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Active commuting to and from school among 106,605 adolescents in 27 Asia-Pacific countries

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ABSTRACT

Introduction: Active school commuting (ASC) can be a promising strategy to promote physical activity among the Asia-Pacific adolescents. This study examined the prevalence of ASC by age, sex, and country income among adolescents from the Asia-Pacific region.
Methods: Data from the Global School-based Student Health Survey, collected between 2007 and 2016, from 27 Asia-Pacific countries, were analysed. Country-specific weighted prevalence of ASC (defined as walking or bicycling to and from school on ≥3 days/week) were computed. Pooled estimates of ASC were computed using random effects meta-analysis. Spearman correlational analysis was used to assess association of ASC prevalence with common global indices.
Results: Data were available for 106,605 adolescents (mean age 14.7 [SD 1.28] years, 52.0% male). Overall, the pooled prevalence of ASC was 42.1% (95% CI 36.7-47.6). The highest prevalence of ASC was in Vietnam and lowest in Timor Leste with six countries reporting the prevalence > 50.0%. Males had significantly higher odds of using ASC than females in seven countries, while females had significantly higher odds in two countries. Compared to younger adolescents (13–15 years), older adolescents (16–17 years) had significantly higher odds of using ASC in six countries, and lower odds in seven countries. The pooled prevalence of ASC was 48.9% (40.9-56.9) in lower-income-, 33.3% (29.4-37.2) in upper-middle-income- and 27.4% (13.7-41.1) in high-income-countries. Prevalence of ASC was negatively associated with country's Gini coefficient (rho = −0.50, p = 0.04).
Conclusions: Across the Asia-Pacific region, two out of five adolescents engaged in ASC with large variability between the countries as well as by age and sex. Future research should examine multiple factors that influence cross-country variations in adolescents' ASC, which can inform country-specific interventions and policies to promote ASC in the Asia-Pacific region.

1. Introduction

Physical activity is well-established as a health-enhancing behaviour for children and adolescents (Poitras et al., 2016). Participation in regular physical activity is associated with improved cardio-metabolic health, better musculoskeletal health, weight maintenance, and increased psychosocial wellbeing of children and adolescents (Poitras et al., 2016; Rhodes et al., 2017; Whooten

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et al., 2019). Based on the demonstrated relationships between physical activity and health outcomes, the World Health Organization (WHO) recommends ≥60 min/day of moderate-to-vigorous intensity physical activity for children and adolescents aged 5–17 years (Rhodes et al., 2017). Globally, however, four out of five (81%) adolescents aged 11–18 years do not meet these recommendations and are insufficiently active (Aubert et al., 2018a; Rhodes et al., 2017).

Active school commuting (ASC; e.g., walking and/or bicycling to/from school) can contribute towards attaining the recommendations of physical activity by integrating ASC into children and adolescents' daily routine (Larouche et al., 2014; Schoeppe et al., 2013; Voss, 2018; Xu et al., 2013). According to a recent meta-analysis, ASC accounts for 23–36% of the daily physical activity in children and adolescents (Martin et al., 2016). Recent findings showed that adolescents using ASC accumulated 39.8% of daily physical activity during the school commute time (Kek et al., 2019). Convincing evidence suggests that children and adolescents who use active commuting are more likely to be physically active than those who rely on motorised (passive) forms of transport (Kek et al., 2019; Larouche et al., 2014; Schoeppe et al., 2013; Voss, 2018). Additionally, ASC may promote independence, development of social skills (Carver et al., 2011), and positive emotional experiences during school commute time in children and adolescents (Ramanathan et al., 2014).

Participation in ASC is low in many countries worldwide (Aubert et al., 2018a, 2018b; González et al., 2018; Manyanga et al., 2018). A study of 72,845 schoolchildren across 34 countries reported that less than 50% of male adolescents in 13 countries and female adolescents in 16 countries used ASC for at least one day of the week (Guthold et al., 2010). Using a different definition of ASC for at least 3 days a week, a recent study with adolescents aged 11–18 years in 26 Latin American and the Caribbean countries reported the ASC prevalence of 42%, with 23 countries reporting a median of < 3 days/week (Aguilar-Farias et al., 2018).

Studies conducted in developed countries reported that a variety of factors such as age, sex, and socioeconomic status are associated with ASC among adolescents. Several studies have found that a greater proportion of younger versus older adolescents (Fulton et al., 2005; Mandic et al., 2015; Pabayo et al., 2011) and male versus female adolescents use ASC (Babey et al., 2009; Nelson et al., 2008; Potoglou and Arslangulova, 2017). While low socioeconomic status such as low family income has been associated with higher rates of ASC (Babey et al., 2009; McDonald, 2008), other socioeconomic status indicators such as parental education or employment were not associated with ASC (Evenson et al., 2003; Timperio et al., 2006). However, only a handful of studies from developing countries examined the rates of ASC by age, sex, and socioeconomic status (Ermagun and Samimi, 2015; Li and Zhao, 2015).

