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Travel mode, transportation-related physical activity, and risk of overweight in Taiwanese adults

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ABSTRACT

Background: Whether active travel and public transportation, as opposed to private vehicle use, are related to physical activity levels and the risk of overweight in Asian countries is unclear. Thus, this study examined the associations of transportation-related physical activity involving three modes of travel and the risk of overweight among Taiwanese adults.
Methods: Data from 51,949 Taiwanese adults were used. The examined variables were objectively-measured height and body mass, self-reported main mode of travel (private vehicle, public transport, active travel), and time spent walking and cycling for transportation using the International Physical Activity Questionnaire-long version. Logistic regression modeling was performed.
Results: After adjustment for potential confounders, public transportation and active travel were found to be significantly associated with a higher probability of engaging in 150 min/wk of transportation-related physical activity (odds ratio (OR)=2.35, 95% confidence interval (CI): 2.21, 2.49; OR=6.31, 95% CI: 5.95, 6.69) and a lower risk of overweight (OR=0.84, 95% CI: 0.79, 0.90; OR=0.83, 95% CI: 0.78, 0.88) compared with traveling by private motor vehicle. Similar patterns were observed in men and women.
Conclusions: Using public transport might be as effective as active transportation to accumulate transport-related physical activity to achieve health-enhancing level and to be associated with lower odds of being overweight in Taiwanese adults. Encouraging public transportation use could promote physical activity and be considered a promising method of preventing overweight in both men and women.

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1. Background

Physical inactivity has been found as a risk factor of mortality and noncommunicable diseases such as cardiovascular disease, type 2 diabetes, and certain types of cancer (Haskell et al., 2007; WHO, 2012). However, nearly 50% of Taiwanese adults fail to meet the minimum health-enhancing physical activity level (Bauman et al., 2009). Moreover, the prevalence of overweight (body mass index (BMI) $\geq 24\ kg/m^2$) in Taiwanese adults was estimated at 38.3% in 2013 (Ministry of Health and Welfare of Taiwan, 2013). Developing effective strategies to encourage Taiwanese adults to engage in sufficient physical activity and prevent obesity is thus a priority.

Traveling is a habitual behavior, and many means of travel can be used in daily life. Various modes of travel (walking, cycling, public transportation use, and private vehicle use) have been found to be related to physical activity levels and health outcomes (Wanner et al., 2012; McCormack and Virk, 2014; Rissel et al., 2012). Research has shown that active travel through walking and cycling is related to increased physical activity (Wanner et al., 2012) as well as decreased risks of cardiometabolic health and all-cause mortality (Wanner et al., 2012; Furie and Desai, 2012; Kelly et al., 2014), and active travel also protects the environment (Merom et al., 2008; Woodcock et al., 2009).

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However, an increasing number of studies have also indicated that increased time and distance traveled in a motor vehicle are associated with higher risks of obesity (McCormack and Virk, 2014), cardiovascular disease death (Warren et al., 2010), unhealthy lifestyles (Ding et al., 2014), and weight gain (Sugiyama et al., 2013). Recently, another travel mode, public transportation, which involves walking and cycling to and from bus stops or train stations and some sitting time during transportation, has been reported as a promising way to increase physical activity (Rissel et al., 2012) and satisfy physical activity recommendations (Villanueva et al., 2008; Wener and Evans, 2007), as well as prevent disease (Laverty et al., 2013). However, previous studies that have addressed the effectiveness of public transportation use in increasing physical activity have been limited in several crucial areas. First, most of these studies have focused on the associations between commuting to work or university and the risk of overweight (Flint et al., 2015; Laverty et al., 2013; Millett et al., 2013; Martin et al., 2015; Wen and Rissel, 2008) or physical activity level (Villanueva et al., 2008) but have not considered other travel purposes (including short trips for purposes such as shopping and leisure) among adults. Second, several studies have focused on only one travel mode (Furie and Desai, 2012; Ding et al., 2014; Sugiyama et al., 2013) or two travel modes (Villanueva et al., 2008; Wener and Evans, 2007; Badlanda and Schofielda, 2008) among adults, but a limited number of studies have compared three travel modes encompassing active travel, public transportation, and private vehicle travel. It is useful to understand whether public transportation use (incidental physical activity) and active travel (continuous physical activity) are related to physical activity levels and the risk of overweight compared with private vehicle use. Third, most previous studies have been conducted in Western countries. More evidence on adults' travel behavior in Asian countries, which may vary from that in Western countries because of differences in population density, culture, and environment, is needed to promote public health and prevent disease. Understanding whether active travel and public transportation, as opposed to private vehicle use, are related to physical activity levels and the risk of overweight in Asian countries is thus crucial.

