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This research note has been written based on data collected with the aim of training on new data collection and structuring tools. The note has NOT been peer-reviewed.
However, we believe that the data collected may bear some interest. Therefore, we decided to publish the results in the form of a preprint article.

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Health, time, and financial co-benefits of active travelling: A case report of one cyclist in the Tokyo metropolitan area

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Abstract

Background: Little data are available on bicycle travelling in the Tokyo Metropolitan area. The present study aimed to quantify the extent of health, time, and financial co-benefits of active travelling in the Tokyo metropolitan area.

Methods: This case report is about one non-active Tokyo inhabitant who decided to switch from sedentary public transportation to active travelling. Geographic and time data from travels registered for 11 months in the Runkeeper application were extracted *a posteriori*. Travels completed by bicycle were identified and compared to the travels on corresponding routes using public transportation with reference to estimated cost and duration. The subject also reported the results of two maximal oxygen consumption tests that he performed before and after the observation period.

Results: Over the 11-month observation period, the subject travelled a total of 3,959 km, which was completed in 16,513 min. The corresponding public transportation duration was estimated at 23,576 min, resulting in an active travelling-related time benefit of 4 days 21 h and 43 min. The financial benefit was estimated to be between 125,620 and 177,120 ¥. Additionally, an increase of 6.8 ml/kg/min in maximal oxygen consumption was noted.

Conclusion: In addition to improvement in physical fitness, adopting active travelling habits seem to induce significant time and financial benefits. Larger scale intervention studies are needed. Communicating on active travelling co-benefits may be a promising physical activity promotion tool.

Keywords: Active travel, active commuting, bicycle, active lifestyle

Introduction

Active travelling, sometimes referred as active transportation or active mobility, describes the activity of moving by using transportation means that require the traveler to be physically active, e.g., walking, cycling, and roller skating. Despite the existence of contrasting findings in the literature [1-3], one may believe that active traveling can play an important role in the prevention of non-communicable diseases by changing sedentary transportation habits into exercising habits. In urban areas, active travelling is also considered a promising option to control a number of important problems such as traffic congestion, inhabitant's exposure to pollutant agents, and noise pollution.

A bicycle is commonly viewed as one of the most suitable active transportation means, especially in flat or less hilly areas. Therefore, an increasing number of cities are integrating bicycle lanes and bicycle sharing services in their transportation networks [4-5]. Policies implementing negative or positive financial incentives have also been tested in different locations and might be considered as an option to promote active travelling at larger scales [6]. At the individual level, such short-term rewards may indeed be more effective than the more distant health-related benefits, yielding easier behavioral changes.

Several studies have been interested in active commuting habits in Japan [7]. Some of these investigated the interaction with the built environment, while others showed a reduced risk for non-communicable diseases in active commuters [8]; however, possibly due to the complexity of conducting an intervention study on this subject, no report has yet described the potential time and financial related benefits of active travelling, in particular in the Tokyo Metropolitan area. The present report explores the health, time, and financial benefits of active travelling for one inhabitant of the Tokyo metropolitan area, who switched from sedentary public transportation to a systematic usage of bicycle. The observation period was 11 months.

Method

The case, data extraction process, and data analysis method have been described further in the supplementary file.

The subject was a healthy 32-year-old Caucasian man living and working in two different wards of the Tokyo 23 metropolitan area. The subject declared to have progressively switched from an active to sedentary lifestyle in the course of his twenties. He reported no regular physical activity in the 6-year period preceding the observation period and had never been diagnosed with any chronic disease. At the beginning of the observation period, the subject presented a BMI of 24.6kg/m^2. On April 2013, he bought a one-gear 27-inch utility bicycle (commonly called "mamachari") and decided to systematically use it to travel within the Tokyo Metropolitan area. He registered all the bicycle travels, which he would otherwise have done using public transportations, in the GPS-based smartphone application Runkeeper (FitnessKeeper, MA, USA) from May 12th 2013, to March 31st 2014. He agreed to share this 11-month travel record. The Ethical Committee of the Ochanomizu University for Biomedical Research has approved the study protocol (ref: 2018-3). The subject gave his written consent to participate to the study. The data extraction and treatment have been explained in detail in the supplementary file.

For each travel, a cost estimation of the same route using public transportations was performed. First, a "low price" estimation was done by selecting the cheapest route suggested by Google Map. If the latter included walking segments lasting more than 20 minutes, a second estimation was performed to match a more "natural use" of public transportations. The sum of all "low price" estimations represents the minimal saving that can be expected by travelling actively for an 11-month period in the Tokyo metropolitan area. In order to reflect a more realistic expectation of pecuniary benefits, the previous calculation was also majored by incorporating the difference between "natural use" and "low price" estimations when relevant. In addition, the duration of each travel was subtracted to compute the estimated duration of the fastest corresponding public transportation route suggested by Google Map. The sum of these differences represents a conservative estimation of time gain that is possibly achievable by travelling actively for an 11-month period in the Tokyo metropolitan area.

