CONHECIMENTO & DIVERSIDADE
ISSN 2237-8049
UnilaSalle Editora

IMPACTS OF REPLACING CONVENTIONAL BICYCLES WITH E-BIKES ON THE PHYSICAL ACTIVITY OF BRAZILIANURBAN CYCLISTS: AN EXPLORATORY STUDY

IMPACTOS DA SUBSTITUIÇÃO DA BICICLETA CONVENCIONAL PELA ELÉTRICA NA ATIVIDADE FÍSICA DE CICLISTAS BRASILEIROS URBANOS: UM ESTUDO EXPLORATÓRIO

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ABSTRACT

The growing adoption of electric bicycles (e-bikes) has been reshaping urban mobility across different contexts, enhancing accessibility and comfort in everyday commuting. Nevertheless, concerns have emerged regarding the possible reduction in physical activity intensity among users who replace conventional bicycles with pedal-assisted models. This study examines the effects of this substitution on the physical activity load of urban cyclists, emphasizing public health and active transportation promotion. This exploratory research analyzed data collected through a questionnaire administered to 35 Brazilian cyclists who had recently transitioned to e-bikes. Variables such as commuting time, weekly frequency, perceived intensity, and motivations for switching were assessed, non-probabilistic convenience sampling. The findings indicate a significant decrease in perceived physical exertion, accompanied by increased regularity of use and longer travel distances. The discussion points to a reconfiguration of physical activity patterns, with implications for mobility planning and health policies. It is concluded that although e-bikes may reduce exertion compared to conventional bicycles, they remain an active and advantageous mode of transport, particularly for groups facing barriers to traditional cycling.

Keywords: Physical activity, Electric bicycles, Urban mobility.

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RESUMO

A crescente adesão às bicicletas elétricas (e-bikes) vem transformando a mobilidade urbana em diversos contextos, ampliando a acessibilidade e o conforto nos deslocamentos cotidianos. Entretanto, surge a preocupação quanto à possível redução da intensidade da atividade física entre usuários que substituem a bicicleta convencional por modelos com assistência elétrica. Este estudo tem como objetivo analisar os efeitos dessa substituição na carga de atividade física de ciclistas urbanos brasileiros, com ênfase nos aspectos relacionados à saúde pública e à promoção do transporte ativo. Busca-se compreender como a adoção da e-bike modifica os padrões de deslocamento, a intensidade do esforço físico e as experiências subjetivas dos usuários, examinando os impactos dessa transição sob a perspectiva da promoção da saúde e da mobilidade ativa. A pesquisa, de caráter exploratório, utilizou dados obtidos por meio de questionário aplicado a 35 ciclistas brasileiros que migraram recentemente para a e-bike, analisando variáveis como tempo de deslocamento, frequência semanal, intensidade percebida e motivos para a troca. Os resultados apontam redução significativa na intensidade do esforço físico, acompanhada de aumento na regularidade do uso e na extensão dos percursos. A discussão evidencia uma reconfiguração dos padrões de atividade física, com implicações para políticas públicas de mobilidade e saúde. Conclui-se que, embora as e-bikes possam diminuir a carga física em relação às bicicletas convencionais, ainda representam um meio ativo e vantajoso de transporte, especialmente para grupos que enfrentam barreiras ao uso da bicicleta tradicional.

Palavras-chave: Atividade física, Bicicletas elétricas, Mobilidade urbana.

Introdução

The rapid growth of cities and the resulting increase in traffic congestion, air pollution, and sedentary lifestyles have placed urban mobility at the center of debates on sustainability, quality of life, and public health (Rabelo, 2019; Giannico et al., 2022). In an urban model historically structured around private automobiles, mobility systems have generated environmental degradation, social inequities, and reduced opportunities for daily physical activity. Consequently, there is a growing demand for solutions capable of combining transport efficiency, environmental responsibility, and population well-being. Within this framework, the bicycle, traditionally associated with clean and active transport, re-emerges not merely as an alternative mode of travel, but as a strategic instrument for promoting sustainable urban restructuring, particularly in large metropolitan areas (Lima et al., 2023).

