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Review

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# Effects of public transportation use on non-exercise activity thermogenesis and health promotion: a mini-review

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**[Purpose]** Public transportation (PT) systems significantly shape urban mobility and have garnered attention owing to their potential impact on public health, particularly the promotion of physical activity. Beyond their transportation functions, PT systems also affect daily energy expenditure through non-exercise activity thermogenesis (NEAT). This mini-review surveys the existing literature to explore the effects of PT use on NEAT levels and subsequent health outcomes.

**[Methods]** A comprehensive literature search was conducted using the electronic databases PubMed, Google Scholar, and Web of Science. Keywords including "public transportation," "non-exercise activity thermogenesis," "physical activity," "health promotion," and related terms were used to identify relevant studies.

**[Results]** This review highlights the multifaceted relationship between PT use and health promotion, emphasizing the potential benefits and challenges of increasing NEAT through public transit utilization. Overall, the findings suggest that PT use contributes positively to NEAT levels, and thus improves health outcomes. However, the extent of this impact may vary depending on individual and contextual factors.

**[Conclusion]** Interventions promoting active transportation modes, including public transit, hold promise for addressing sedentary behavior and fostering healthier lifestyles at the population level.

**[Keywords]** public transportation, NEAT, health promotion, physical activity, sedentary behavior, active transportation, well-being

## INTRODUCTION

In recent years, the world has witnessed a significant decline in physical activity (PA), primarily because of the rapid advancement of mobility technology[1]. While these developments have brought numerous benefits in terms of efficiency, convenience, and economic growth, they have also engendered unintended consequences, notably a decline in PA levels[1]. As mobility technology continues to permeate various aspects of daily life, from transportation to communication, the propensity for sedentary behavior has significantly increased[1,2]. This trend has raised concerns about the health and well-being of the population[1,2]. Sedentary lifestyles and excessive reliance on transportation technology pose significant health risks and societal challenges[3,4]. Here we explore the multifaceted nature of this issue and propose potential solutions to mitigate the adverse effects of decreased PA.

The rapid proliferation of mobility technologies, including automobile and ride-sharing services, has led to a gradual decline in PA levels across all age groups in Korea[5,6]. Physical inactivity has become a global health concern, contributing to the rise of various non-communicable diseases (e.g., obesity, cardiovascular diseases, and diabetes) and premature mortality[6,7]. Moreover, a sedentary lifestyle can adversely affect mental health and contribute to stress, anxiety, and depression[8,9]. Although the health benefits of regular PA are well documented, recent research has shed light on the importance of non-exercise activity thermogenesis (NEAT) in contributing to total daily energy expenditure (EE) and overall metabolic health[10]. NEAT encompasses various activities including walking, standing, fidgeting, and other movements typically associated with daily routines[11]. Importantly, even minor NEAT increases have meaningful implications for energy balance and metabolic health, suggesting that interventions targeting NEAT may hold promise for combating sedentary behavior and its associated health risks[10-13]. The relationship between non-communicable diseases and the decrease in PA owing to the rapid development of mobility technology is shown in Figure 1.

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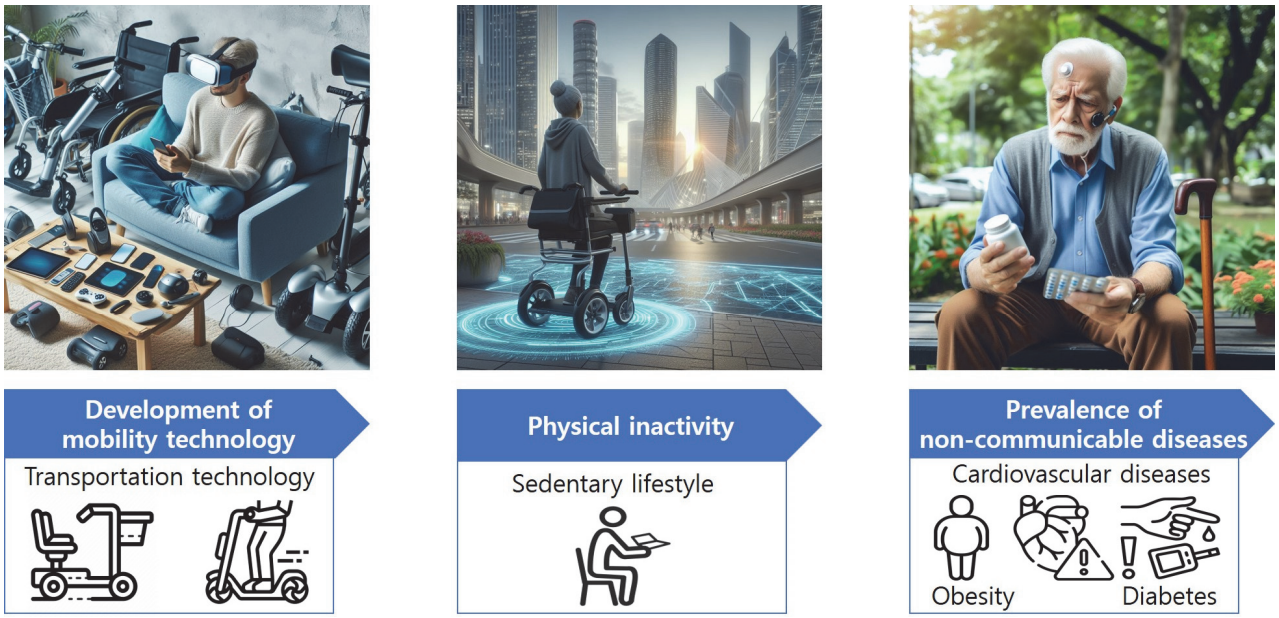