Many of the countries in the Asia-Pacific region are characterised by growing urbanisation, increased use of technology (Pawar, 2017), and a rapid growth in motorisation (Leung et al., 2017), which may limit the opportunities for active commuting. Though the prevalence of insufficient physical activity among adolescents in Asia-Pacific countries is high, ranging from 73% in South-East Asian countries to 85.0% in Western Pacific countries (Darfour-Oduro et al., 2018; Rhodes et al., 2017), little is known about the prevalence of ASC across this region with the exception of data from Australia (Schranz et al., 2018) and New Zealand (Smith et al., 2018). Understanding the local context and cross-country differences in adolescents' ASC patterns is essential to inform development of policies and programs to promote ASC and ultimately increase physical activity levels among adolescents in the Asia-Pacific region. The aim of the present study was to assess the prevalence of ASC by sex and age groups, and examine the association of ASC with global indices (e.g., human development index, Gini coefficient) among adolescents from 27 Asia-Pacific countries.

2. Methods

Publicly available data from the Asia-Pacific countries that participated in the Global School-based Student Health Survey (GSHS) between 2007 and 2016 were analysed (World Health Organization, n.d.). The GSHS is a population-based survey of school-going children and adolescents around the world. The GSHS uses the same standardised sampling technique, study methodology, and the same self-administered anonymous questionnaire in all participating countries.

The GSHS questionnaire included 10 core modules that address the leading causes of morbidity and mortality among school-aged children and adolescents and adults worldwide. The survey participants completed a self-administered anonymous questionnaire, which included, but was not limited to, questions on demographics (e.g., age, sex), and physical activity behaviours including active commuting to and from school.

As of 31 January 2019, 30 Asia-Pacific countries/territories had at least one GSHS dataset publicly available with the surveys being conducted between 2007 and 2016 (World Health Organization, n.d.). For countries that had more than one GSHS dataset, the most recent dataset available was used in this study. Of the 30 countries, 27 had ASC data in the GSHS with 106,605 adolescents aged 13–17 years completing the ASC item of the survey, and thus formed the analytical sample for these analyses. All countries provided nationally representative samples.

The GSHS received ethics approval from the Ministry of Education or a relevant Institutional Ethics Review Committee, or both in each of the participating countries. Only those adolescents and their parents who provided written or verbal consent participated. As the current study used retrospective, de-identified, publicly available data, ethics approval was not required for this secondary analysis.

2.1. Active commuting to and from school

ASC was assessed using the question: 'During the past 7 days, on how many days did you walk or ride a bicycle to and from school?' with response options being: 0 to 7 days. Students were classified as 'active transport' users if they rode or walked to and from school on at least three days during the past 7 days, in accordance with previous research (Aguilar-Farias et al., 2018).

2.2. Other measures

Adolescents self-reported age and sex in the survey. World Bank country classification, at the time of the survey for the respective countries, was used to group the countries into three income categories (i.e., low- and lower-middle income, upper-middle income, and high-income) (World Bank, n.d.). Of the 27 countries, 16 were classified as low- and lower-middle income, seven as upper-middle-income, and three as high-income economies. French Polynesia and Wallis and Futuna were considered as high-income countries as those island nations are overseas collectivities of the French Republic, which is a high-income country. Information on Cook Island's income classification was not available (supplementary Table e1).

Country-level data on the Human Development Index (2007-16 data; a higher score represents a greater human development) (United Nations Development Programme, n. d.-c), Gender Inequality Index (2005–2016 data; a higher score represents greater gender inequality) (United Nations Development Programme, n.d.-b) and the Gini coefficient (2010-15 data; a higher coefficient represents greater income inequality) (United Nations Development Programme, n.d.-d), and expenditure on health (total health expenditure as percentage of GDP, 2005–2015 data) (United Nations Development Programme, n.d.-a) were collected. The Human Development Index and Expenditure on health were available for 22 countries (data were not available for Cook Island, French Polynesia, Nauru, Tuvalu, and Wallis and Futuna). The Gini coefficient was available for 20 countries (data not available for Brunei Darussalam, Cambodia, Cook Island, French Polynesia, Nauru, Tuvalu, and Wallis and Futuna). The Gender Inequality Index was available for 18 countries (data not available for Cook Island, French Polynesia, Kiribati, Nauru, Solomon Islands, Timor Leste, Tuvalu, Vanuatu, and Wallis and Futuna).