Finally, the subject reported the results of two ergo-cyclometer ramp tests, which were performed in December 2012 and April 2014, at the same location. These tests provided body weight and maximal oxygen consumption data measured before and after the observation period.

Results

Data quality

Of the 659 entries identified on the Runkeeper application for the 11-month observation period, 574 were used for the estimation of public transportation costs, while 556 were used for the comparison between bicycle and public transportation durations. More details about the treatment of corrupted data and data quality results can be found in the supplementary file.

Travelling habits

Over the 11-month observation period, the subject completed 574 active travels. Of the 556 entries where distances were available, it has been determined that the subject completed a total of 3,959 km. The application reported an average speed of 14.9 km/h. Ninety-nine percent of travels were completed inside the Tokyo 23 special wards area. Travels shorter than 5 km, between 5 and 10 km, and over 10 km accounted for 18, 78, and 4% of the active travelling time, respectively. The longest recorded travel was 20.0 km. The longest distance travelled in one day was 40.1 km. The commuting route was typically covered a distance of 8 to 9 km, and it accounted for 66% of the active travelling time. It consisted of 1) small roads with low traffic in high density residential areas (Fig. 1A, 62% of the route), 2) multilane boulevards with higher traffic (Fig. 1B, 22% of the route), and sidewalks with bicycle lanes (Fig. 1C 16%). The average elevation was 93 m. Thus, a typical working day consisted of about 17 km. The Runkeeper application reported an average speed of 15.3 km/h for all the commuting travels, resulting in 1 h 07 min of moderate to vigorous physical activity per working day. Other recurrent routes included visits to the nearest commercial district, community center, children's school, etc.

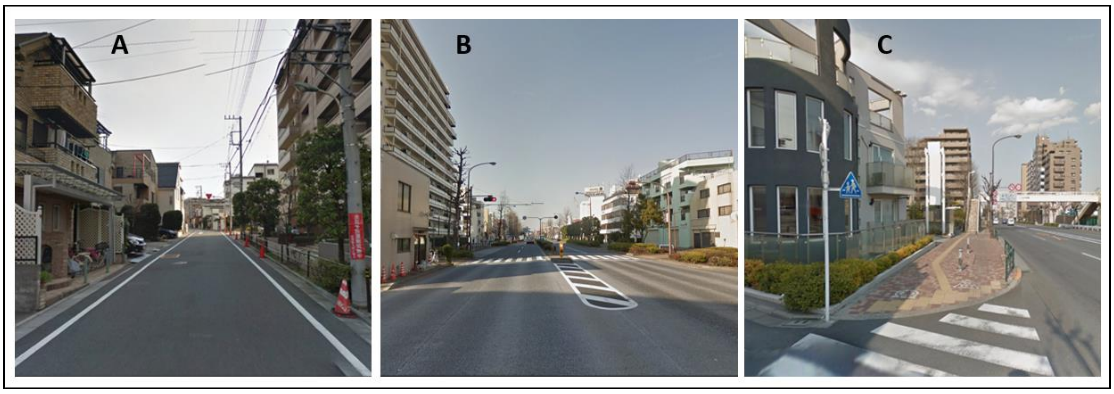

Figure 1. A. An example of small roads found in Tokyo high density residential areas. B. An example of multilane boulevards found in Tokyo. C. An example of sidewalk integrating both walking (left) and bicycle (right) lanes. Taken from Google Street View (under the fair use agreement).

Time benefits

Over the 11-month observation period, the subject spent a total of 16,513 minutes (or 11 days 11 h 13 min) in active travelling. The corresponding public transportation duration was estimated at 23,576 min (16 days 8 h 56 min) resulting in a time benefit of 7,063 min (4 days 21 h 43 min). More details on the active travelling-related time benefits have been presented in Table 1.

Table 1. Estimated time and pecuniary benefits of active travelling in Tokyo

	N	Time (min)		N	Cost (¥)	
Travels		Fastest public transportation	Bike		Route 1	Route 2
All	556	23,576	16,513	574	176,730	125,620
Commuting	343	15,744	10,935	343	111,520	65,210
Non-commuting	214	7,832	5,578	231	65,210	60,020
< 5km	131	3,771	2,461	131	27,560	23,890
5–9.9km	402	18,399	12,900	419	132,550	86,410
≥ 10	24	1,406	1,153	24	12,000	11,230

In total, 574 travels were identified and used for the public transportation cost estimation. Only 556 of them with properly recorded or recovered time and distance data were used for the time estimation shown in this table. Route 1: Cheapest route suggested by Google Map, which may include travels with over 20 min walking segments (referred in the text as "low price" estimation); Route 2: Cheapest route suggested by Google Map that excludes travels with over 20 min walking segments (referred in the text as "natural use" estimation).