Within this context, electric bicycles (e-bikes) have gained prominence as a technological innovation that integrates active mobility with electrically assisted propulsion. By partially reducing the physical effort required for pedaling, e-bikes expand accessibility to a broader demographic profile, including older adults,

individuals with physical limitations, and commuters facing structural barriers such as long distances, heavy traffic, or steep topography. This assisted modality may therefore mitigate traditional constraints associated with conventional cycling while preserving elements of physical engagement. As a result, e-bikes hold significant potential to democratize access to active transportation and foster modal shifts in urban commuting patterns (Santos et al., 2022).

In recent years, academic interest in the health implications of e-bike use has intensified, particularly regarding their contribution to overall physical activity levels. Empirical evidence suggests that although the physiological demand of e-biking is generally lower than that of conventional cycling, users frequently compensate through longer trip distances and higher riding frequency. Studies conducted by Bourne et al. (2018) and MacVicar et al. (2022) indicate that e-bike use can generate moderate-intensity physical activity, contributing to energy expenditure and reductions in sedentary behavior. These findings challenge binary interpretations of active versus passive transport and reinforce the need for more nuanced analytical frameworks.

Despite these advances, important knowledge gaps persist concerning usage patterns and the implications of substituting conventional bicycles with e-bikes among Brazilian urban cyclists, particularly within the broader Latin American context. Sociocultural dynamics, urban infrastructure disparities, and socioeconomic inequalities may shape adoption patterns differently from those observed in high-income countries. Variables such as perceived exertion intensity, frequency of use, commuting motivations, and behavioral adaptation processes remain insufficiently explored in national literature. This limitation constrains the development of evidence-based public policies capable of integrating mobility planning with health and sustainability agendas (Lima et al., 2024).

This article seeks to analyze the effects of substituting conventional bicycles with e-bikes on the physical activity load of Brazilian urban cyclists, with particular emphasis on implications for public health and the promotion of active transportation. Specifically, it investigates how e-bike adoption influences commuting dynamics, perceived and actual exertion intensity, travel frequency, and

users' subjective experiences. By examining both behavioral and physiological dimensions, the study aims to provide a comprehensive assessment of how this transition affects overall physical activity patterns.

The study is grounded in the urgent need to promote sustainable and inclusive transportation alternatives capable of contributing to public health improvement and reducing inequalities in access to active mobility. In urban environments marked by spatial segregation and mobility barriers, e-bikes may function as enabling technologies that lower entry thresholds to cycling practices. By attenuating common obstacles, such as physical conditioning requirements, distance constraints, and topographical challenges, this modality may stimulate meaningful and sustained behavioral change (Richetta & Karepov, 2023; Ramos et al., 2024). Its relevance extends beyond academia, informing researchers, public managers, urban planners, physical education professionals, traffic engineers, and policymakers engaged in intersectoral strategies.

Furthermore, this research encourages critical reflection on conventional definitions of physical activity and active transport, acknowledging that hybrid and adaptive mobility solutions may better correspond to contemporary urban demands. Rather than framing mobility modes within rigid dichotomies, it is necessary to recognize gradations of physical engagement and their cumulative health effects. From this perspective, the e-bike represents a pragmatic equilibrium between physical exertion and functional efficiency, aligning individual mobility needs with broader sustainability objectives and contributing to ongoing transformations in urban transport systems and health promotion strategies.

Methods

This study adopted a quantitative and exploratory design, grounded in the analysis of primary data collected through a structured questionnaire administered to 35 Brazilian urban cyclists who transitioned from conventional bicycles to electric models. The primary objective was to examine the impact of this transition on physical activity load, frequency of use, commuting patterns, user motivations,

and subjective perceptions related to daily mobility. The sample was defined by convenience sampling, consistent with the preliminary, descriptive, and hypothesis-generating nature of the investigation, based on retrospective self-reported comparisons.