2.3. Statistical analyses

The analysis was restricted to adolescents aged 13–17 years as all the GSHS participating countries have data in this age range (World Health Organization, n.d.). Participants with missing data for sex, age, and ASC were excluded from the analyses. To examine the potential for these missing data to bias the findings, logistic regression was used to compare demographic characteristics between adolescents with and without the missing data. For each country, ASC data were summarised by using median and inter-quartile range. Country-wise weighted estimates of the prevalence of ASC and their 95% confidence interval (95% CI) were computed by sex and age group (13–15 vs 16–17 years), by taking into account the weighting factor that was applied to each participant record to adjust for non-response and the varying probability of selection. This weighting factor was applied in an identical way to estimate the outcome variables of interest in each country where the GSHS was conducted. Within the GSHS protocol, weighting accounted for the probability of selection of schools and classrooms, non-responding schools and students, and distribution of the population by sex and grade.

Random effects meta-analysis with the DerSimonian and Laird inverse-variance method (Sterne, 2009) was used to generate pooled estimates of overall prevalence of ASC and the prevalence by country's income category (e.g., low- and lower-middle income, upper-middle income, and high-income). *metaprop*, a Stata meta-analysis routine for binary outcomes, was used to estimate the pooled prevalence with exact method to compute the 95% CI for the estimates. Possible sex and age group differences on ASC were also examined by using logistic regression with weights for each country separately. Spearman correlational analysis was used to assess how prevalence of ASC was associated with common global indices.

3. Results

Among adolescents in this sample (n = 106,605) the mean age was 14.7 (SD = 1.28; range 13-17) years and 52.0% were males. Descriptive characteristics, including survey year, response rate, sex, and age distribution for each of the Asia-Pacific countries included in the analysis are presented in supplementary Table e1. No significant differences in demographic characteristics were observed between adolescents with complete data and those excluded because of missing data.

Overall, the median days adolescents used active transport to and from school was 2 days for males and 1 day for females (supplementary Table e1). Two out of five adolescents in the participating countries used active transport to and from school at least 3 days/week with weighted pooled prevalence being 42.1% (95% CI 36.7-47.6) (Table 1). In six countries (Bangladesh, Cambodia, Mongolia, Myanmar, Vanuatu, and Vietnam), over 50% of the adolescents reported using active transport to and from school on at least 3 days/week with Vietnamese adolescents having had the highest prevalence of 73.9% (72.3-75.4) (Fig. 1). The three countries with the lowest prevalence of ASC (Brunei Darussalam, Timor Leste, and Tuvalu) reported that less than a fifth of their adolescents used active transport to and from school on at least 3 days/week with the lowest prevalence in the Timor Leste (16.5%, 15.1-17.9).

The prevalence of ASC on at least 3 days/week was 40.8% (34.9-46.7) among females and 43.1% (37.7-48.4) among males (Table 1). However, significant sex differences were observed in a third (n = 9) of the countries with greater prevalence of ASC among female adolescents in two countries (Mongolia and the Philippines) and greater prevalence of ASC among male adolescents in seven countries (Bangladesh, Brunei Darussalam, India, Malaysia, Nepal, Pakistan, and Timor Leste) (Table 2). For example, female adolescents in Mongolia had 46% higher odds of using ASC compared to their male counterparts (OR 1.46, 95% CI 1.28-1.66). In contrast, in Pakistan female adolescents had one-third the odds of using ASC (0.34, 0.29-0.39), which means that male adolescents in Pakistan had three times higher odds of using ASC than their female counterparts.

When data were analysed by age group, 41.7% (35.8-47.7) of the older adolescents (aged 16–17 years) reported using ASC compared to 43.0% (37.5-48.4) for younger adolescents (aged 13–15 years) (Table 1). About half (13/27) of the countries demonstrated mixed age differences in the use of ASC (Table 2). Compared to younger adolescents, older adolescents had higher odds of

Table 1
Prevalence of active school commuting (≥3 days/week) among adolescents across the Asia-Pacific countries, by country income, sex, and age, 2007–2016.

