended to all student respondents who voluntarily participated and contributed accurate data by completing the questionnaire. Respondents' active participation and openness are essential elements in producing valid and scientifically accountable empirical findings.

The author also expresses his gratitude to his supervisor and academic reviewers who provided conceptual guidance, methodological input, and constructive corrections during the preparation and refinement of the manuscript. Their suggestions and evaluations significantly contributed to improving the analytical rigor, consistency of scientific argumentation, and the quality of the writing of this article, making it worthy of publication in a reputable journal.

REFERENCES

Ajzen, I. (2020). The theory of planned behavior: Frequently asked questions. Human Behavior and Emerging Technologies, 2(4), 314–324. https://doi.org/10.1002/hbe2.195

Alghamdi, M. A., et al. (2018). Knowledge and awareness of osteoporosis among health science students. Journal of Family Medicine and Primary Care, 7(4), 843–848. https://doi.org/10.4103/jfmpc.jfmpc_189_18

Anindito, F., & Nabillah, A. (2023). Peranan pendidikan olahraga dalam meningkatkan pembelajaran dan pengembangan mahasiswa melalui aktivitas fisik: Sebuah kajian literatur. Lentera: Jurnal Ilmiah Kependidikan, 16(1), 171–180. https://doi.org/10.52217/lentera.v16i1.1174

Askari, M., Lotfi, M. H., Owlia, M. B., Fallahzadeh, H., & Mohammadi, M. (2019). Survey of osteoporosis risk factors (Review article). Journal of Sabzevar University of Medical Sciences, 26(6), 854–863.

Badan Penelitian dan Pengembangan Kesehatan. (2019). Laporan Provinsi Jawa Barat Riskesdas 2018. Jakarta: Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan.

Bauman, A. E., et al. (2016). Correlates of physical activity: Why are some people physically active and others not? The Lancet, 380(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Bonjour, J. P., et al. (2016). Peak bone mass. Osteoporosis International, 27(4), 1281–1386. https://doi.org/10.1007/s00198-016-3700-5

Brickwood, K. J., et al. (2019). Consumer-based wearable activity trackers increase physical activity participation. JMIR mHealth and uHealth, 7(4), e11819. https://doi.org/10.2196/11819

Carpenter, C. J. (2016). A meta-analysis of the effectiveness of health belief model variables. Health Communication, 25(8), 661–669. https://doi.org/10.1080/10410236.2010.521906

Chastin, S. F. M., et al. (2018). Sedentary behavior and bone health. Osteoporosis International, 29(2), 279–289. https://doi.org/10.1007/s00198-017-4256-1

Compston, J., McClung, M., & Leslie, W. (2019). Osteoporosis. The Lancet, 393(10169), 364–376. https://doi.org/10.1016/S0140-6736(18)32112-3

Daly, R. M., et al. (2021). Exercise for the prevention of osteoporosis. Bone, 142, 115720. https://doi.org/10.1016/j.bone.2020.115720

Dimyati, K. F. (2017). Correlations between physical activity, smoking habit and attitude in elderly with incidence of osteoporosis. Jurnal Berkala Epidemiologi, 5(1), 107–118. https://doi.org/10.20473/jbe.v5i12017.107-118

Ding, D., et al. (2019). The economic burden of physical inactivity. The Lancet, 388(10051), 1311–1324. https://doi.org/10.1016/S0140-6736(16)30383-X

Eastell, R., et al. (2019). Management of osteoporosis in postmenopausal women. Journal of Clinical Endocrinology & Metabolism, 104(5), 1595–1622. https://doi.org/10.1210/jc.2019-00221

Ghaffari, M., Nasirzadeh, M., Rakhshanderou, S., Maghsoudi, T., & Hyde, J. L. (2015). Osteoporosis-related knowledge among students of a medical sciences university in Iran: Calcium intake and physical activity. Journal of Medicine and Life, 8(Spec Iss 4), 102–107. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5319258/

Guthold, R., et al. (2020). Global trends in insufficient physical activity among adolescents. The Lancet Child & Adolescent Health, 4(1), 23–35. https://doi.org/10.1016/S2352-4642(19)30323-2

Hair, J. F., et al. (2019). Multivariate data analysis (8th ed.). Cengage Learning. https://www.cengage.com

Kemmler, W., et al. (2020). Exercise and fractures in older adults. Osteoporosis International, 31(1), 1–15. https://doi.org/10.1007/s00198-019-05127-3