**Figure 1. Decreasing physical activity owing to the rapid development of mobility technology has increased the prevalence of non-communicable diseases**.

Although traditional approaches, such as recreational facilities and exercise programs, remain essential, there is growing recognition of the importance of incorporating PA into daily routines, including commuting behaviors[14-23]. Encouraging active modes of transportation such as walking, cycling, and public transit presents an opportunity to integrate PA into daily routines[18,24]. Public transportation (PT) is a viable option for promoting incidental PA, particularly in urban settings, where it is readily available and widely used[18]. PT systems offer a promising avenue for achieving this goal by providing opportunities for individuals to engage in PA during their daily lives[18]. Thus, this review examined the potential benefits of PT in increasing NEAT levels and promoting health and well-being.

## DEVELOPMENT OF PUBLIC TRANSPORTATION

PT, also known as public or mass transit, refers to shared transportation services available to the general public[25-27]. Typically, these services have fixed routes, schedules, and fare systems[25-27]. PT encompasses various modes, including buses, trains, subways, trams, ferries, and other forms of communal transport designed to efficiently transport a large number of people within urban and suburban areas[25-27]. The history of PT can be traced back to ancient civilizations, where rudimentary forms of public transit, such as horse-drawn carriages and early ferries, facilitated movement within cities and across water bodies[28]. However, the modern concept of organized PT began to take shape in the 19th century with industrialization and urbanization[29].

The horse-drawn omnibus was one of the earliest forms of PT, emerging in the early 19th century[30]. The omnibus offered, for a fare, scheduled transportation along fixed routes[30]. The invention and widespread adoption of steam engines in the early 19th century revolutionized transportation, leading to the development of steam-powered trains and railways[31]. This innovation laid the foundation for expanding public transit networks that connected cities and regions[32]. The late 19th and early 20th centuries witnessed further advancements in PT, including the introduction of electric streetcars, cable cars, and subways[25,29]. These modes provide faster, more reliable, and more comfortable travel options for urban residents, thereby contributing to the worldwide growth and development of cities.

Throughout the 20th century, PT continued to evolve with the introduction of buses, trolley buses, and modern rapid transit systems[25,28,29]. PT plays a crucial role in urban mobility by serving millions of people daily in cities worldwide[33]. Technological advancements such as smart cards, real-time tracking systems, and electric vehicles are transforming public transit, making it more accessible, convenient, and environmentally friendly[34,35]. As cities continue to grow and face new transportation challenges, the evolution of PT remains essential for shaping the future of urban mobility[27,36].

## IMPACT OF PUBLIC TRANSPORTATION ON NON-EXERCISE ACTIVITY THERMOGENESIS

In an era marked by rapid urbanization, increasing concerns regarding environmental sustainability, and a growing focus on public health, the role of PT systems has garnered

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significant attention[37]. In addition to facilitating mobility, these systems have the potential to influence various aspects of individual and population health[14-23]. One aspect that has emerged as a subject of interest is NEAT, which encompasses the energy expended during daily living activities, excluding formal exercise[10-12]. The utilization of PT represents a unique intersection point where transportation behavior intersects NEAT, offering an intriguing avenue for exploration.