Data collection was conducted in accordance with established ethical standards, ensuring autonomy, confidentiality, and participant privacy. All respondents received detailed information regarding the study's objectives, procedures, risks, and eligibility criteria prior to participation (Ethics Approval No. 14,568). Inclusion criteria comprised individuals aged 18 years or older, with at least six months of prior experience using conventional bicycles and regular use of e-bikes for a minimum of three months, ensuring familiarity with both modalities. Participation was formalized through electronic informed consent. The questionnaire was developed based on instruments previously validated in research on active mobility, urban health, and cyclist behavior, enhancing content validity and methodological consistency (Bourne et al., 2020).

The final instrument consisted of 25 items: 20 closed-ended questions (including Likert-scale, multiple-choice, and dichotomous formats) designed to generate quantifiable indicators, and 5 open-ended questions aimed at capturing subjective perceptions regarding physical exertion, well-being, perceived safety, autonomy, and behavioral adaptation following e-bike adoption. The average completion time was approximately 10 minutes, minimizing respondent burden and supporting data reliability.

The survey was administered online via the Google Forms platform between April and May 2025. Recruitment occurred through cycling groups on social media platforms and urban mobility forums across three municipalities in the western region of Paraná State, Cascavel, Toledo and Foz do Iguaçu. This recruitment strategy facilitated access to participants actively engaged in cycling communities and contributed to a heterogeneous sample in terms of age, gender, and occupational background, although within the constraints inherent to non-probabilistic sampling.

The quantitative variables analyzed included daily commuting time (in minutes), weekly cycling frequency (number of days), average distance traveled (in kilometers), and perceived physical exertion measured on a five-point ordinal scale. These indicators were selected to approximate changes in physical activity exposure associated with modal substitution. Responses to open-ended items were examined using thematic content analysis, enabling systematic identification of recurrent experiential patterns and interpretative dimensions related to e-bike use.

Data analysis comprised descriptive statistical procedures (means, medians, and standard deviations) to characterize central tendencies and variability, combined with direct within-subject comparisons between prior habits (conventional bicycles) and current practices (e-bikes). Qualitative responses were independently reviewed and manually categorized to identify recurring themes, divergences, and meaningful variations in participants' accounts of mobility changes and perceived physical activity intensity.

Given the exploratory design, limited sample size, and non-probabilistic sampling strategy, the findings should not be generalized to the broader population of Brazilian cyclists. Nonetheless, the study offers analytically relevant preliminary evidence capable of informing hypothesis refinement and guiding future research employing probabilistic sampling and longitudinal designs. The adopted methodological approach enables a structured initial mapping of the effects of transitioning from conventional to electric bicycles within everyday urban contexts, while maintaining ethical rigor and analytical coherence.

Results

In order to characterize the impacts of transitioning from a conventional bicycle to an electric model on commuting habits, perceived physical exertion, spatial reach, and reported motivations, the principal findings were organized and systematized. Table 1 summarizes the most relevant quantitative and qualitative results, enabling an integrated assessment of changes in active mobility patterns following the adoption of the e-bike.

Table 1 – Comparison between the use of conventional bicycles and e-bikes. Descriptive statistics and motivations for transition (n = 35)

Indicator	**Conventional bicycle**	**E-bike (electric)**	**Variation / Observations**
Weekly usage frequency (days)	Mean = 3.2	Mean = 4.6	Increase of 1.4 days per week
Average trip duration (minutes)	Mean = 28	Mean = 37	Increase of 9 minutes per trip
Average distance traveled per day (km)	Mean = 6.8	Mean = 10.4	Increase of 3.6 km
Perceived physical exertion (Likert scale from 1 to 5)	Mean = 4.2	Mean = 2.6	Reduction of 1.6 points in perceived physical effort
Reason for adopting the e-bike: fatigue with conventional bicycle	41%	—	Most frequently reported reason
Reason for adopting the e-bike: staying active without exhaustion	32%	—	Second most cited reason
Reason for adopting the e-bike: avoiding public transportation	19%	—	Functional factor related to urban autonomy
Reason for adopting the e-bike: trend/status symbol	8%	—	Low symbolic influence
Perception of safety (qualitative report)	—	Increased	Especially on hills and intersections due to assisted acceleration
Maintenance of active routine (qualitative report)	—	Facilitated	Greater consistency despite lower physical effort
Subjective well-being	—	Increased	Comfort and vitality reported despite reduced physical exertion