As in the United States (McKenzie and Rapino, 2011), United Kingdom (Laverty et al., 2013), and Australia (Australian Bureau of Statistics (ABS), 2009), most Taiwanese adults (71.8%) use a private motorcycle or car as a main mode of traveling to work and other destinations, and only 17.2% and 10% of adults use public transportation and walking or cycling as main traveling modes, respectively (Ministry of Transportation and Communication, 2014). To encourage adults to engage in sufficient physical activity and prevent overweight, increasing knowledge regarding the association of various travel modes with time spent engaging in transportation-related physical activity and the risk of overweight is thus critical. This study hypothesized that (1) public transportation travel may be as effective as active travel for accumulating 150 min of incidental transportation physical activity per week and (2) if so, negative associations could exist between public transportation travel and the risk of overweight. (3) The aforementioned associations may differ by gender because gender differences between travel mode and physical activity or overweight risks have been revealed (Wen and Rissel, 2008; Gordon-Larsen et al., 2009). Thus, this study thus aimed to examine associations among three travel modes involving transportation-related physical activity and the risk of overweight in Taiwanese adults.

2. Methods

2.1. Participants

The National Adult Fitness Survey in Taiwan was designed by the Ministry of Education for the purpose of investigating health-related physical fitness performance in adults. Participants in our study were recruited using convenience sampling at 35 test stations in 22 cities and counties. Potential survey participants were approached by staff at each test station, and a combination of advertisements, posters, and direct mail was also used to recruit participants. A total of 87,684 Taiwanese adults aged 20–65 years were recruited to participate in this survey. After the physical fitness test, a standardized questionnaire on traveling behavior was administered to the participants by trained interviewers; each participant answered the questionnaire voluntarily. Finally, 62,955 adults participated in the physical fitness tests and completed the questionnaire (response rate: 71.8%). A gift with a value of approximately US$3 in 2013 was offered to each participant who completed the test and questionnaire. This study was approved by the Institutional Review Board of the Department of Physical Education, Ministry of Education, Taiwan, and written informed consent was obtained from each participant.

2.2. Outcome variables

The outcome variables included BMI and time spent engaging in transportation-related physical activity. For BMI, height and body mass were measured by nationally certified examiners by using standardized electronic scales and wall-mounted tape measures. BMI was calculated as body mass (kg) divided by height squared (m^2), and participants were classified into nonoverweight (<24.0 kg/m^2) and overweight (≥ 24.0 kg/m^2) according to Asian cutoff points (Health Promotion Administration, Ministry of Health and Welfare Taiwan, 2012). For transportation-related physical activity, information regarding time spent walking and cycling for transportation were obtained from the Taiwanese version of the International Physical Activity Questionnaire (long version) (IPAQ-LV), which has been widely used in telephone-based surveys (Reis et al., 2013; Parra et al., 2011). This exhibited high test–retest reliability ($r=0.78$) and acceptable criterion validity ($r=0.31$–0.41) compared with accelerometers (Liou et al., 2008). The second part of the IPAQ-LV was used to measure the frequency (number of days in the previous 7 days) and duration (minutes per day) of engaging in "walking for transport" and "cycling for transport". The total time spent engaging in transportation was calculated by multiplying frequency of transportation per week by duration of transportation per day. The total time spent walking and cycling for transportation was categorized according to the recommendation for physical activity and health (satisfying 150 min/week) by the World Health Organization (Haskell et al., 2007; WHO, 2012).

2.3. Exposure variables

The exposure variable is categorized as travel mode. Respondents were asked to choose their main mode of travel to various destinations such as work, shopping centers, and movie theaters. Participants could select the following as their main mode of travel: (1) private vehicles (i.e., private cars or motorcycles), (2) public transportation (i.e., buses, mass rapid transit, rail, and high speed rail), or

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