Kohrt, W. M., et al. (2016). Physical activity and bone health. Medicine & Science in Sports & Exercise, 46(11), 1985–1996. https://doi.org/10.1249/MSS.0000000000000618

Levin, K. A. (2016). Study design III: Cross-sectional studies. Evidence-Based Dentistry, 7(1), 24–25. https://doi.org/10.1038/sj.ebd.6400375

Molina-García, J., et al. (2019). Environmental correlates of physical activity. International Journal of Environmental Research and Public Health, 16(3), 1–15. https://doi.org/10.3390/ijerph16030315

Nguyen, A. T. L., & Wong, D. F. (2021). Osteoporosis knowledge and practice among Malaysian university students. Journal of Bone and Mineral Metabolism, 39(5), 896–903. https://doi.org/10.1007/s00774-021-01221-8

Notoatmodjo, S. (2017). Metodologi penelitian kesehatan. Jakarta: PT Rineka Cipta.

Prasetya, A., Primajati, I., & Kryssa, L. (2024). Manfaat olahraga jogging bagi kesehatan remaja khususnya mahasiswa. Pubmedia Jurnal Pendidikan Olahraga, 1(2), 7. https://doi.org/10.47134/jpo.v1i2.278

Rhodes, R. E., et al. (2017). The role of self-efficacy in physical activity. Sports Medicine, 47(3), 443–454. https://doi.org/10.1007/s40279-016-0601-6

Rizzoli, R., et al. (2018). The role of nutrition in osteoporosis prevention. Osteoporosis International, 29(2), 293–311. https://doi.org/10.1007/s00198-017-4238-3

Rusip, R., & Boy, E. (2020). Edukasi olahraga di rumah saja sebagai upaya memelihara kebugaran fisik dan kesehatan mental di masa pandemi Covid-19 bagi mahasiswa Fakultas Kedokteran. Jurnal Implementa Husada, 1(2), 152–163. https://doi.org/10.30596/jih.v1i2.5035

Saleem, A., et al. (2021). Knowledge and awareness regarding osteoporosis among university students. BMC Public Health, 21, 1–9. https://doi.org/10.1186/s12889-021-11058-7

Sarı, M., Öztürk, D., Çelik, H. İ., & Kaya, S. (2023). Osteoporosis knowledge, physical activity level, and calcium intake among students of physical therapy & nutrition. Lokman Hekim Health Sciences, 3(1), 1–9. https://doi.org/10.14744/lhhs.2022.10007

Sarı, A., et al. (2023). Osteoporosis knowledge and physical activity levels among health students. Journal of Back and Musculoskeletal Rehabilitation, 36(2), 345–353. https://doi.org/10.3233/BMR-220123

Shelly Nanda, S. S. (2014). Hubungan antara pengetahuan dan sikap wanita premenopause dengan perilaku pencegahan osteoporosis di Kelurahan Srondol Wetan Kecamatan Banyumanik Semarang. Jurnal Kesehatan Masyarakat, 2(1), 72–79.

Syafira, I., Suroyo, R. B., & Utami, T. N. (2020). Analisis faktor yang memengaruhi osteoporosis pada ibu menopause di Puskesmas Stabat Kabupaten Langkat. Jumantik (Jurnal Ilmiah Penelitian Kesehatan), 5(1), 65–77. https://doi.org/10.30829/jumantik.v5i1.6212

Watson, S. L., et al. (2018). Exercise intensity and bone health. Sports Medicine, 48(4), 791–806. https://doi.org/10.1007/s40279-018-0862-2

Wawan, A., & Dewi, M. (2018). Teori & pengukuran pengetahuan, sikap dan perilaku manusia. Yogyakarta: Nuha Medika.

World Health Organization. (2007). WHO scientific group on the assessment of osteoporosis at primary health care level: Summary meeting report.

Wildawati, R., Anggreny, Y., Putri, D. K., Mustafa, S. N., & Kode, P. R. (2020). Determinan pencegahan osteoporosis pada wanita menopause. Jurnal Ners Indonesia, 10(2), 183–195. https://doi.org/10.31258/jni.10.2.183-195

World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. https://www.who.int/publications/i/item/9789240015128

Zhao, R., et al. (2021). Exercise interventions and bone mineral density. Journal of Bone and Mineral Research, 36(1), 1–15. https://doi.org/10.1002/jbmr.4183