The data demonstrate a marked transformation in cycling behavior after the introduction of electric assistance. Before the transition, participants reported riding conventional bicycles an average of 3.2 days per week, with trips lasting around 28 minutes. Following the adoption of e-bikes, frequency rose to 4.6 days weekly and average duration reached 37 minutes, indicating broader spatial reach and more consistent engagement in daily commuting.

With respect to perceived exertion, a substantial decline was identified. On the 1-to-5 Likert scale, conventional bicycles averaged 4.2 points, whereas e-bikes averaged 2.6. These results indicate that even though usage became more frequent and trips extended in duration, the intensity of effort required per ride decreased considerably.

Daily travel distance also expanded, increasing from 6.8 km to 10.4 km. This pattern reinforces the interpretation that electric assistance enables cyclists to cover longer routes with greater feasibility, incorporating trips that might previously have been perceived as physically demanding, albeit with lower metabolic strain.

Regarding motivations for adopting e-bikes, the most frequently cited reason was fatigue associated with conventional bicycles (41%), followed by the intention to remain active without excessive exhaustion (32%) and the possibility of avoiding public transportation (19%). Only a small proportion (8%) indicated trend or status considerations, suggesting that practical functionality outweighed symbolic factors in the decision-making process.

Qualitative reports further revealed an enhanced perception of safety, particularly on inclines and at complex intersections, where assisted acceleration was associated with improved control. Participants also noted greater continuity in maintaining an active commuting routine, despite reduced physical intensity, which may represent an indirect contribution to overall health and subjective well-being.

Discussion

The results obtained in this study indicate that replacing conventional bicycles with electric models was associated with lower perceived physical exertion, alongside increases in weekly frequency and distance traveled. This pattern reflects a reconfiguration of urban physical activity exposure: although cardiovascular demand per trip declined, cumulative engagement in active commuting expanded. From a dose–response perspective, the balance between intensity and volume becomes central. While greater regularity may partially compensate for reduced effort, the extent of this compensation remains empirically uncertain and warrants cautious interpretation.

Assuming that increased frequency can fully substitute for the physiological benefits derived from higher intensity overlooks consolidated evidence from exercise physiology and epidemiology, which identify intensity as a critical determinant of cardiorespiratory adaptation, metabolic regulation, and chronic disease prevention. Recommendations from the American College of Sports Medicine (ACSM) and the World Health Organization (WHO) emphasize that substantial health gains are associated with moderate to vigorous physical activity totaling at least 150 minutes per week (Lima; Levy; Luiz, 2014). Consequently, reductions in exertion intensity among e-bike users may influence the qualitative dimension of physical activity, even when cumulative exposure increases.

Moreover, projecting that elevated usage frequency will be sustained over time introduces uncertainty. Longitudinal evidence regarding durable adherence to e-bikes remains limited, and existing studies suggest that behavioral patterns may shift after the initial adoption phase (Mcvicar et al., 2022). Without long-term follow-up data, equating the sustained physiological impact of e-bikes with that of conventional cycling may be premature.

From a public health perspective, there is a potential risk of inadvertently diluting established physical activity benchmarks by implicitly validating lower-intensity practices as equivalent substitutes. Such reinterpretation could weaken

the conceptual rigor underpinning active transportation strategies and reduce their preventive effectiveness against chronic non-communicable diseases.

