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Analysis of Commuting Time and Health Impact in Jakarta Metropolitan Area: A Comparative Review

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ABSTRACT

Commuting in the Jakarta Metropolitan Area (Jabodetabek) presents significant challenges, including long travel times, congestion, and environmental concerns, which affect commuters' health and well-being. This study provides a comparative review of commuting patterns, transportation modes, and their associated health impacts. By analyzing secondary data, the research identifies key issues such as the prevalence of private vehicle use, overcrowded public transport, and limited infrastructure for sustainable travel. The findings reveal that prolonged commutes are linked to physical inactivity, musculoskeletal problems, respiratory conditions, and mental stress, exacerbated by inadequate transportation systems and environmental factors. Comparisons with other global cities underscore the importance of integrated transit networks, sustainable transport policies, and urban planning to mitigate these impacts. This review aims to inform policy decisions to enhance the quality of life for Jakarta's commuters and foster a more sustainable urban future.

Keywords: Commuting-time, Jakarta Metropolitan Area, Health impacts, Public transportation, Private transportation

INTRODUCTION

The Jakarta Metropolitan Area, often referred to as Jabodetabek (Jakarta, Bogor, Depok, Tangerang, and Bekasi), is the largest urban agglomeration in Indonesia and one of the most populous metropolitan regions in the world. It serves as a central hub for economic activity, attracting a continuous influx of people from across the country. Many of these newcomers initially reside in boarding houses, known locally as *kosts*, while those with more stable employment often settle in suburban areas due to the unreachable cost of housing in the city center. This dynamic has created a commuting culture where millions travel daily from the suburbs to Jakarta's core for work [1], [2].

The transportation landscape in Jakarta is diverse, with commuters relying on a mix of modes, including private cars, buses, commuter trains, motorcycles, and even informal

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transport like *ojek* (motorcycle taxis). Private cars and motorcycles remain the dominant modes for those seeking convenience and flexibility; however, they contribute significantly to the city's notorious traffic congestion and air pollution. Public transportation options such as TransJakarta BRT (Bus Rapid Transit) and the Kereta Rel Listrik (KRL) Commuter Line are essential for moving large numbers of passengers efficiently, yet these systems face challenges like overcrowding during peak hours and limited coverage in suburban areas [3], [4].

Informal transportation modes like *ojek* and app-based ride-hailing services have become increasingly popular due to their ability to navigate Jakarta's dense traffic and offer door-to-door service. However, these modes are generally more expensive for daily use and contribute to road congestion during peak times. Despite their drawbacks, many commuters prefer these options for shorter distances or as first-mile and last-mile solutions, bridging gaps in Jakarta's public transport network [5].

The variability in the reliability, safety, and comfort of these modes also influences commuters' choices. Public transportation systems like buses and trains often suffer from cleanliness issues, inadequate seating, and inconsistent schedules, deterring some commuters from using them. On the other hand, private vehicles offer comfort and security but are costly, environmentally detrimental, and time wasting. Efforts to improve public transportation infrastructure, expand coverage, and promote sustainable options are vital to reducing reliance on private and informal modes [6].

A particularly pressing concern is the potential impact of long commuting times on public health. Extended exposure to physical and mental stressors during commutes, ranging from crowded and poorly ventilated conditions to prolonged sedentary periods, raises significant questions about the health outcomes for the population. For example, when people need to maintain sitting posture during traffic in a car or standing posture in public transport. Additionally, prolonged commuting exposes individuals to air and noise pollution, which has been associated with respiratory problems and chronic stress [7]. In Jakarta, where pollution levels often exceed global safety standards and high traffic jams, the health risks are amplified. By focusing on the time spent commuting, this research aims to examine whether longer commutes could impact positive or negatively on health, with the goal of contributing to a deeper understanding of urban sustainability and well-being in one of Southeast Asia's most dynamic cities.

METHODS

This study uses a comparative review approach to examine the impact of commuting time on health in the Jakarta Metropolitan Area. Secondary data from government reports, academic studies, and transportation statistics were analyzed. The analysis focuses on three main

aspects: demographic factors (such as age, occupation, and residential location), commuting conditions (like average travel time, transport modes, and environmental factors), and health impacts (including physical issues like respiratory and cardiovascular health and mental health indicators like stress and fatigue).

