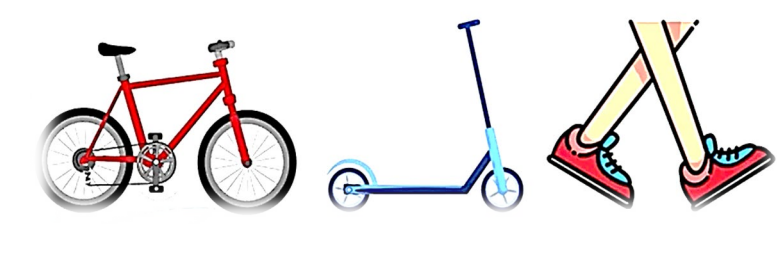


# Analysis of Physiological Responses of Children to Active Travel

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## Background

Physical and mental health of children in Austria is declining. The World Health Organization (WHO) recommends at least 1 hour of daily physical activity, however, a substantial proportion of children fail to achieve.



Concept of "Active Travel" to promote physical activity and overall well-being of children.

Lack of quantitative understanding of the impacts of "Active Travel" on children, especially direct, objective evidence of physiological responses to active travel at the trip level.

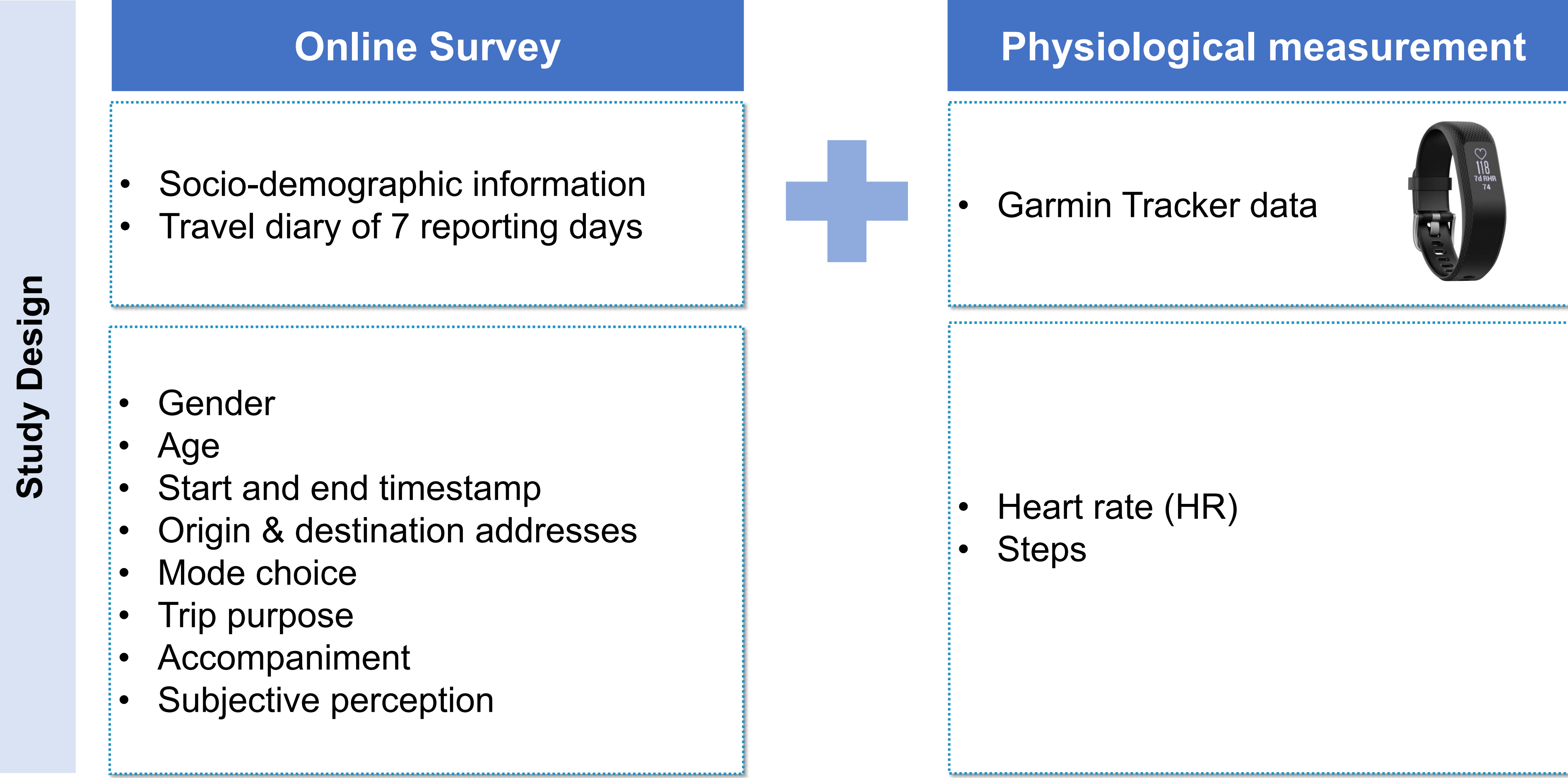
## Objective and Contributions

This research investigates the relationship between active travel and children's physiological responses in trips. In this research, heart rate is selected as the physiological objective indicator.

- Reveals how different levels of active travel usage affect heart rate of children in trips.
- Identifies the factors that influence children's heart rate during trips.

## Methodology

### Mixed survey with physiological measurement



Data collection during April and May 2023: **70 children** (average age of 13) from **3 schools** in Austria, **7 consecutive days** per child

- 1,146 Trips
- 28,206 Records (1 data per minute)

## Mixed-effects Models

Four mixed linear models were developed using a stepwise method, integrating four types of independent variables for predicting physiological responses (Heart rate).

The models incorporated both fixed and random effects to model variation between individuals and within individuals across the repeated measurements.