Empirical investigations by Bourne et al. (2020) indicate that e-bike users achieve approximately 75% of the physical activity load observed among conventional cyclists, while remaining substantially more active than users of private motor vehicles or public transport. These findings position e-bikes within an intermediate zone of exertion, representing improvement relative to sedentary mobility, yet not a complete replacement for higher-intensity cycling.

The discourse emphasizing social inclusion through e-bikes is pertinent but requires structural scrutiny. Electric assistance lowers physiological barriers to cycling, benefiting older adults, individuals with limited fitness, those undergoing rehabilitation, and residents of areas characterized by steep terrain. Nevertheless, such functional accessibility does not neutralize socioeconomic constraints, particularly high acquisition and maintenance costs that restrict diffusion among lower-income populations (Haufe et al., 2022; Silveira; Rocha; Vargas, 2020; Lima; Souza; Sampaio, 2025).

Technological availability alone does not guarantee democratization. In the absence of targeted subsidies, inclusive financing mechanisms, or equitable public sharing systems, access remains concentrated among higher-income groups. Additionally, safe and sustained adoption depends on adequate cycling infrastructure, coherent urban planning, and multimodal integration, conditions frequently deficient in peripheral territories. Under such circumstances, narratives of inclusion risk reproducing spatial inequalities favoring central urban areas (Lee; Sener, 2023; Machado; Piccinini, 2018).

At the same time, expanded access should not obscure the central role of activity intensity in generating robust physiological adaptations. International guidelines such as WHO (2020) underscore the protective effect of moderate to vigorous activity against hypertension, type 2 diabetes, obesity, and depression. Lower exertion levels associated with e-bike use may constrain certain adaptations, reinforcing the need for complementary strategies to ensure adequate health stimulus.

Nonetheless, reduced effort does not imply absence of benefit. Increased frequency and behavioral consistency represent meaningful progress from a population-health standpoint. Regular engagement in moderate-intensity activity is associated with cumulative metabolic, psychological, and functional advantages. In this regard, e-bikes may function as transitional instruments facilitating progression from sedentary lifestyles toward more sustained physical activity routines, particularly among individuals facing motivational or physical barriers.

The expansion in average daily distance traveled suggests altered mobility patterns. This may indicate partial substitution of passive modes such as cars and buses with a more active and environmentally sustainable alternative. Such shifts imply potential collective gains, including reduced emissions, lower noise levels, and mitigation of traffic congestion, contributing to a more balanced urban mobility ecosystem.

However, optimistic interpretations regarding modal substitution require empirical verification. Increased travel distance does not necessarily confirm displacement of private vehicles or public transport; it may reflect extension of trips previously undertaken by conventional bicycle or the addition of discretionary journeys (Lima; Souza; Sampaio, 2025). Without precise modal comparison data, substitution effects remain inferential.

In certain contexts, e-bikes may compete not only with motorized transport but also with walking or high-capacity public systems such as subways and bus rapid transit corridors. Under these conditions, anticipated environmental and public health gains may be attenuated. Furthermore, comprehensive sustainability assessments must incorporate lifecycle considerations, including battery production, disposal processes, energy sources, and infrastructure demands (Lima; Lima; Sampaio, 2021).

An additional concern involves reverse substitution, whereby e-bikes replace trips previously completed on foot or by conventional bicycle. Research on transport innovation indicates that such shifts can reduce overall physical activity exposure if technologically assisted modes displace more demanding forms of

movement (Haas et al., 2022). By lowering effort thresholds for short distances, e-bikes may unintentionally discourage vigorous spontaneous activity.

Collective environmental benefits, such as reductions in air pollution, noise, and congestion, depend on contextual determinants including adoption scale, specific modes displaced, and coherence with sustainable mobility policies. In the absence of robust evidence demonstrating net vehicle displacement and measurable emission reductions, projected environmental gains remain provisional. E-bikes should therefore be interpreted as components within broader systemic transitions rather than autonomous solutions (Valentini; Wangel; Holmgren, 2023).