Country	Males % (95% CI)	Females % (95% CI)	Younger (13–15 years) % (95% CI)	Older (16–17 years) % (95% CI)	Overall % (95% CI)
Lower-middle income countries					
Bangladesh	62.8 (60.0-65.6)	52.2 (49.7-54.6)	59.1 (57.1-61.0)	66.4 (59.7-72.6)	59.1 (57.2-60.9)
Cambodia	55.7 (53.0-58.5)	60.1 (57.7-62.6)	59.3 (57.0-61.7)	56.9 (53.9-59.9)	57.7 (55.9-59.6)
India	50.7 (49.1-52.2)	43.2 (41.4-45.0)	47.6 (46.4-48.9)	53.4 (49.4-57.3)	47.5 (46.4-48.7)
Indonesia	33.1 (31.7-34.6)	31.8 (30.5-33.2)	34.2 (33.1-35.3)	26.4 (24.4-28.4)	32.4 (31.4-33.4)
Kiribati	41.6 (37.8-45.5)	39.2 (35.9-42.6)	40.2 (37.5-43.0)	44.0 (37.3-50.9)	40.2 (37.8-42.8)
Laos	36.5 (34.2-38.9)	39.6 (37.4-41.8)	39.0 (36.7-41.5)	37.3 (35.1-39.4)	37.8 (36.2-39.4)
Mongolia	66.9 (64.8-68.9)	74.6 (72.8-76.4)	69.5 (67.8-71.1)	73.9 (71.5-76.1)	70.8 (69.5-72.1)
Myanmar	69.5 (66.9-72.0)	68.7 (66.0-71.2)	70.0 (67.9-72.0)	68.6 (64.5-72.4)	69.1 (67.2-70.9)
Nepal	48.6 (46.7-50.5)	41.5 (39.7-43.3)	45.6 (44.0-47.1)	47.3 (44.8-49.8)	44.6 (43.3-45.9)
Pakistan	59.9 (58.3-61.5)	33.1 (30.5-35.8)	49.5 (48.1-50.9)	56.0 (48.1-63.6)	49.5 (48.1-50.9)
Philippines	34.5 (32.9-36.1)	36.9 (35.5-38.4)	34.4 (33.2-35.7)	40.3 (38.2-42.4)	35.7 (34.6-36.8)
Solomon Islands	33.7 (30.0-37.6)	34.6 (30.7-38.6)	33.3 (30.1-36.6)	34.3 (29.5-39.4)	34.1 (31.4-36.9)
Sri Lanka	50.7 (47.6-53.8)	48.7 (45.9-51.5)	50.9 (48.8-53.0)	38.8 (28.1-50.3)	49.7 (47.6-51.7)
Timor Leste	19.7 (17.5-22.1)	13.3 (11.7-15.2)	15.1 (13.2-17.0)	18.0 (16.0-20.2)	16.5 (15.1-17.9)
Vanuatu	64.5 (59.5-69.4)	64.7 (60.3-68.9)	65.0 (61.4-68.6)	72.9 (65.6-79.5)	64.4 (61.1-67.6)
Vietnam	73.5 (71.1-75.8)	74.3 (72.1-76.4)	78.2 (76.2-80.1)	69.2 (66.6-71.7)	73.9 (72.3-75.4)
Pooled prevalence	50.1 (42.5-57.7)	47.3 (38.4-56.2)	49.4 (41.7-57.2)	50.2 (40.7-59.7)	48.9 (40.9-56.9)
Upper-middle income countries					
Fiji	34.0 (31.6-36.5)	35.8 (33.4-38.3)	32.2 (29.8-34.7)	36.0 (33.6-38.5)	35.2 (33.5-36.9)
Malaysia	39.8 (38.9-40.7)	38.2 (37.3-39.1)	38.5 (37.8-39.3)	40.5 (39.5-41.6)	39.0 (38.4-39.6)
Nauru	36.5 (29.5-43.9)	29.9 (24.6-35.7)	36.2 (30.7-42.1)	27.4 (20.8-34.8)	32.5 (28.2-37.1)
Samoa	37.2 (33.9-40.6)	34.7 (32.0-37.4)	36.0 (33.8-38.2)	34.5 (26.7-43.1)	36.4 (34.3-38.5)
Thailand	32.5 (30.5-34.6)	33.0 (31.3-34.8)	35.7 (34.1-37.4)	29.7 (27.4-32.1)	32.8 (31.5-34.2)
Tonga	38.4 (35.3-41.6)	37.1 (34.2-40.0)	39.0 (36.8-41.3)	31.3 (25.4-37.7)	37.7 (35.6-39.8)
Tuvalu	18.3 (14.3-22.9)	18.8 (14.9-23.2)	19.1 (15.7-23.0)	15.4 (10.9-21.0)	18.5 (15.7-21.7)
Pooled prevalence	33.9 (29.5-38.3)	32.8 (29.2-36.4)	34.0 (30.5-37.5)	30.9 (24.9-36.9)	33.3 (29.4-37.2)
High income countries					
Brunei	19.9 (17.6-22.4)	14.6 (12.7-16.6)	16.0 (14.3-17.8)	21.1 (18.1-24.3)	17.4 (15.9-19.0)
French Polynesia	38.8 (36.1-41.6)	36.7 (34.1-39.3)	38.0 (35.6-40.4)	37.5 (34.4-40.6)	37.7 (35.9-39.6)
Wallis and Futuna	24.4 (20.2-29.0)	30.0 (25.8-34.5)	31.8 (27.9-35.8)	23.1 (18.4-28.4)	27.2 (24.2-30.4)
Pooled prevalence	27.7 (15.0-40.5)	27.0 (11.6-42.5)	28.5 (13.1-44.0)	27.3 (16.1-38.5)	27.4 (13.7-41.1)
Country income unclassified					
Cook Island	40.2 (34.7-45.8)	36.3 (31.1-41.8)	45.8 (40.6-51.1)	26.9 (21.8-32.4)	38.5 (34.8-42.4)
Overall	43.1 (37.7-48.4)	40.8 (34.9-46.7)	43.0 (37.5-48.4)	41.7 (35.8-47.7)	42.1 (36.7-47.6)

ASC in six countries (Brunei Darussalam, Fiji, India, Malaysia, Mongolia, and the Philippines), and lower odds in seven countries (Cook Island, Indonesia, Sri Lanka, Thailand, Tonga, Vietnam, and Wallis and Futuna). For example, the odds of using ASC was 38% higher among older adolescents versus younger adolescents in Brunei Darussalam (OR 1.38, 1.09-1.75). In contrast, the odds of using ASC was 40% lower among older versus younger adolescents in Sri Lanka (0.60, 0.38-0.97).