The study compares commuting and health dynamics across Jakarta's metropolitan regions, including the central business district, inner suburbs (e.g., Depok, Tangerang), and outer suburbs (e.g., Bekasi, Bogor). Additionally, it incorporates comparisons with other densely populated metropolitan areas within Indonesia and internationally. While limitations such as reliance on secondary data are acknowledged, this approach offers valuable insights into the relationship between commuting and health in Jakarta and similar conditions.

RESULTS AND DISCUSSION

Demography of Jakarta Metropolitan Area

Jakarta had approximately 10.5 million inhabitants within its city limits according to the 2020 census, and it is projected to reach a population of 11.8 million by 2035. Jakarta proper has a population density of 15,907 people per square kilometer, making it comparable to cities like Seoul[8]. The metropolitan area of Jakarta, also called The Greater Jakarta, includes three neighboring regencies—Bekasi, Tangerang, and Bogor—and five surrounding cities: Bogor, Depok, Bekasi, Tangerang, and South Tangerang. The area had a combined population of 32.6 million [9], [10], [11].

In Greater Jakarta, 14.9% of the population commutes across municipal boundaries, with 90% of these commuters being workers. Greater Jakarta (Jabodetabek) hosts a workforce of approximately 15.2 million people, representing 65.21% of its working-age population [12]. Among the workforce in Greater Jakarta, 31.6% reside between 10 and 19 kilometers from their places of employment, and 46.3% spend between 10 and 12 hours outside their homes each day. The predominant mode of transportation for these commuters is private vehicles, utilized by 79% of the commuting population, while 19.5% rely on public transport and 1.4% engage in active commuting. Notably, South Jakarta is the most popular destination, attracting about 880,000 commuters daily from various parts of Greater Jakarta. In comparison, Bogor is a key source of commuters, with around 580 thousand individuals leaving the city each day. This movement from Bogor significantly influences the commuting patterns in the Greater Jakarta area [13].

Commuting Condition in Jakarta Metropolitan Area

- ***Peak and Off-Peak Commuting Hours***

Commuting patterns in Jakarta are defined by pronounced rush hours that reflect the city's high population density and economic activity. Morning peak times typically begin around 6:00 AM and begin to ease by 9:00 AM, while evening rush hours start at approximately 4:00 PM and subside around 7:00 PM. These timings coincide with standard office hours, significantly impacting traffic congestion. Commuters with flexibility in their schedules often find that traveling outside these peak periods reduces travel time and stress. The Jakarta Transportation Agency has highlighted these peak-hour trends, emphasizing the necessity for staggered work hours to mitigate congestion [2].

- ***Transportation Modes, Facilities, and Passenger Volumes***

Jakarta offers a wide range of transportation modes, each catering to diverse commuter needs for each transport issue with different reaches, advantages, and disadvantages. Private vehicles, such as motorcycles and cars, dominate the transportation landscape, with most commuters using motorcycles and smaller portion relying on cars. Private vehicles offer flexibility for travel, seating, and parking, yet they exacerbate congestion, pollution, also crowds the traffic for emergencies and goods transport [1]. Public transportation systems such as TransJakarta BRT, KRL Commuterline, Mass Rapid Transport (MRT), and Long Rapid Transport (LRT) provide alternative options. The TransJakarta BRT, which serves over 1 million passengers daily, benefits from dedicated lanes, but overcrowding and delays during peak hours persist. Similarly, KRL Commuterline efficiently handles long-distance commutes with a faster and on-time schedule, though the overcrowding creates more problems. On the contrary, the MRT and LRT systems in Jakarta provide modernized transport with better air-conditioned facilities and rapid transit capabilities. However, the limited coverage remains a drawback and with the packed city traffic, construction of new rail and facilities faces many challenges [4].

The Jakarta Government attempts to integrate these public transportations to create better reaches and accessibility for commuters. The approach mainly includes infrastructure improvements to connect various transportation modes like MRT, LRT, KRL Commuterline, TransJakarta, and Soekarno-Hatta Airport trains. The Transit-Oriented Development (TOD) approach focuses on creating connecting facilities, such as the Dukuh Atas Interchange Station, which acts as an interconnected hub for multiple transport modes. This integration minimizes the need for users to leave stations to transfer between services, making public transportation more efficient and attractive. Features like designated pedestrian pathways, elevators, and escalators at interchange points further improve accessibility and reduce commuting time.[14] Another is the JakLingko program that was created to enhance the accessibility and affordability of public transit for commuters. This integration includes uniform ticketing systems using e-wallet and app-based QR-code to improve

interconnectivity between modes such as TransJakarta, MRT, LRT, and KRL. This includes the feeder systems to connect stations for commuters [15].