The subjective dimension of e-bike use also merits attention. Participants frequently reported enhanced perceptions of safety and control, particularly in physically demanding environments such as steep inclines and complex intersections. Assisted acceleration appears to increase confidence and reduce stress, factors closely linked to sustained adherence in active commuting behaviors.

Economic accessibility remains a structural challenge. Despite growing popularity, high upfront costs continue to limit access predominantly to higher-income segments. This reinforces the importance of policy instruments, including subsidies, public financing schemes, and shared mobility systems, to prevent technological innovation from reinforcing social stratification.

Promotion of e-bike adoption should therefore be embedded within comprehensive active mobility ecosystems encompassing infrastructure investment, educational initiatives, intersectoral health programs, and integration with public transport networks. A coordinated systems approach enhances the probability that individual behavioral shifts translate into collective health and environmental benefits.

Nevertheless, assuming that integration alone guarantees effectiveness risks normative overstatement. Implementation of coordinated policies depends on institutional capacity, fiscal stability, regulatory continuity, and political commitment—conditions that are often fragile in the Brazilian context (Lima et al., 2023).

Framing e-bikes primarily as policy-enhanced instruments may also obscure dynamics of market capture and elitization. Infrastructure investments disproportionately serving higher-income users can widen territorial inequalities when peripheral populations remain excluded due to persistent cost barriers (García-Palomares et al., 2023).

Another limitation lies in presuming automatic alignment between e-bike promotion and public health objectives. As discussed, reduced exertion intensity may limit certain physiological adaptations; therefore, health gains are not inherently guaranteed without complementary behavioral or institutional strategies (Santos et al., 2022).

Furthermore, systemic integration rhetoric may diffuse institutional accountability by redistributing responsibility across loosely defined governance arrangements. In such cases, symbolic incentives risk substituting for structural transformation, weakening policy effectiveness (Mcvicar et al., 2022).

Ultimately, while the concept of an integrated active mobility ecosystem is normatively desirable, it is insufficient on its own to ensure that e-bikes function as consistent allies of health and sustainability. Recognizing political, economic, infrastructural, and behavioral constraints is essential to prevent overestimation of their transformative potential.

In summary, the expansion of electric bicycle use in urban environments constitutes a significant innovation at the intersection of transport, public health, and sustainability. E-bikes occupy an intermediate position between passive motorized mobility and higher-intensity cycling, offering pragmatic accessibility while maintaining measurable physical engagement. Their long-term contribution depends on preserving adequate activity intensity, ensuring equitable access, verifying genuine modal substitution, and embedding adoption within coherent intersectoral policy frameworks. Only under these conditions can e-bikes consolidate their role as structurally relevant components of sustainable urban health strategies.

Final Considerations

The replacement of conventional bicycles with electric models represents a substantive shift in urban physical activity patterns, characterized by lower exertion intensity alongside increased frequency and extended travel distances. This transformation suggests a redistribution of effort rather than its elimination, potentially broadening participation in active transportation among individuals with heterogeneous physical capacities, age profiles, and health conditions. By mitigating barriers such as steep topography, long commuting distances, and physical fatigue, e-bikes may facilitate adherence to active mobility routines within increasingly complex and motorized urban environments. In this sense, their expansion can be interpreted as part of a broader transition toward more flexible and inclusive forms of physically engaged transport.

Nevertheless, the potential benefits of e-bike adoption require careful and evidence-informed interpretation. Reduced physiological demand may limit the achievement of moderate-to-vigorous physical activity thresholds recommended for substantial cardiometabolic protection, raising questions about the qualitative sufficiency of this modality when considered in isolation. Accordingly, the integration of e-bikes into urban mobility systems should be accompanied by coordinated public policies that promote complementary exercise practices, equitable financial access, and safe, well-connected cycling infrastructure. Moreover, sustained investment in longitudinal and comparative empirical research is essential to clarify long-term behavioral adherence, net health impacts, and environmental outcomes. Only through such multidimensional evaluation can e-bikes be responsibly positioned as effective contributors to sustainable mobility and population health.

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