The prevalence of ASC decreased with the increase of country's economic status with a pooled prevalence of 48.9% (40.9-56.9) in low- and lower-middle-income countries, 33.3% (29.4-37.2) in upper-middle-income countries, and 27.4% (13.7-41.1) in high-income countries (Table 1). Male adolescents had significantly higher prevalence of ASC than female adolescents in lower-middle-income countries (51.1% vs 47.3%, $p < 0.001$) and upper-middle-income countries (33.9% vs 32.8%, $p = 0.024$). In upper-middle-income countries, younger adolescents had significantly higher prevalence than their older counterparts (34.0% vs 30.9%, $p < 0.001$).

The country prevalence of ASC in adolescents was negatively associated with the country Gini coefficient (rho = −0.50, $p = 0.04$); however, none of the other global indices was significantly associated with the prevalence of ASC (Human Development Index $p = 0.13$; Gender Inequality Index $p = 0.94$; expenditure on health $p = 0.54$; Fig. 2).

4. Discussion

In this study, the pooled prevalence of adolescents' ASC in the Asia-Pacific region was 42.1% (95% CI 36.7-47.6) with considerable variations across the countries. Similarly, the pooled prevalence of ASC by sex and age varied across countries and within countries with significant differences observed in some but not all countries. Prevalence of ASC in adolescents was negatively associated with country's Gini coefficient and decreased with the increase of country's economic status. Taken together, these findings demonstrate a large variability in the prevalence of adolescents' ASC in Asia-Pacific region as well as differences in adolescents'

Table 2
Sex and age differences in the prevalence of active school commuting across the Asia-Pacific countries, 2007–2016.

Country	N	OR (95% CI) of being female[a]	p-value	OR (95% CI) of being older[b]	p-value
Bangladesh	2,818	0.65 (0.53-0.79)	< **.001**	1.26 (0.83-1.92)	0.284
Brunei Darussalam	2,381	0.70 (0.56-0.88)	**0.002**	1.38 (1.09-1.75)	**0.009**
Cambodia	2,824	1.16 (0.98-1.38)	0.088	0.91 (0.76-1.09)	0.305
Cook Island	641	0.81 (0.58-1.13)	0.212	0.43 (0.31-0.61)	< **.001**
Fiji	2,951	1.14 (0.98-1.34)	0.098	1.19 (1.01-1.39)	**0.032**
French Polynesia	2,614	0.93 (0.79-1.10)	0.395	0.97 (0.82-1.16)	0.774
India	7,073	0.74 (0.67-0.83)	< **.001**	1.23 (1.02-1.48)	**0.032**
Indonesia	8,771	0.94 (0.85-1.04)	0.228	0.69 (0.61-0.78)	< **.001**
Kiribati	1,506	0.90 (0.73-1.12)	0.357	1.17 (0.87-1.57)	0.313
Laos	3,599	1.13 (0.97-1.30)	0.115	0.94 (0.81-1.08)	0.380
Malaysia	24,983	0.93 (0.88-0.99)	**0.025**	1.09 (1.02-1.16)	**0.011**
Mongolia	4,510	1.46 (1.28-1.66)	< **.001**	1.22 (1.06-1.41)	**0.006**
Myanmar	2,528	1.02 (0.85-1.22)	0.855	0.94 (0.75-1.16)	0.547
Nauru	455	0.71 (0.47-1.08)	0.113	0.67 (0.43-1.06)	0.086
Nepal	5,589	0.77 (0.67-0.87)	< **.001**	1.05 (0.91-1.21)	0.476
Pakistan	5,039	0.34 (0.29-0.39)	< **.001**	1.12 (0.80-1.58)	0.503
Philippines	7,776	1.12 (1.00-1.24)	**0.046**	1.29 (1.15-1.45)	< **.001**
Samoa	2,014	0.89 (0.74-1.08)	0.235	0.93 (0.64-1.35)	0.697
Solomon Islands	1,193	1.07 (0.81-1.40)	0.631	1.05 (0.79-1.40)	0.733
Sri Lanka	2,301	0.94 (0.80-1.12)	0.500	0.60 (0.38-0.97)	**0.036**
Thailand	4,856	1.08 (0.91-1.27)	0.371	0.75 (0.63-0.91)	**0.002**
Timor Leste	2,716	0.63 (0.51-0.79)	< **.001**	1.23 (0.99-1.53)	0.066
Tonga	2,048	0.94 (0.78-1.14)	0.533	0.71 (0.53-0.97)	**0.030**
Tuvalu	685	1.03 (0.69-1.52)	0.900	0.77 (0.50-1.19)	0.233
Vanuatu	865	0.90 (0.65-1.24)	0.526	1.45 (0.97-2.16)	0.069
Vietnam	3,031	1.06 (0.90-1.26)	0.484	0.63 (0.53-0.74)	< **.001**
Wallis and Futuna	838	1.25 (0.92-1.69)	0.159	0.65 (0.46-0.90)	**0.010**