### Model Formulation

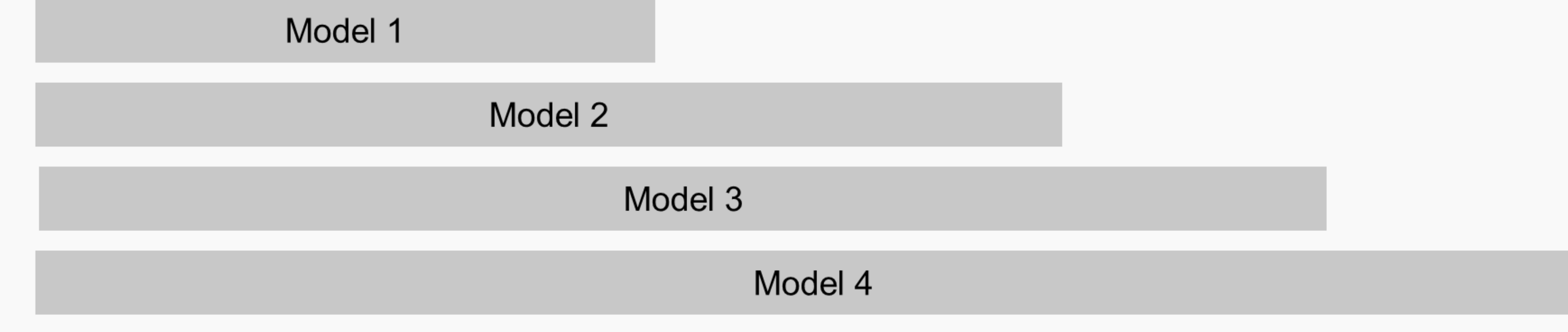
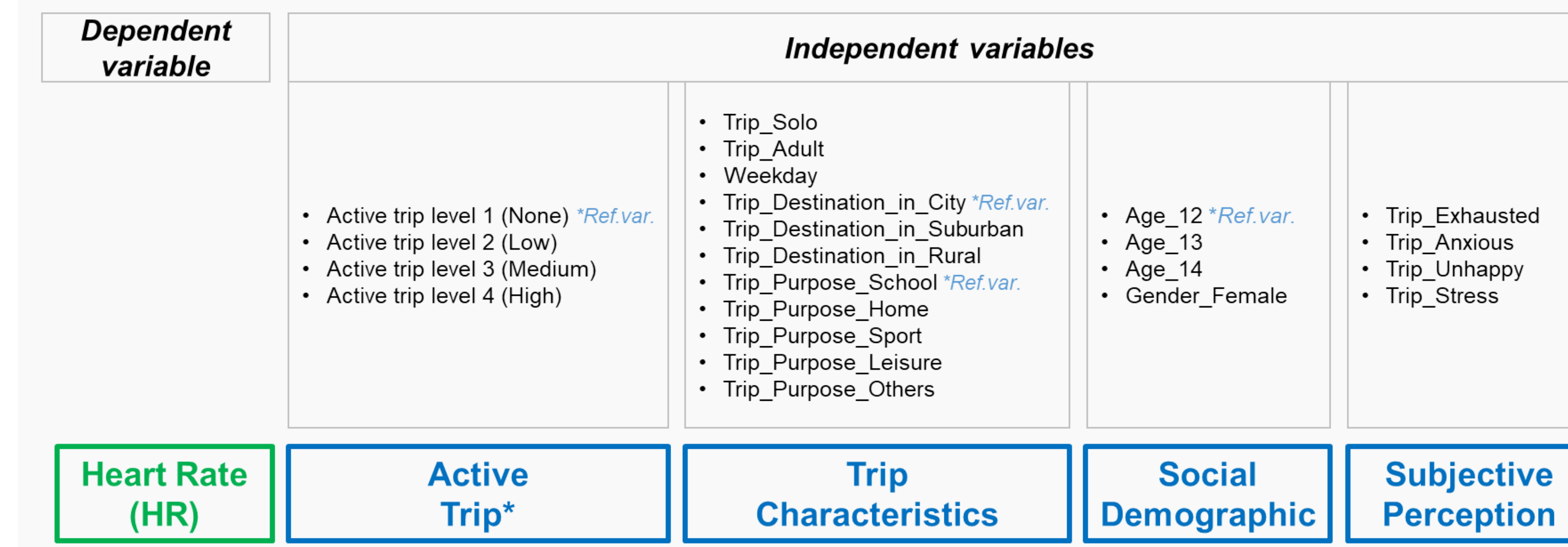
$$Y_{ij} = \beta_{0j} + \beta_1 x_{1j} + \dots + \beta_m x_{mj} + e_{0ij} \quad (1)$$

$$\beta_{0j} = \beta_0 + u_{0j} \quad (2)$$

Where:

- $Y_{ij}$  = physiological measurement (heart rate value)  $i$  of individual  $j$
- $\beta_{0j}$  = intercept of individual  $j$
- $x_{mj}$  = exposure variable  $m$  of individual  $j$
- $\beta_m$  = model coefficient for variable  $m$
- $\beta_0$  = a fixed component
- $u_{0j}$  = specific component of individual  $j$
- $e_{0ij}$  = error