Pecuniary benefits

According to the "low price" estimation, the completion of the 574 travels using public transportations corresponding to the 574 active travels would have cost 125,620 ¥. The "natural use" estimation indicated a cost of 177,120 ¥. Thus, the pecuniary benefits that can be expected from an 11-month period of active travelling in the Tokyo Metropolitan area would be somewhere between 120,000 and 180,000 ¥. More details on the active travelling-related pecuniary benefits have been shown in Table 1.

Changes in physical fitness

The maximal oxygen consumption capacity of the subject increased by 6.8 points (43.7 to 50.5 ml/kg/min) between December 2012 and April 2014. During the same period, the subject lost 3.0 kg (82.3 to 79.3).

Discussion

The present case allowed a quantitative estimation of some co-benefits of active travelling in the Tokyo metropolitan area, Japan. Over the 11-month observation period, the subject was able to 1) reduce his transportation time by 4 days 21 h 43 min, 2) save a minimum of 125,620 ¥ on transportation fees, and 3) improve his overall physical fitness with a 6.8-point gain in VO_2 max and a 3.0 kg weight loss.

The time benefit observed in the present study may be considered a minimal estimation. First, the duration of corrupted entries were replaced by the average duration of similar travels completed in the same direction plus one standard deviation (see supplementary file), resulting in conservative figures for 140 of the 556 bicycle travels. Second, 18 missing travels could not be retrieved and were consequently not included in the estimation. It is therefore likely that the actual time benefit significantly exceed 5 days, which represents a considerable amount of time in one of the most holiday-deprived nations among the developed countries.

The pecuniary benefits have been estimated between 125,620 and 176,730 ¥, which, in the Tokyo Metropolitan area, would be equivalent to a 1 to 1.5 months' rent for a 3–4-member family. While these figures may be lowered relative to the cost of a brand new mamachari-type bicycle (which costs 12,000–24,000 ¥), maintenance fees (7,000 ¥), and parking fees (6,300 ¥), the overall picture suggests that adopting active travelling habits could contribute to a better work-life balance, not only by making more time available for leisure or family activities, but also by providing the necessary funding for these activities.

Finally, the 3.0 kg weight loss and 6.8-point increase in VO_2 max observed in the present case certainly represent promising outcomes for the active travelling enthusiasts who are willing to maintain a healthy lifestyle. According to Laukkanen et al. [9], such an improvement in physical fitness would reduce the risk of mortality by 50% for all the causes of mortality. In addition, bicycling is usually categorized as a moderate-to-vigorous physical activity [10], and bicycling for a distance similar to the commuting route of the present case would help fulfill most of the World Health Organization (WHO) recommendations for daily physical activity (WHO).

Limitations

First, the case study design does not allow us to make overall conclusions on the co-benefits of active travelling, not even in the Tokyo Metropolitan area. The subject's VO_2 max at the beginning of the observation period (43.7 ml/kg/min) may reflect a good aerobic capacity, and individuals with lower physical fitness may not be able to maintain a similar pace. In addition, active commute was the most important contributor to the time gain (-4,805 min, cf. Table 1) and the present observations cannot prevail for cases where the commuting routes may present a different profile (shorter or longer distance, higher elevation, higher proportion of small roads in high density residential areas, etc.). Second, while the safety issue is a recurrent focus in studies on active travelling, the present report did not address this dimension [11]. Para-data from interviews with the subject indicated his willingness to maintain a high pace during travels without compromising with the traffic code. However, this subject has been a victim of one collision with another bicycle while he was walking with his own bicycle in a parking lot area. He reported no physical damage. Finally, the subject also admitted to feeling at risk when riding on multilane boulevards. Third, one may believe that the improvement in physical fitness could have been induced by some structured exercise activities performed during the observation period. Apart from active travelling activities, the subject declared that he did not engage in regular exercise habits. Only, 30 leisure running activities were registered in the application. They consisted of sessions comprising 2.1 to 14.6 km runs (average distance: 7.4 km), a significant part of which were completed during holiday periods (summer and winter). While the contribution of these 30 running activities to the increase in maximal oxygen consumption capacity cannot be overlooked, the overall picture of the present case would suggest that the 574 active travels performed by bicycle also had significant impact.

To summarize, the present case study aimed at offering insight on possible individual-level co-benefits of active travelling in the Tokyo Metropolitan area. Over a nearly 1-year period of active traveling, the subject gained approximately 5 days equivalent to the transportation time, saved over 120,000 ¥ on transportation fees, and significantly improved his physical fitness. Communicating on time and financial co-benefits could be a powerful individual-level promotion tool. The present results should encourage researchers to design large scale studies investigating individual-level factors that would favor active travelling behaviors in Japanese people.

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Supplementary file available at:

http://www.eng.ocha.ac.jp/Tripette_Site/Tripette&Ohta2018_Suppl.pdf