Note: Values in bold indicate p-value of 0.05 or lower.
[a] Compared to males as reference.
[b] Aged 16–17 years compared to younger adolescents aged 13–15 years as reference.

environmental, and policy factors that influence adolescents' ASC behaviours (Sallis et al., 2006). Understanding ASC correlates in the local context will help inform the design and tailoring of country- and/or region-specific interventions and policies for promoting ASC and ultimately integrating physical activity into everyday life of adolescents.

This study identified significant variations in the prevalence of adolescents' ASC across the Asia-Pacific countries ranging from 73.9% in Vietnam to 16.5% in Timor Leste. Similar cross-country variations in adolescents' ASC have been previously reported across 34 countries worldwide (Guthold et al., 2010) and in 26 Latin American and the Caribbean countries (Aguilar-Farias et al., 2018). The average prevalence of ASC reported in this study is similar to the prevalence of adolescents' ASC found in Australia (Schranz et al., 2018) and New Zealand (Smith et al., 2018). ASC provides an opportunity for adolescents to accumulate physical activity (Chillón et al., 2011; Larouche et al., 2014; Saksvig et al., 2007; Schoeppe et al., 2013; Voss, 2018) and could add up to a substantial amount of weekly physical activity in this age group even if they combine active and motorised modes of transport to and from school (Kek et al., 2019).

In the current study, the pooled prevalence of ASC also varied by sex and age across Asia-Pacific countries. Significantly higher rates of ASC in females were observed in nine countries, higher rates in males in seven countries, and no significant sex differences in 11 countries. Similarly, compared to younger adolescents, older adolescents had significantly higher odds of ASC in six countries and lower odds in seven countries, whereas no significant age differences in ASC were found in 14 countries. Many studies from high-income countries reported higher rates of ASC among male versus female adolescents (Nelson et al., 2008; Potoglou and Arslangulova, 2017) and among younger versus older adolescents (Fulton et al., 2005; Pabayo et al., 2011). A recent New Zealand study reported that adolescents using ASC as part of their school journey achieved higher levels of daily physical activity measured using accelerometers compared to adolescents relying solely on motorised transport to and from school with the observed differences being mainly for adolescent females (Kek et al., 2019). Therefore, in addition to sex-related differences in the prevalence of ASC, the amount of physical activity accumulated during ASC may be different in adolescent males versus females. Country-specific efforts for encouraging ASC as a means to increase physical activity among adolescents need to focus on subgroups of adolescents who would benefit most from such interventions and programs.

Available evidence suggests a wide range of individual, social, environmental, and policy factors influence ASC in adolescents (Davison et al., 2008; Panter et al., 2008; Pont et al., 2009; Wong et al., 2011), with distance to school being one of the major determinants of ASC (Davison et al., 2008; Ikeda et al., 2018; Panter et al., 2008). In addition, factors such as parental support for ASC (Aibar Solana et al., 2018; Carver et al., 2010; Huertas-Delgado et al., 2017), built environment-related factors such as presence of footpaths and cycle lanes (Pocock et al., 2019), factors related to traffic and personal safety (Carver et al., 2005; Esteban-Cornejo et al., 2016; Hopkins and Mandic, 2017; Mandic et al., 2017a), and school policies on whether adolescents have to enrol in the closest school (Mandic et al., 2017b) differ between countries and even within the countries (such as in urban versus rural areas). These