PT gives individuals opportunities for increased NEAT through incidental PA associated with commuting[18,38]. Unlike passive modes of transportation such as driving or being a passenger in a private vehicle, public transit often involves walking to and from transit stops, navigating stations, or standing during transit rides[39]. In a previous study, calorie consumption of NEAT (sitting EE: 1.47±0.48 kcal/min; leg juggling EE: 1.75±0.51 kcal/min; standing EE: 1.54±0.5 kcal/min; walking (4.5 km/h) EE: 4.73±0.94 kcal/min; walking (6.0 km/h) EE: 6.68±1.25 kcal/min; climbing up 1 style EE 2.59±0.87 kcal/min; and climbing up two styles EE: 2.64±0.87 kcal/min) was measured in healthy adult males and females[13]. Although seemingly modest, these activities can contribute to a substantial increase in daily EE. The relationship between PT use and PA level is complex and multifaceted[40]. Studies have consistently demonstrated a positive association between PT use and PA levels[40]. Several factors influence how individuals engage in PA while utilizing PT[40-42]. One significant pathway is active commuting, where individuals walk or cycle to access transit stops by incorporating exercise into their daily travel routine[40-42]. Moreover, PT often involves incidental walking during transfers or access to final destinations, contributing to an increase in daily step count, total EE, and overall PA accumulation[18,24,43,44]. These findings underscore the potential of PT systems as catalysts for increasing the population level of PA[18,24,43,44]. Moreover, frequent PT users are more likely to meet the recommended PA guidelines, leading to various health benefits, including improved cardiovascular (CV) fitness, weight management, and mental well-being[15-23]. However, understanding the relationship between PT use and PA activity remains challenging. Factors such as transit access, service quality, safety concerns, and built environment characteristics can influence an individual's willingness and ability to engage in active transportation behaviors[45,46]. Limited access to transit stops or stations, long waiting times, and unsafe walking or cycling conditions may prevent individuals from using PT to increase their PA[3,40,44]. Moreover, disparities in transit access and infrastructure investment can exacerbate existing health inequities, disproportionately affecting marginalized communities with limited mobility options[47,48].

## IMPACT OF PUBLIC TRANSPORTATION ON HEALTH PROMOTION

Despite these challenges, PT represents a promising avenue for promoting PA and improving population health[49]. Promoting PT to increase PA aligns with broader public health objectives to reduce sedentary behaviors and promote active lifestyles[49]. Promoting PA through PT has several health benefits[15-23]. Regular PA is associated with reduced risk factors of chronic diseases, including improved CV health, better weight management, and enhanced metabolic function[50,51]. Encouraging individuals to incorporate walking and cycling into their daily commutes reduces the prevalence of chronic diseases such as obesity, diabetes, and CV disorders[52]. Furthermore, PT facilitates incidental PA, making it a feasible option for individuals with busy schedules who struggle to find time for structured exercises[18,44,52]. Promoting active transportation can create environments conducive to PA and foster population health and well-being[18,44,52]. Moreover, active transportation options (e.g., walking and bicycling) offer environmental benefits by reducing greenhouse gas emissions and traffic congestion and promoting public health through cleaner air and safer streets[53].

PT positively affects the body composition, CV system, metabolism, and mental health[15-23]. A cross-sectional study in the United Kingdom found that men and women who commuted to work by active means and PT had significantly lower body mass index (BMI) and body fat percentage than those who used other means of transportation[15]. Specifically, men who commuted via public or active modes had a BMI of 1.10 kg/m$^2$ and 0.97 kg/m$^2$ lower than those who used private transport. Women who commuted via public or active modes had a BMI of 0.72 kg/m$^2$ and 0.87 kg/m$^2$ lower than those using private transport[15]. A systematic review and meta-analysis found a consistent association between PT use and a lower BMI. Switching from automobile use to PT is associated with lower BMI (−0.30 kg/m$^2$, 95% confidence interval: −0.47, −0.14)[16]. A lower BMI is generally associated with better CV system and metabolic health. Higher levels of PT commuting are associated with lower prevalence of overweight (−0.32%, 95% CI: −0.05, −0.59) and obesity (−0.21%, 95% CI: −0.03, −0.39) 1 year later[16]. Being overweight or obese is a risk factor for CV disease and metabolic syndrome. PT often involves PA such as walking or cycling to and from a transfer station[18]. This is five times more PA than that of those who only use private transport[18]. Regular PA is beneficial for CV and metabolic health. The quality of transportation provision affects well-being and stress because it affects the quality of commuting and travel experiences[19-21]. PT interventions positively impact mental health by reducing commuting time and easing traffic[19-21]. PT improves access to schools, jobs, healthy food options, and medical care[22,23]. It can also improve mental health and well-being by providing independence to people with the ability to get around and connect with others in their communities[22,23].