- ***Condition of Facilities and Environmental Factors***

The satisfaction rate regarding the transportation infrastructure in the Jakarta metropolitan area (Jabodetabek) appears to be low, as indicated by the 2023 Commuter Survey. A significant reliance on private vehicles is evident, with 79% of commuters using motorcycles and cars, while only 19.5% utilize public transportation. Accessibility issues are highlighted, with 54.7% of households living over one kilometer from the nearest mass transit stop. Health complaints among commuters, such as fatigue and respiratory issues, further suggest dissatisfaction with the commuting experience. Additionally, 67.3% of commuters have faced severe traffic congestion, and many express concerns about the safety and comfort of public transport, leading to reluctance in switching from private to public transportation. Overall, these factors contribute to a negative perception of the transportation infrastructure in the region.[13]

In another study, user satisfaction with Transjakarta services is generally high, with 90% of respondents expressing overall contentment. Key factors include the quality of service from officers (92%) and bus drivers (94%). However, timeliness is a concern, with only 61% satisfied with bus arrival times. Facilities on buses and at stops received a 68% satisfaction rating, while 85% rated route information positively. Additionally, 78% found corridor integration satisfactory, and 91% appreciated the non-cash payment system. Users desire extended operational hours, indicating areas for improvement in facilities and timeliness.[16]

Satisfaction among MRT users in Jakarta is also high, driven by the quality of service from staff, comfort, and safety. Accessibility features, such as elevators and tactile paths, enhance user experience. The integration of MRT with other modes of transport, like Transjakarta buses, adds convenience. Modern infrastructure and amenities, including book corners and food courts, further contribute to overall satisfaction.[17]

Passenger satisfaction with the Jak Lingko urban transportation system (micro transit) is generally positive, driven by cleanliness, ease of access, and an efficient payment system. However, areas for improvement include terminal cleanliness, employee tidiness, and the accuracy of information provided. Passengers have raised concerns about obtaining schedule information and officer responsiveness during emergencies, indicating that while service quality has improved, further enhancements are needed.[18]

On the other hand, user complaints regarding the Jabodetabek Commuter Line Train in Indonesia primarily focus on several critical issues such as malfunctioning air conditioning, inadequate lighting, and failures of the station notification system. Overcrowding due to

insufficient KRL units leads to longer waiting times, highlighting a gap between user expectations and actual service. A study by Aswanti Setyawati and Husni Hasan indicates that service quality and facilities account for 78.30% of user satisfaction, emphasizing the need for improvements to enhance commuter experiences.[19]

Long Commute and Health Impact

The prolonged exposure to suboptimal transportation facilities and environmental condition in Jakarta has significant health implications for commuters. Extended hours spent in congested traffic, overcrowded public transportation, and polluted tropical environments amplify physical and mental stress. For instance, commuters using overcrowded TransJakarta buses or KRL Commuterline trains often face long periods of standing due to limited seating, leading to musculoskeletal issues such as lower back pain and joint discomfort. Additionally, poor air quality during peak hours exacerbates respiratory conditions like asthma and bronchitis, particularly for those commuting on motorcycles or in poorly ventilated public transport systems.[20]

The health impacts of commuting are significant and multifaceted, as evidenced by various studies examining the relationship between commuting time, mode of transportation, and health outcomes. Overall, lengthy commutes are associated with increased risks of physical inactivity, sleep problems, obesity, and musculoskeletal issues, highlighting the need for policymakers to consider these factors in urban planning and transportation systems.

One of the primary findings across the studies is that long commuting times negatively affect physical activity levels and sleep quality. For instance, individuals commuting more than five hours a week are at higher odds of experiencing physical inactivity and sleep problems.[21] This suggests that lengthy commutes can have detrimental effects on overall health by limiting opportunities for physical activity and disrupting sleep patterns. As a result, individuals may find themselves engaging less in exercise and experiencing poorer sleep quality, which can compound health issues over time.

In urban areas with well-developed public transport systems, such as Hong Kong, commuting times that exceed 90 minutes are linked to a higher risk of obesity.[22] This correlation underscores the potential for long commutes to contribute to weight gain and related health problems. Another study also found that the extended time spent commuting takes away substantial time from essential activities such as sleep and food preparation.[23] This reduction in time dedicated to health-promoting behaviors can lead to negative health outcomes, including obesity and other chronic conditions. This is evident in the negative relation between commuting time and cardiorespiratory fitness, and the positive association with body mass index (BMI) and waist circumference.[24] This relationship indicates that longer commutes may contribute to poorer metabolic health outcomes.