### Model Development

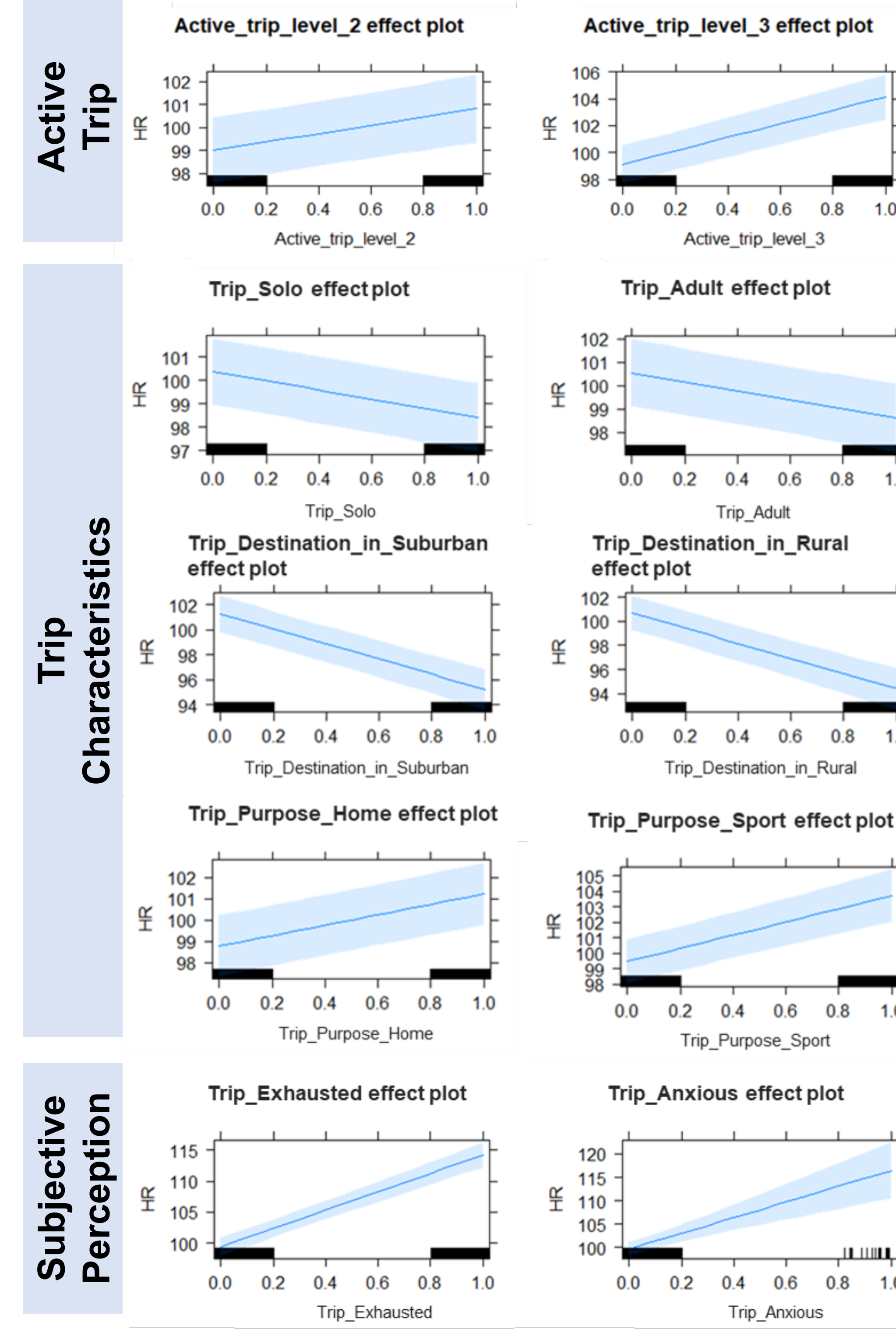


\*4 Levels of Active Trip were defined according to the time share of using active travel modes (Walking, Bike, Kick-scooter and e-Bike) in each trip: Level 1 (None), time share = 0%; Level 2 (Low), time share < 50%; Level 3 (Medium), time share >= 50%; Level 4 (High), time share = 100%.

Fit Statistics	Model 1	Model 2	Model 3	Model 4
R <sup>2</sup>	0.17	0.19	0.2	0.22
AIC	239793.4	238946.9	238953.3	238358.2
Model p-value	< 0.001	< 0.001	< 0.001	< 0.001

## Results and Discussion

### Fixed effects (Model 4)



### Significant association between

- Higher level of active trip engagement leads to higher physical effort and cardiovascular activity.
- The result indicates that regardless of mode of transport, as the mode is increasingly utilized, the physical intensity increases.

### Impacts of subjective perception

- Exhaustion, anxiety, and stress during trips have negative effects on heart rate.
- Unhappiness has negative effects on heart rate and disinterested behaviour.
- The results provide evidence that perceived stress and anxiety significantly influence children's heart rates during travel.

### Impacts of social factors on heart rate

- The presence of adults during trips is associated with higher heart rates, suggesting that adults' companionship seems to have a positive effect on children's heart rates.
- Compare to solo travel, travelling with peers has a positive effect on heart rate.
- The results align with previous studies on the positive impact of social interactions on children's physiological responses.

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