These findings suggest that PT use, which often involves walking or cycling to and from transit stations, can contribute to PA levels and thus positively affect body composition, the CV system, metabolism, and mental health[15-23]. Figure 2 shows the effect of PT on health by increasing NEAT. However, individual results may vary depending on the distance and intensity of walking or cycling, overall lifestyle, and diet.

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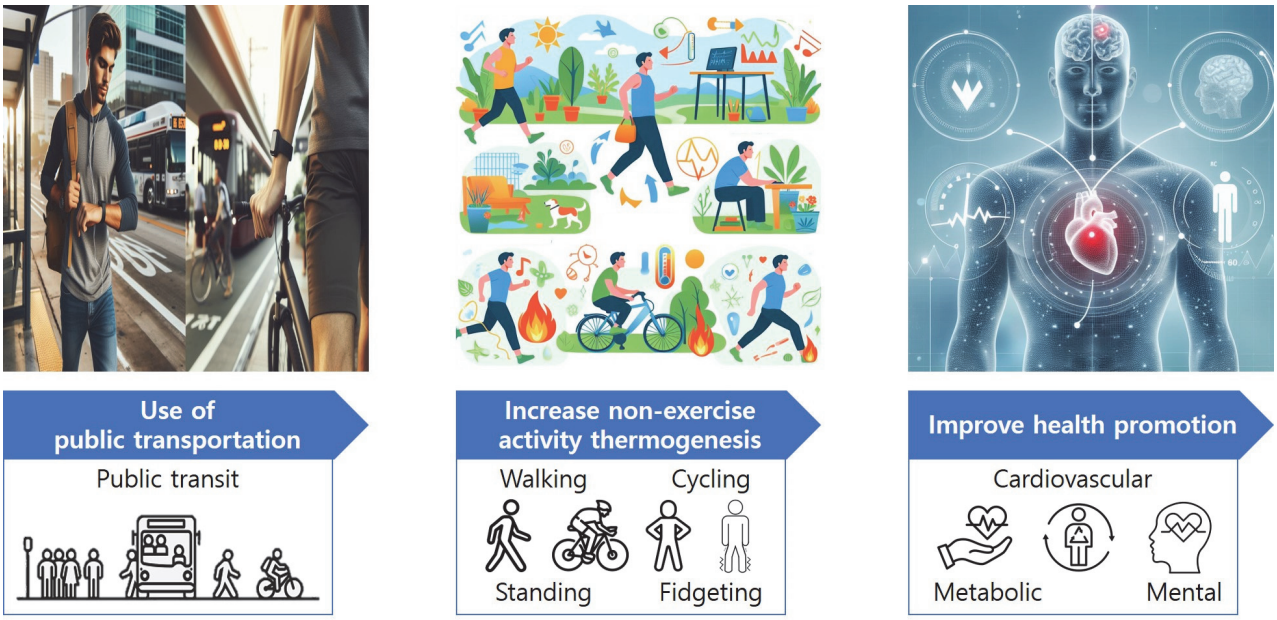


**Figure 2.** The use of public transportation helps improve health by increasing non-exercise activity thermogenesis.

## CONCLUSION AND FURTHER RESEARCH

PT represents a promising avenue for promoting NEAT and mitigating sedentary behaviors in urban populations. Commuting via public transit involves activities that contribute to EE, such as walking and standing, which can enhance overall health and well-being. By promoting active commuting and creating a supportive environment for PT use, cities can harness the health benefits of NEAT and foster healthier communities.

Overall, this mini-review underscores the importance of considering PT as a potential contributor to NEAT and highlights opportunities to harness its benefits in promoting active lifestyles and reducing sedentary behavior. Further research is warranted to better understand the complex interactions between PT use and NEAT and to develop tailored interventions that maximize PA opportunities within transit environments.

Further research on PT and its intersection with public health should be conducted to advance this knowledge. Investigating the long-term health effects of regular PT use on various demographic groups can provide valuable insights. Studies could delve into factors such as CV health, respiratory health, mental well-being, and overall mortality rates among individuals who rely on PT compared with those who primarily use private vehicles or other modes of transport. Additionally, research on effective interventions that promote PT adoption among diverse populations is essential. These could involve targeted strategies tailored to specific demographic groups such as low-income communities, older people individuals, people with disabilities, and suburban residents.

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