Moreover, long commuting times are associated with musculoskeletal problems, such as low back pain (LBP) and shoulder and neck pain. Among workers, long commuting times are correlated with higher odds of experiencing work-related LBP [25]. Another source also shows that workers who commute more than 50 minutes are identified as high risk for musculoskeletal pain and burnout.[26] In particular, neck and shoulder pain are mediating factors that increase the likelihood of burnout among these individuals.

However, these effects are not the same across all commuting modes. People who commute by vehicle experience higher rates of musculoskeletal problems, such as low back pain and postural abnormalities, compared to those who walk, with vehicle commuters exhibiting a greater prevalence of issues like anteflexion limits and crouching failures.[27] Changes in commuting modes also significantly impact both physical and mental health. Switching from car travel to active modes of transportation leads to improved physical health and enhanced mental health. Conversely, transitioning from active travel to car use results in a notable decline in physical health and health satisfaction, while switching from active travel to public transport negatively affects mental health.[28]

City Based Comparison

Jakarta's commuting challenges share similarities with some urban centers internationally, offering valuable lessons in reducing travel times. Like Bangkok and Manila, Jakarta struggles with severe traffic congestion and disorganized public transit systems. Bangkok's expansion of its BTS Skytrain and MRT networks, paired with integrated ferries and buses, has significantly reduced travel delays [29]. Manila, on the other hand, is modernizing its iconic jeepneys and constructing a subway to streamline transit which Jakarta is trying to emulate by expanding its MRT and BRT coverage and improving intermodal integration.

Similar to Mexico City and Lagos, Jakarta faces inefficiencies from overcrowded public transit and reliance on informal modes like angkots (public minibus in Jakarta). Mexico City's dual approach of expanding metro lines and implementing a BRT system with dedicated lanes has successfully cut travel times, while Lagos's BRT prioritization reduced gridlock caused by minibusses [30], [31]. Jakarta could replicate these strategies, emphasizing better suburban connections and transit prioritization.

European cities like London, Paris, and Berlin demonstrate how robust infrastructure and urban planning can transform mobility. London's integrated ticketing system, the Oyster Card, and congestion pricing have reduced road traffic, freeing up capacity for buses and taxis. Paris addresses overcrowding with high-frequency Métro services and suburban rail networks (RER), while Berlin's integration of U-Bahn, S-Bahn, and buses ensures seamless connections between the city center and suburbs. For Jakarta, adopting a unified ticketing system and expanding rail services could drastically improve commuter efficiency [32].

Sustainability and accessibility lessons from Amsterdam, Stockholm, and Copenhagen are also instructive. Amsterdam's cycling culture, supported by bike lanes and bike-sharing programs, provides affordable last-mile connectivity, while Stockholm combines congestion pricing with investments in green transit, like electric buses. Copenhagen's automated metro system delivers high-frequency, reliable services [32]. Jakarta could benefit from these approaches by building dedicated bike lanes, introducing electric BRT fleets, and exploring automated systems for high-demand corridors.

CONCLUSION

This study highlights the significant impact of commuting time on health and well-being in the Jakarta Metropolitan Area, emphasizing the interplay between transportation infrastructure, commuter behavior, and environmental factors. Long commuting times are associated with physical, mental, and environmental health challenges, underscoring the need for integrated and sustainable transportation solutions. Lessons from international case studies suggest that improving public transit integration, expanding coverage, and promoting active and sustainable transport modes can alleviate these issues. Addressing these challenges through better urban planning and transportation policies will be crucial to fostering healthier, more sustainable, and accessible urban living in Jakarta.

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CONFLICT OF INTEREST

Authors declared no conflict of interest

REFERENCES

[1] A. Aritenang, "Examining Socio-Economic Inequality Among Commuters: The Case of the Jakarta Metropolitan Area," *UP*, vol. 7, no. 3, pp. 172–184, Jul. 2022, doi: 10.17645/up.v7i3.5271.

[2] Y. Sofiyandi and A. A. Siregar, "Exploring the Changes of Commuting Patterns, Commuting Flows, and Travel-to-work Behaviour in the Jakarta Metropolitan Area from 2014 to 2019: A Comparative Analysis of Two Cross-sectional Commuting Surveys," in *Lembaga Penyelidikan Ekonomi dan Masyarakat - Fakultas Ekonomi dan Bisnis - Universitas Indonesia*, Aug. 2020.