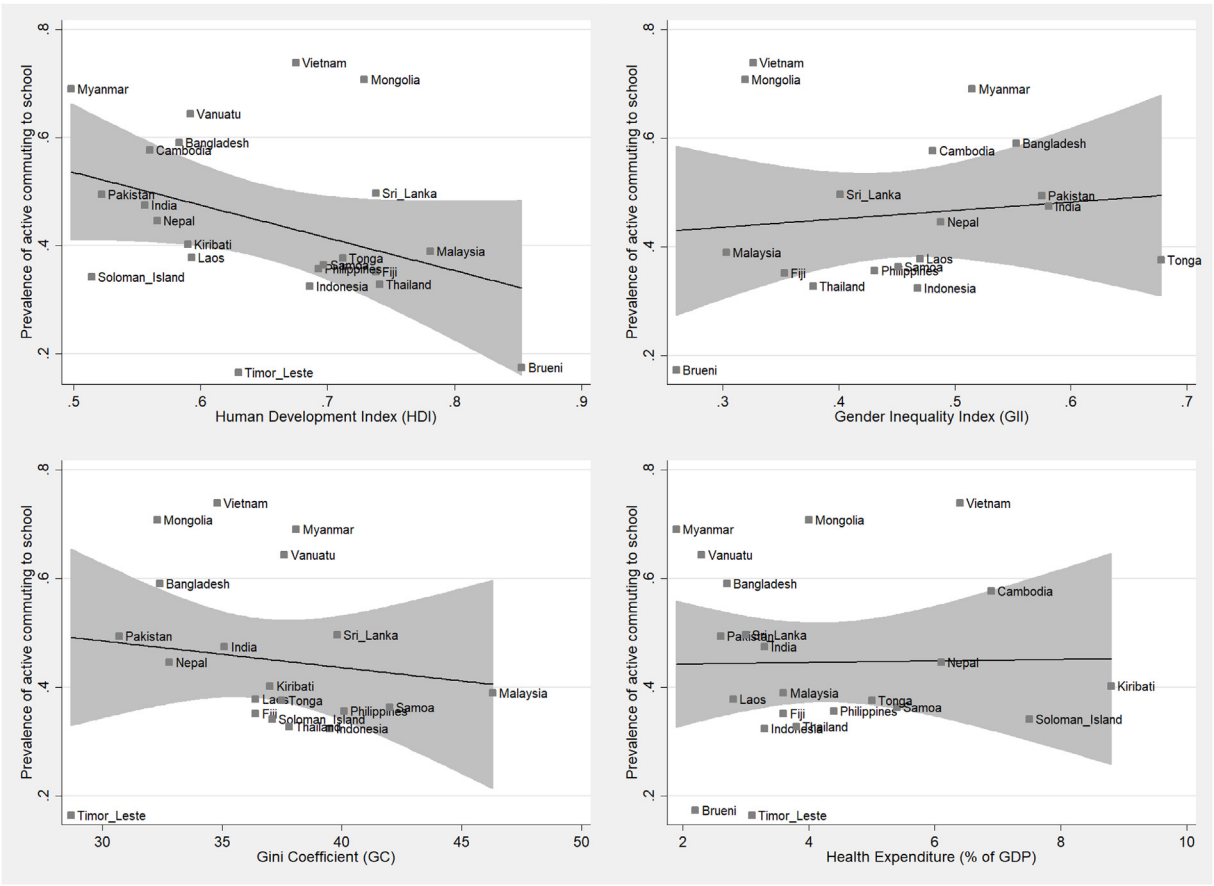

Fig. 2. Associations of prevalence of active school commuting among adolescents in Asia-Pacific countries with common global indices.

differences may contribute to cross-country variations in rates of ASC among adolescents observed in this and other studies. Additional factors such as school uniform requirements (Hopkins and Mandic, 2017), school bag weight (Mandic et al., 2018), and cycling helmet legislation (Molina-García et al., 2018) also vary across the countries and may further influence country-specific rates of ASC among adolescents. However, most of the current evidence on correlates of ASC in adolescents is available from studies conducted in high-income countries and may not be generalisable to the low- and medium-income countries or the Asia-Pacific region where ASC may often be a necessity rather than a choice (Manyanga et al., 2018).

The present study showed that the prevalence of ASC increased with a decrease of country's economic status and an increased degree of income inequality within a country (i.e., higher Gini index). These findings suggest that individual, social, environmental, and policy factors that influence ASC (and possibly their relative contributions) likely also vary by country's economic status and should be examined in LMICs (in addition to studies conducted in high-income countries). For example, cross-country differences in factors such as distance to school, availability of vehicles and bicycles at home, existence and quality of a pedestrian and/or cycling infrastructure, traffic and personal safety, and availability and affordability of public transport are at least in part influenced by countries' economic status. These findings further emphasise the need for collecting and reporting country-specific data on ASC correlates, particularly in LMICs where such data are currently lacking. Such country-specific data are fundamental to inform the design of future interventions and guide policy development efforts in LMICs to encourage ASC among adolescents.