[3] A. Gaduh, T. Gračner, and A. D. Rothenberg, "Life in the slow lane: Unintended consequences of public transit in Jakarta," *Journal of Urban Economics*, vol. 128, p. 103411, Mar. 2022, doi: 10.1016/j.jue.2021.103411.

[4] T. Tjahjono, A. Kusuma, and A. Septiawan, "The Greater Jakarta Area Commuters Travelling Pattern," *Transportation Research Procedia*, vol. 47, pp. 585–592, 2020, doi: 10.1016/j.trpro.2020.03.135.
[5] T. P. B. Pradonoputro and O. Kozo, "Understanding Commuter's Motivation of Transportation Choice: A Case Study of Greater Jakarta," *Jurnal Manajemen Transportasi & Logistik (JMTRANSLOG)*, 2021.
[6] D. A. Christian, A. Bachtiar, and C. Candi, "Analysis of Health-Based Transportation System for Health Transformation in DKI Jakarta," *JOSR*, vol. 2, no. 11, pp. 4103–4112, Oct. 2023, doi: 10.55324/josr.v2i11.1568.
[7] G. Syuhada *et al.*, "Impacts of Air Pollution on Health and Cost of Illness in Jakarta, Indonesia," *IJERPH*, vol. 20, no. 4, p. 2916, Feb. 2023, doi: 10.3390/ijerph20042916.
[8] Statistics Korea, "Regional population and population density [Internet]," Statistics Korea, 2023. [Online]. Available: https://www.index.go.kr/unity/potal/main/EachDtlPageDetail.do?idx_cd=1041
[9] Badan Pusat Statistik Provinsi DKI Jakarta, "Jumlah Penduduk Menurut Kabupaten/Kota di Provinsi DKI Jakarta - Tabel Statistik." Accessed: Nov. 22, 2024. [Online]. Available: https://jakarta.bps.go.id/id/statistics-table/2/MTI3MCMy/jumlah-penduduk-menurut-kabupaten-kota-di-provinsi-dki-jakarta-html
[10] Badan Pusat Statistik Provinsi Jawa Barat, "Jumlah Penduduk Menurut Kabupaten/Kota - Tabel Statistik." Accessed: Nov. 22, 2024. [Online]. Available: https://jabar.bps.go.id/id/statistics-table/2/MTMzIzI=/jumlah-penduduk-menurut-kabupaten-kota.html
[11] Badan Pusat Statistik Provinsi Banten, "Jumlah Penduduk Menurut Kabupaten/Kota dan Jenis Kelamin di Provinsi Banten - Tabel Statistik - Badan Pusat Statistik Provinsi Banten." Accessed: Nov. 22, 2024. [Online]. Available: https://banten.bps.go.id/id/statistics-table/2/NTIxIzI=/jumlah-penduduk-menurut-kabupaten-kota-dan-jenis-kelamin-di-provinsi-banten.html
[12] BPS-Statistics Indonesia Dki Jakarta, "Labor Force Participation Rate - Statistical Data." Accessed: Apr. 25, 2025. [Online]. Available: https://jakarta.bps.go.id/en/statistics-table/2/NzcyIzI=/labor-force-participation-rate.html
[13] R. S. Hutajulu, F. T. Ayuningrum, P. I. Firdaus, R. Solih, and F. Hermawati, *Statistik Komuter Jabodetabek Hasil Survei Komuter Jabodetabek 2023*, vol. 3. Badan Pusat Statistik, 2024.
[14] T. Agustina, S. P. Eni, R. Ismanto, and U. Ulinata, "Connecting facilities of several modes of transportation with transit-oriented development approach," *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 878, no. 1, p. 012036, Oct. 2021, doi: 10.1088/1755-1315/878/1/012036.
[15] H. L. H. Spits Warnars, Y. Lanita, A. Prasetyo, and R. Randriatoamanana, "Smart Integrated Payment System for Public Transportation in Jakarta," *Bulletin EEI*, vol. 6, no. 3, pp. 241–249, Sep. 2017, doi: 10.11591/eei.v6i3.655.
[16] A. D. Nurlukman, Y. Fadli, and Nurhakim, "Satisfaction Impact of Transjakarta Integrated Transportation System Quality Services," *J Phys: Conf Ser*, vol. 1477, 2020, doi: 10.1088/1742-6596/1477/7/072014.

[17] F. A. Mahendra, M. S. Widodo, and M. R. A. Pratama, "Reputation of the Quality Portrait Satisfaction of Jakarta's Integrated Mass Rapid Transit (MRT) Implies Community Sustainability," vol. 1, no. 2, pp. 148–159, Oct. 2024, doi: 10.55606/mri.v1i2.1059.

[18] W. B. Dermawan, E. F. Tandilino, and M. Isradi, "Passenger Satisfaction Analysis of Urban Transportation System Service Jak Lingko," *ADRI International Journal of Engineering and Natural Science*, vol. 6, no. 1, 2021, doi: 10.29138/aijens.v6i01.27.

[19] A. Setyawati and H. Hasan, "Effect of service quality and facilities on commuter line train user satisfaction: a case of Indonesia," *Journal of Economics, Management, Entrepreneur, and Business*, vol. 1, no. 2, pp. 187–200, 2021.

[20] A. F. Both, D. Westerdahl, S. Fruin, B. Haryanto, and J. D. Marshall, "Exposure to carbon monoxide, fine particle mass, and ultrafine particle number in Jakarta, Indonesia: Effect of commute mode," *Science of The Total Environment*, vol. 443, pp. 965–972, Jan. 2013, doi: 10.1016/j.scitotenv.2012.10.082.

[21] J. I. Halonen *et al.*, "Commuting time to work and behaviour-related health: a fixed-effect analysis," *Occup Environ Med*, vol. 77, no. 2, pp. 77–83, Feb. 2020, doi: 10.1136/oemed-2019-106173.

[22] F. Sha, B. Li, Y. W. Law, and P. S. F. Yip, "Associations between commuting and well-being in the context of a compact city with a well-developed public transport system," *Journal of Transport & Health*, vol. 13, pp. 103–114, Jun. 2019, doi: 10.1016/j.jth.2019.03.016.

[23] T. J. Christian, "Trade-Offs Between Commuting Time and Health-Related Activities," *J Urban Health*, vol. 89, no. 5, pp. 746–757, Oct. 2012, doi: 10.1007/s11524-012-9678-6.

[24] C. M. Hoehner, C. E. Barlow, P. Allen, and M. Schootman, "Commuting Distance, Cardiorespiratory Fitness, and Metabolic Risk," *Am J Prev Med*, vol. 42, no. 6, pp. 571–578, Jun. 2012, doi: 10.1016/j.amepre.2012.02.020.

[25] J. Jung, J. B. Park, K.-J. Lee, Y. Seo, and I. Jeong, "Association between commuting time and work-related low back pain with respect to sports and leisure activities in Korean workers," *Ind Health*, vol. 62, no. 2, pp. 133–142, 2024, doi: 10.2486/indhealth.2023-0100.

[26] Y.-H. Chen, J. J. Lin, C. Yang, H.-M. Tang, G.-P. Jong, and T.-Y. Yang, "The effect of commuting time on burnout: the mediation effect of musculoskeletal pain," *BMC Health Serv Res*, vol. 24, p. 468, Apr. 2024, doi: 10.1186/s12913-024-10908-1.

[27] M. Kimura *et al.*, "Influence of commuting methods on low back pain and musculoskeletal function of the lower limbs in elementary school children: A cross-sectional study," *Journal of Orthopaedic Science*, vol. 27, no. 5, pp. 1120–1125, Sep. 2022, doi: 10.1016/j.jos.2021.05.013.

[28] N. Jacob, L. Munford, N. Rice, and J. Roberts, "Does commuting mode choice impact health?," *Health Econ*, vol. 30, no. 2, pp. 207–230, Feb. 2021, doi: 10.1002/hec.4184.

[29] R. Noichan and B. Dewancker, "Analysis of Accessibility in an Urban Mass Transit Node: A Case Study in a Bangkok Transit Station," *Sustainability*, vol. 10, no. 12, Art. no. 12, Dec. 2018, doi: 10.3390/su10124819.

[30] T. Teunissen, "An ex-post evaluation framework for BRT and MRT in Mexico : A study on the impacts of Bus Rapid Transit and Mass Rapid Transit in Mexico City," Mar. 2014, [Online]. Available: http://essay.utwente.nl/65036/

[31] A. H. Xiao, "The congested city and situated social inequality: Making sense of urban (im)mobilities in Lagos, Nigeria," *Geoforum*, vol. 136, pp. 312–320, Nov. 2022, doi: 10.1016/j.geoforum.2021.04.012.

[32] C. Mulley, J. Nelson, and S. Ison, Eds., *The Routledge Handbook of Public Transport*. London: Routledge, 2021. doi: 10.4324/9780367816698.