4.1. Strengths and limitations

Study strengths include a pooled analysis with a large number of participants (n = 106,605) from nationally representative samples from 27 countries in the Asia-Pacific region. Study limitations include travel to/from school being self-reported using a single survey question, lack of data related to distance from home to school and use of public transport for school travel, and lack of GSHS data from Australia and New Zealand. Unavailability of information about characteristics of the non-respondents limited the scope of comparing respondents with non-respondents and their potential effects on the interpretation of the findings. Studies conducted in high-income countries found that socioeconomic factors such as fewer vehicles at home (Mandic et al., 2015; McDonald, 2008), and low socioeconomic status and household income (Davison et al., 2008; Pabayo et al., 2011) are associated with higher rates of ASC in adolescents. Therefore, future studies comparing ASC across different countries should examine factors related to geographical,

cultural, and socioeconomic contexts including distance to school, the availability and use of public transport, and social and built environment to understand between-country variations in ASC. Collecting information on different ASC-related factors is particularly important in LMICs in which such data may not be readily available from other sources. Understanding of country-specific factors related to the built environment and urban and social planning policies would help identify the levers for country-specific policy actions to encourage ASC among adolescents.

5. Conclusions

In this study, two out of five adolescents in the Asia-Pacific region used ASC with large variations between the countries as well as by age and sex. Prevalence of ASC in adolescents was negatively associated with country's Gini coefficient and decreased with the increase of country's economic status. These findings underscore the importance of understanding multiple factors that influence adolescents' ASC within each country/region. Interventions to boost ASC tailored to the local context will have the potential to contribute to increasing levels of physical activity and ultimately improving the health and wellbeing of adolescents, including those living in the Asia-Pacific region.

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Ethical approval

In each of the participating countries, the GSHS received ethics approval from the Ministry of Education or a relevant Institutional Ethics Review Committee, or both. Only adolescents and their parents who provided written or verbal consent participated. As the current study used retrospective publicly available data, we did not need ethics approval from any Institutional Ethics Review Committee.

Conflict of interest

None to declare.

Authors' contributions

Uddin and Khan were involved in the conception and design of the study, and extraction and collation of data from the GSHS database. Uddin and Khan analysed the data. Uddin, Mandic, and Khan interpreted the data. Uddin, Mandic, and Khan drafted the article, and approved the final version to be published.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jth.2019.100637.

References

Aguilar-Farias, N., Martino-Fuentealba, P., Carcamo-Oyarzun, J., Cortinez-O'Ryan, A., Cristi-Montero, C., Von Oetinger, A., Sadarangani, K.P., 2018. A regional vision of physical activity, sedentary behaviour and physical education in adolescents from Latin America and the Caribbean: results from 26 countries. Int. J. Epidemiol. 47, 976–986.

Aibar Solana, A., Mandic, S., Generelo Lanaspa, E., Gallardo, L.O., Zaragoza Casterad, J., 2018. Parental barriers to active commuting to school in children: does parental gender matter? J. Transport. Health 9, 141–149.

Aubert, S., Barnes, J.D., Abdeta, C., Abi Nader, P., Adeniyi, A.F., Aguilar-Farias, N., Andrade Tenesaca, D.S., Bhawra, J., Brazo-Sayavera, J., Cardon, G., Chang, C.-K., Delisle Nyström, C., Demetriou, Y., Draper, C.E., Edwards, L., Emeljanovas, A., Gába, A., Galaviz, K.I., González, S.A., Herrera-Cuenca, M., Huang, W.Y., Ibrahim, I.A.E., Jürimäe, J., Kämppi, K., Katapally, T.R., Katewongsa, P., Katzmarzyk, P.T., Khan, A., Korcz, A., Kim, Y.S., Lambert, E., Lee, E.-Y., Löf, M., Loney, T., López-Taylor, J., Liu, Y., Makaza, D., Manyanga, T., Mileva, B., Morrison, S.A., Mota, J., Nyawornota, V.K., Ocansey, R., Reilly, J.J., Roman-Viñas, B., Silva, D.A.S., Saonuam, P., Scriven, J., Seghers, J., Schranz, N., Skovgaard, T., Smith, M., Standage, M., Starc, G., Stratton, G., Subedi, N., Takken, T., Tammelin, T., Tanaka, C., Thivel, D., Tladi, D., Tyler, R., Uddin, R., Williams, A., Wong, S.H.S., Wu, C.-L., Zembura, P., Tremblay, M.S., 2018a. Global Matrix 3.0 physical activity Report Card grades for children and youth: results and analysis from 49 countries. J. Phys. Act. Health 15, S251–S273.

Aubert, S., Barnes, J.D., Aguilar-Farias, N., Cardon, G., Chang, C.-K., Delisle Nyström, C., Demetriou, Y., Edwards, L., Emeljanovas, A., Gába, A., Huang, W.Y., Ibrahim, I.A.E., Jürimäe, J., Katzmarzyk, P.T., Korcz, A., Kim, Y.S., Lee, E.-Y., Löf, M., Loney, T., Morrison, S.A., Mota, J., Reilly, J.J., Roman-Viñas, B., Schranz, N., Scriven, J., Seghers, J., Skovgaard, T., Smith, M., Standage, M., Starc, G., Stratton, G., Takken, T., Tammelin, T., Tanaka, C., Thivel, D., Tyler, R., Williams, A., Wong,